REQUEST FOR PROPOSAL 016203

PART 1 - PROCUREMENT MATERIALS INCLUDING ADDENDA 1 TO 10

KEEYASK GENERATING STATION PROJECT

GENERAL CIVIL WORKS

DECEMBER 5, 2013 **WITH ADDENDA 1-10**

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SUMMARY OF REQUEST FOR PROPOSAL 016203

This Request for Proposal for the General Civil Works for Manitoba Hydro's Keeyask Generating Station is comprised of two parts:

PART 1 - PROCUREMENT MATERIALS
Part 1 addresses the procurement process as follows:

a) Instructions to Proponents
b) Form of Proposal
c) Part 1 Forms and Appendices

PART 2 – CONTRACT DOCUMENTS
Part 2 consists of Volumes 1 to 3 which include the documents that will form Manitoba Hydro Contract 016203 for the General Civil Works between Manitoba Hydro and the successful Proponent.

Volume 1:

a) Articles of Agreement
b) General Specification
c) Terms and Conditions of Payment
d) ECIS Obligations

Volume 2:
Technical Specification

Volume 3:
Appendices

In addition, all or relevant parts of the successful Proponent's completed Form of Proposal (called the “Contractor’s Submission in Contract 016203) are intended to be included in and will form part of Contract 016203.

KEEYASK GENERATING STATION
GENERAL CIVIL WORKS
REQUEST FOR PROPOSAL 016203

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DEFINITIONS

DEFINITIONS

The following capitalized terms, when used in Part 1 of this Request, shall have the following ascribed meanings:

"Commercial Terms"	Shall have the meaning ascribed to it in Subsection 5.3 Required Changes to Commercial Terms in the Instructions to Proponents
"Early Contractor Involvement Team" or "ECI Team"	The collaborative association involving Manitoba Hydro, the Project Designer and the Contractor selected through this Request which is to be developed and used for the Keeyask Generating Station Project in accordance with terms of the ECI Team Agreement.
"ECIS Obligations"	Shall have the meaning ascribed to it in Subsection 12.2.1 Early Contractor Involvement Services Obligations in the Instructions to Proponents.
"Form of Proposal"	The document of the same name included in Part 1 of this Request that is required to be completed by the Proponent in responding to this Request.
"General Civil Works"	All of the various work and services to be done, executed and performed by the General Civil Works Contractor during Phase I and Phase II of the Keeyask Generating Station Project as set out in the General Civil Works Contract.
"General Civil Works Contract"	The agreement contemplated to be entered into between Manitoba Hydro and the General Civil Works Contractor for the work and services to be done and materials and equipment to be furnished pursuant to this Request, in the form of contract attached as Volume 2 to this Request, including the Articles of Agreement, General Specification, Terms and Conditions of Payment, ECIS Obligations, Technical Specification, those extracts from the General Civil Works Contractor's Submission that Manitoba Hydro elects at its discretion to include in the agreement, and all appendices and attachments expressly named in Section 3 of the Articles of Agreement at the time of execution as forming part of said agreement.
"General Civil Works Contractor"	The party or parties named as such in the General Civil Works Contract and its or their legal personal representatives, successors and assigns.
"Keeyask Generating Station Project"	This part of the Keeyask Project consists of temporary cofferdams, ice boom, south access road, expansion accommodations for an additional 1500 workers (Main Camp Phase 2), the permanent hydroelectrical station and related works, including all dams, dykes, channels, excavation and roads, and transmission lines, all of which, if built, will contribute approximately 695 megawatts to Manitoba Hydro's integrated power system.
"Keeyask Infrastructure Project"	This part of the Keeyask Project consists of the infrastructure construction work and services required for the proposed Keeyask Generating Station Project including a 25 kilometre two-lane, all-weather gravel road (North Access Road), the Looking Back Creek bridge, the Startup Camp near the junction

	of PR 280 and the North Access Road, the site preparation and the sewer and water for the Main Camp Phase 1 and Phase 2, the Main Camp Phase 1 and all camp support facilities and equipment.
"Keeyask Project"	The proposed project that consists of the Keeyask Infrastructure Project and the Keeyask Generating Station Project.
"Mandatory Meetings"	Shall have the meaning ascribed in Section 4 MANDATORY MEETINGS of the Instructions to Proponents.
"Manitoba Hydro"	Manitoba Hydro, its successors and assigns.
"Other Contractor"	A contractor, consultant or supplier engaged by or through Manitoba Hydro in connection with the Keeyask Project, other than the General Civil Works Contractor and those engaged by or through the General Civil Works Contractor.
"Phase I"	The collaborative detailed design phase of the Keeyask Generating Station Project to be performed by the ECI Team with particular scopes of work for the Project Designer as set out in its design services agreement with Manitoba Hydro and for the General Civil Works Contractor as set out in the ECIS Obligations.
"Phase II"	The construction phase of the Keeyask Generating Station Project to be performed by the General Civil Works Contractor pursuant to the General Civil Works Contract and coordinated with the work and services of Other Contractors by Manitoba Hydro as project manager.
"Project Designer"	Hatch Ltd.
"Proponent"	As the context requires, any party or parties responding to this Request.
"Proposal"	The Form of Proposal, as completed by a Proponent and submitted to Manitoba Hydro in response to this Request.
"Request"	This Request for Proposal 016203 including Part 1 Procurement Materials and Part 2 Contract Documents and all documents attached to or incorporated by reference herein.
"Site"	The geographic location and immediate vicinity where the Keeyask Generating Station Project is to be constructed for Manitoba Hydro as further described in Section 9 SITE LOCATION AND ACCESS of the Instructions to Proponents.
"Submission Close"	Shall have the meaning ascribed to it in Section 1 INVITATION of the Instructions to Proponents.
"Technical and Schedule Requirements"	Shall have the meaning ascribed to it in Subsection 5.2 Proposed Changes to the General Civil Works in the Instructions to Proponents.

NOTE: Where the context so requires, the singular number shall be read as if the plural were expressed and the masculine or neuter gender as if the masculine, feminine or neuter were expressed.

References to "sole discretion" and similar terms in Part 1 of this Request in relation to Manitoba Hydro mean in the sole and absolute discretion of Manitoba Hydro acting subjectively in the best interest of Manitoba Hydro.

INSTRUCTIONS TO PROPONENTS

KEEYASK GENERATING STATION	DECEMBER 5, 2013
GENERAL CIVIL WORKS	WITH ADDENDA 1- 10

KEEYASK GENERATING STATION
GENERAL CIVIL WORKS
REQUEST FOR PROPOSAL 016203

INSTRUCTIONS TO PROPONENTS

1 INVITATION

TO:
Bechtel Barnard EllisDon JV c/o Bechtel Infrastructure Corporation
Dragados-Ledcor JV
Peter Kiewit Infrastructure Co.
UAB JV c/o URS Corporation

Manitoba Hydro is seeking Proposals from capable and well-experienced heavy civil construction contractors with considerable relevant prior experience and proven success completing work of similar scale and complexity in remote northern locations, under conditions and to achieve results such as those described below.

This Request is open only to those contractors expressly invited by Manitoba Hydro, at any time prior to the Submission Close, to submit a Proposal. Proposals submitted by any party other than those expressly invited to submit a Proposal will be rejected.

Manitoba Hydro wishes to obtain four competitive Proposals from the Proponents invited above. However, it is recognized that a Proponent may require a change in its proposed partners or members, or in the legal name and structure of the Proponent from that identified by a Proponent in response to Manitoba Hydro's Request for Pre-Qualification 016122 Keeyask Generating Station Project - General Civil Works.

A Proponent may not change its partners, or its joint venture, consortium or other members, or add to or supplement them, or change its legal structure, without Manitoba Hydro's prior written consent, which consent may be refused without reasons or may be given subject to such terms and conditions as Manitoba Hydro at its sole discretion considers to be in the best interest of Manitoba Hydro. Such terms and conditions may include rejecting any request by a Proponent for an extension to the Submission Close and requiring that such Proponent place additional parent company guarantees, letters of credit or other performance security. The Proponent has the onus to convincingly demonstrate to Manitoba Hydro's complete satisfaction that any such requested change will result in a reconstituted Proponent that is comparable or more experienced and qualified than it was when it first received this Request.

If one or more of the above invited Proponents notifies Manitoba Hydro that it will not submit a Proposal or a proposed reconstituted Proponent is refused by Manitoba Hydro, Manitoba Hydro reserves the right at its sole discretion to invite another party to become a Proponent in its place and compete for the General Civil Works Contract. The terms and conditions under which a new Proponent, if any, may be invited to submit a Proposal in response to this Request are at the sole discretion of Manitoba Hydro.

In no event will Manitoba Hydro receive Proposals from more than four Proponents.

If Manitoba Hydro invites a new Proponent, or a newly reconstituted Proponent, to submit a Proposal, that Proponent will not be required to attend the Mandatory meetings described in Section 4 of this Request but, instead, shall attend a site meeting at a date scheduled by Manitoba Hydro and shall receive a copy of any transcribed notes referred to in Section 4 that were distributed to all Proponents.

Pursuant to the Joint Keeyask Development Agreement (the "JKDA") signed May 29, 2009 between Cree Nation Partners (consisting of Tataskweyak Cree Nation and War Lake First Nation), York Factory First Nation, Fox Lake Cree Nation and Manitoba Hydro regarding potential development of the Keeyask Project, it was agreed that the Manitoba Bid Depository will be made available for First Nations groups to submit subcontract bids for consideration by Proponents. As noted in Section 25.2 of the Instructions to Proponents, Proponents are strongly encouraged to obtain, review and consider such subcontract bids prior to finalizing their Proposals.

The closing time for receipt of Proposals under this Request is:

16:00:00 hours Manitoba local time
December 5, 2013
(date and time hereinafter jointly referred to as the "Submission Close")

The closing time for receipt of subcontract bids into the Bid Depository as provided for in Subsection 25.2 – Bid Depository of the Instructions to Proponents is:

16:00:00 hours Manitoba local time
November 28, 2013

Proposals must be submitted electronically through MERX (www.merx.com) in a searchable .pdf electronic format, with appropriate bookmarks and organization to allow for easy navigation.

NOTE: Manitoba Hydro at its sole discretion may, by addenda issued at any time (including immediately prior to the Submission Close), change the Submission Close. A Proposal received after the Submission Close will not be opened or considered for evaluation by Manitoba Hydro unless, after evaluating, ranking and negotiating the General Civil Works Contract with Proponents who submitted a Proposal prior to the Submission Close, Manitoba Hydro at its sole discretion decides not to award the General Civil Works Contract based on any of the Proposals received prior to Submission Close.

Manitoba Hydro assumes no risk, makes no guarantee, warranty or representation whatsoever, and shall have no responsibility or liability whatsoever, including in contract or in tort, for or in connection with:

(a) the timely delivery of any information or documentation, including, without limitation, this Request, whether by mail, by courier, by hand, by MERX, or otherwise, in connection with this Request;
(b) the timely receipt of any Proposals, revisions, amendments, notice of withdrawals, or any other information or documentation from any Proponent or any person, or;
(c) the working order, functioning or malfunctioning, of any electronic information system (including MERX).

All matters arising out of or related to the procurement process under this Request [including, without limitation, contracts (if any) arising therefrom] shall be subject to, interpreted, performed and enforced in accordance with the laws of Manitoba without regard to Manitoba or Canadian law governing conflicts of law, even if the Proponent may be resident of or domiciled in any other province or country. The Proponent and Manitoba Hydro hereby irrevocably attorn to the exclusive jurisdiction of the Court of Queen's Bench of Manitoba, Winnipeg.

NOTE: This Request is not a legal offer but only an invitation to provide information. This Request is subject to an evaluation and negotiation process as set out in Section 5 PROPOSAL EVALUATION PROCESS of these Instructions to Proponents.

The Proponent assumes the entire risk of failure of MERX and Manitoba Hydro for any reason whatsoever to receive some or all of its Proposal prior to the Submission Close, whether such failure results from any of the above causes or any other problems or issues. The Proponent is advised that it may encounter delays or failures if attempting to transfer all of its Proposal information through MERX shortly before the Submission Close and is strongly encouraged to submit its Proposal sufficiently in advance to ensure its entire Proposal is submitted prior to the Submission Close.

2 PURPOSE OF THIS REQUEST

This Request is in furtherance to Manitoba Hydro's Request for Pre-Qualification 016122 Keeyask Generating Station Project - General Civil Works.

Provided that Proposals acceptable to Manitoba Hydro are received in response to this Request, it is Manitoba Hydro's intention, through the process set out in Section 5 PROPOSAL EVALUATION PROCESS of these Instructions to Proponents, to award a General Civil Works Contract to the General Civil Works Contractor for the following work and services in relation to the Keeyask Generating Station Project:

Phase I - Participation in Early Contractor Involvement - the General Civil Works Contractor will act as one of three primary participants in Manitoba Hydro's Early Contractor Involvement (ECI) Team to review constructability and provide input into value engineering exercises that will assist the Project Designer and Manitoba Hydro to optimize the final design, schedule and cost, and prepare for construction of the General Civil Works for the Keeyask Generating Station Project; and

Phase II – the General Civil Works Contractor will construct the General Civil Works for the Keeyask Generating Station Project.

A detailed description of the Contractor's required performance for Phase I and Phase II of the Keeyask Generating Station Project are set out in these Instructions to Proponents below.

3 GENERAL INTERPRETATION

Defined words and phrases used in Part 1 Procurement Materials of this Request have the meaning ascribed to them in the Definitions section at the front of this Request, or as expressly defined elsewhere in Part 1 of this Request. The Proponent shall also have regard to the definitions set out in the General Specification of the draft General Civil Works Contract documents set out in Part 2 of this Request for defined terms relevant to performance of the General Civil Works. All references to days or weeks in this Request shall mean calendar days or calendar weeks, as applicable. Headings are used for convenience only, and they shall not affect the interpretation or meaning of the clauses, terms and conditions in this Request.

4 MANDATORY MEETINGS

NOTE: Except for re-constituted or new Proponents as contemplated in Section 1 INVITATION of the Instructions to Proponents, Manitoba Hydro will not consider a Proposal from a Proponent who has not participated in the Mandatory Meetings as set out below.

Each Proponent shall attend the following meetings:

(a) Mandatory kick-off meeting - June 27th, 2013, in Winnipeg
(b) Mandatory site meeting (Days 1-3) at Keeyask:
  i) Bechtel Barnard EllisDon JV - July 8-10, 2013
  ii) Peter Kiewit Infrastructure Co. - July 11-13, 2013
  iii) UAB JV - July 15-17, 2013
  iv) Dragados-Ledcor JV - July 18-20, 2013

(all of the above collectively referred to as the "Mandatory Meetings").

Proponents will be required to sign-in at the Mandatory Meetings, confirming the legal name of the entity that will be submitting a Proposal in response to this Request which shall correspond to the legal name of the entity that submitted an Information Package in response to Manitoba Hydro's Request for Pre-Qualification 016222 – General Civil Works Keeyask Generating Station Project. Subject to changes in the legal name of a Proponent that may be allowed by Manitoba Hydro pursuant and subject to Section 1 INVITATION of the Instruction to Proponents, the Proponent's Proposal shall reflect the legal name of the Proponent as set out on the sign-in sheet of the Mandatory Meetings.

The Proponent shall, on or before **June 11, 2013**, send notification with the name and number of all persons that will be attending the mandatory site meeting to:

Mr. Keith Freeman, P. Eng
Contract Engineer, Keeyask Construction and Engineering Department
Telephone: (204) 360-5943
E-mail address: kfreeman@hydro.mb.ca

Individuals representing the Proponent will be accommodated for the mandatory site meeting. The Purchaser will provide accommodations and travel according to the table below.

The Proponent is required to arrange travel and accommodations, at their own cost, to Thompson and from Gillam. The Proponent's representatives will be required to provide their own safety footwear while on the Site and any other areas designated by Manitoba Hydro.

The agenda for the mandatory site meeting will include:

Date	Time	Activity
Mandatory kick-off meeting		
June 27	08:30 to 16:30	Meeting with Manitoba Hydro in Winnipeg.
Mandatory site meeting:		
Day 1	07:00 – 09:30	Pickup at hotel in Thompson and travel to Site.
	09:30 – 18:00	Orientation, lunch and helicopter tour of Site and South side.
		Meals and accommodations provided at Site camp.
Day 2	07:00 – 18:00	Site tour - Contractor's input required to define agenda.
		Meals and accommodations provided at Site camp.
Day 3	07:00 – 15:00	Travel to Kettle for plant tour, inspect core samples, lunch in Gillam.
		Depart from Gillam Airport

Transcribed notes of each mandatory site meeting may be prepared by Manitoba Hydro and distributed to all Proponents.

In submitting a Proposal, the Proponent shall be deemed to have made a careful examination of the Site to satisfy itself as to the working conditions, the nature and extent of the General Civil Works, risks associated therewith, the obstacles or difficulties that may be encountered, and any other matters and things necessary for a proper understanding of the General Civil Works, the Site and the conditions under which the General Civil Works will be performed.

Responses to enquiries from one or more Proponents arising from the Mandatory Meetings, that in the sole judgment of Manitoba Hydro, require a correction to any of the General Civil Works Contract documents will be made via an addendum to this Request. A Proponent shall not be entitled to rely on any information or interpretation received at the Mandatory Meetings, including any transcribed notes prepared, unless that information or interpretation is providing in writing by Manitoba Hydro via an addendum to this Request.

5 PROPOSAL EVALUATION PROCESS

5.1 Overview

This Request is not intended to constitute, or to be interpreted as, a call for tenders. This Request is not a legal offer and is not a tender process.

Manitoba Hydro seeks competitive Proposals from Proponents and desires, through an evaluation process and, if necessary, limited negotiation, to award a

General Civil Works Contract for the performance of the General Civil Works to its preferred Proponent.

Proposals submitted in response to this Request are for information, evaluation and discussion purposes. A Proposal submitted by a Proponent shall not be binding upon Manitoba Hydro or the Proponent; however, Manitoba Hydro will consider the Proponent's Proposal submitted to be its best offer for performance of the General Civil Works on the Commercial Terms (as defined in Subsection 5.3 below) of the draft General Civil Works Contract documents set out in Part 2 of this Request as at Submission Close. To allow comparison of Proposals on the same Commercial Terms, pursuant to the process described in Section 5.3 Manitoba Hydro will, on or about November 1, 2013, by addendum issue amended Commercial Terms that incorporate those requested changes by Proponents to the draft Commercial Terms attached to this Request that Manitoba Hydro is prepared to make in order to obtain Proposals based on the same Commercial Terms from all Proponents. By submitting a Proposal, the Proponent agrees to the terms and conditions set out in this Request.

5.2 Proposed Changes to the General Civil Works

Manitoba Hydro includes in this Request its intended Technical Specification, proposed construction schedule, drawings and supporting documents and information for the General Civil Works all of which are collectively referred to as the "Technical and Schedule Requirements" for inclusion in the final form of the General Civil Works Contract.

The Proponent may make a proposal to modify any portion of the Technical and Schedule Requirements, including with respect to scope, schedule or methodology, with the exception of the following:

(a) Temporary and principal structure footprint, heights or alignments
(b) Turbine water passage geometry
(c) Sturgeon spawning work restriction must be observed (May 15 to July 15)
(d) All aspects in the Environmental Protection Plan
(e) Mobilization to Site no earlier than June 27, 2014
(f) First concrete not before May 1, 2016
(g) Terms and conditions of the Keeyask Generating Station Project labour agreement (Burntwood/Nelson Agreement)

The Proponent shall review the Technical and Schedule Requirements. On or before **August 30, 2013**, the Proponent shall submit to Manitoba Hydro on the Form of Proposal page provided at Section 13 - Project Change Proposals, any proposed modifications that the Proponent wishes to make to the Technical and Schedule Requirements. Any such proposals shall be received on a confidential basis by Manitoba Hydro.

At Manitoba Hydro's sole discretion, a confidential meeting may then be scheduled with any one or more Proponents who have proposed modifications to the Technical and Schedule Requirements of the intended General Civil Works Contract.

Manitoba Hydro will review any proposed modifications to the Technical and Schedule Requirements and inform the Proponent **on or before September 24, 2013** of any of the Proponent's proposed modifications that are approved to be included in the Proponent's Proposal. Any proposals submitted by a Proponent in its Proposal with respect to modifications to the Technical and Schedule Requirements shall be received on a confidential basis by Manitoba Hydro until final award of the General Civil Works Contract.

5.3 Required Changes to Commercial Terms

Manitoba Hydro includes in this Request its intended Articles of Agreement, General Specification, Terms and Conditions of Payment and ECIS Obligations Terms and Conditions of Agreement, all of which are collectively referred to as the "Commercial Terms" for inclusion in the final form of the General Civil Works Contract.

(a) Proponent's Mandatory Revisions

The Proponent shall review the Commercial Terms. **On or before July 26, 2013**, the Proponent shall submit to Manitoba Hydro on the Form of Proposal page provided at Section 14 - Commercial Terms Change Proposals, any items that would prevent the Proponent from either submitting a Proposal or from entering into a General Civil Works Contract (the "Proponent's Mandatory Revisions"), and the Proponent's proposed modifications including revised contractual language that would be acceptable to the Proponent.

The Proponent's Mandatory Revisions shall be received on a confidential basis by Manitoba Hydro.

At Manitoba Hydro's sole discretion, one or more confidential meetings may be scheduled with any one or more Proponents on such Proponent's Mandatory Revisions. Following any such confidential meeting(s) and after consideration of all Commercial Terms Change Proposals received from all Proponents, Manitoba Hydro will issue, by way of addendum **on or about September 20, 2013**, a revised draft form of General Civil Works Contract set out in Part 2 of this Request incorporating changes that Manitoba Hydro is prepared to accept.

On or before October 4, 2013, Proponents will have one further opportunity to submit to Manitoba Hydro on the Form of Proposal page provided at Section 14 – Commercial Terms Change Proposals, any further Proponent's Mandatory Revisions the Proponent considers to have arisen based upon this amended and re-

issued draft form of General Civil Works Contract and the Proponent's proposed modifications including revised contractual language that would be acceptable to the Proponent.

After considering these further Proponent's Mandatory Revisions and potentially following further confidential discussions with one or more Proponents, Manitoba Hydro will issue final Commercial Terms for inclusion in the final form of the General Civil Works Contract in an addendum issued to Proponents **on or before November 1, 2013.**

On or before **November 25, 2013** the Proponent shall submit Form of Proposal 14A confirming that the Proponent is prepared to enter a General Civil Works Contract with Manitoba Hydro on the Commercial Terms as issued on **November 1, 2013** if it is the successful Proponent or advising that the Proponent is not prepared to enter into a General Civil Works Contract with Manitoba Hydro on the Commercial Terms as issued on **November 1, 2013** and therefore will not proceed to submit a Proposal.

(b) Proponent's Requested Revisions

On or before August 16, 2013 (if the Proponent has not already done so), the Proponent shall submit to Manitoba Hydro on the Form of Proposal page provided at Section 14 - Commercial Terms Change Proposals, any items that the Proponent requests Manitoba Hydro to consider changing (the "Proponent's Requested Revisions"), but which if not made by Manitoba Hydro will not prevent the Proponent from submitting a Proposal without qualifications or exceptions to the Commercial Terms, or from entering into a General Civil Works Contract on the Commercial Terms as issued by Manitoba Hydro. For each of the Proponent's Requested Revision, the Proponent should include the proposed modifications, the reasons why such modifications would benefit Manitoba Hydro, and the Proponent's proposed modifications including revised contractual language.

At Manitoba Hydro's sole discretion, one or more confidential meetings may then be scheduled with any one or more Proponents to discuss their respective Proponent's Requested Revisions. Whether Manitoba Hydro elects to amend the Commercial Terms for all Proponents to address any one or more of the Proponent's Requested Revisions shall be at Manitoba Hydro's sole discretion.

(c) Proposals to be based on Final Form of Commercial Terms

Following the process described in Subsection 5.3(a) and 5.3(b) above, Manitoba Hydro will amend and issue the final form of the Commercial Terms.

All Proponents shall prepare, price and submit their Proposals on the basis of the final form of the Commercial Terms of the General Civil Works Contract as

issued by Manitoba Hydro **on or before November 1, 2013**. Manitoba Hydro will not thereafter entertain negotiations with respect to Commercial Terms of the intended General Civil Works Contract unless exceptions to this general intention are communicated to all Proponents prior to Submission Close.

5.4 Submission of Joint Venture/Consortium Agreement, if Applicable

In addition, **on or before July 15, 2013**, in the event the Proponent is comprised of more than one entity or member, the Proponent shall submit to Manitoba Hydro the Proponent's fully signed joint venture or consortium agreement setting out the participation and terms and conditions upon which all members comprising the Proponent will perform the General Civil Works Contract, if awarded to the Proponent.

5.5 Project Site Visit

Manitoba Hydro may wish to visit an active project of the Proponent to witness how the Proponent's methodologies are being implemented. **On or before July 15, 2013** the Proponent shall submit such information in Form of Proposal Section 33 – Project Site Visit to Manitoba Hydro.

5.6 Bilateral Meetings between Manitoba Hydro and Proponents

In addition to the Mandatory Meetings, prior to Submission Close, Manitoba Hydro at its sole discretion may schedule one or more meetings with Proponents. Such meetings may be called by Manitoba Hydro on its own initiative or in response to a request from a Proponent for a meeting. Meetings may be held in person, by teleconference, by videoconference or any combination thereof. Meetings in person will generally be held in Winnipeg, Manitoba but may also be held in other locations if mutually convenient and accessible for Manitoba Hydro and Proponents.

Manitoba Hydro at its sole discretion may develop a written protocol to be followed for meetings, copies of which will be made available to Proponents in advance of meetings.

At its sole discretion, Manitoba Hydro may schedule and conduct such meetings as joint meetings with all Proponents or as a series of separate meetings with each Proponent. Where joint meetings are scheduled, Manitoba Hydro may schedule such meetings to commence as a joint meeting with all Proponents to address matters of common interest, followed by a private meeting with each Proponent to address matters unique to that Proponent or questions that the Proponent may have regarding the Request or the proposed General Civil Works Contract which it may wish to keep confidential, and conclude with another joint meeting to recap and summarize matters discussed of common interest to all Proponents. Where separate meetings are held, either as part of the aforesaid joint meeting process or on their own, Manitoba Hydro will use reasonable effort to provide each

Proponent with an approximately equal opportunity in terms of the number and length of such meetings, but it is up to each Proponent to determine for itself whether and the extent to which they wish to take advantage of such meetings.

The meeting agendas may include any and all such matters as Manitoba Hydro and Proponents may wish to raise in such meetings, including:

(a) Issues relating to the Request, including the Form of Proposal and Appendices, the Commercial Terms, and the General and Technical Specifications;
(b) Issues relating to coordination of the General Civil Works Contract with Voith Hydro Inc. and the Other Contractors;
(c) Issues related to environmental matters;
(d) The ECIS Obligations and proposed ECIS Team Agreement;
(e) Information from Manitoba Hydro on any material changes proposed or contemplated by Manitoba Hydro to the Request or other documents incorporated into the Request; and
(f) Potential alternate Proposals or options that Proponents may wish to discuss with Manitoba Hydro to obtain from Manitoba Hydro a preliminary indication of whether such alternate Proposals or options will even be considered by Manitoba Hydro as potentially acceptable or will be rejected outright.

Manitoba Hydro may have the Project Designer, technical advisors and others (including legal counsel) present as Manitoba Hydro may require to facilitate discussion at that meeting or to advise Manitoba Hydro.

Manitoba Hydro will use reasonable efforts to distribute to all Proponents any new documents or information provided by Manitoba Hydro to any Proponent during a meeting, save and except documents or information that may be related to one or more items raised by a Proponent that are in response to questions submitted and marked as “In Commercial Confidence” or otherwise considered by Manitoba Hydro to be “confidential” to that Proponent, such as potential alternates and options that the Proponent may wish to discuss with Manitoba Hydro.

Proponents acknowledge and agree that during the meetings between Proponents and Manitoba Hydro certain information and documents may be provided by Manitoba Hydro to one or more Proponents that is not provided to all Proponents, including for such reasons as outlined above, and Proponents waive any and all rights to contest or protest based on the fact that information or documentation may have been received by one or more competing Proponents that was not provided to them.

To facilitate free and open discussion at any of the above-described meetings, Proponents acknowledge that any comments or opinions provided by or on behalf

of Manitoba Hydro during any meeting, including in respect to anything said or any matter raised by a Proponent or any document or information provided by a Proponent, whether prior to or during the meeting, will not in any way bind Manitoba Hydro. Minutes of meetings will not be circulated to Proponents. If a Proponent wishes to rely upon anything said or indicated at a meeting, the Proponent must verify that the document, matter, information or statement upon which it wishes to rely upon is confirmed in an addendum to this Request is issued by Manitoba Hydro to Proponents. If Proponents request an addendum be issued to confirm they may rely upon a document, matter, information or statement that was provided during a meeting, they shall do so in writing and provide details as to why they require such an addendum. Manitoba Hydro is not required to comply with the request and whether to issue an addendum is at the sole discretion of Manitoba Hydro. No statement, consent, waiver, acceptance, approval or anything else said or done in any meeting by any personnel, consultants or advisors of or to Manitoba Hydro shall amend or waive any provision of the Request, Commercial Terms, Technical and Schedule Requirements or any other documents incorporated into this Request, or be binding on Manitoba Hydro, the Project Designer or their personnel, consultants or advisors, or be relied upon in any way by Proponents, except if, and only to the extent expressly confirmed in writing, in an addendum issued to the Request pursuant to Section 30 ADDENDA of the Instructions to Proponents.

5.7 Evaluation

Proposal evaluations will begin upon Submission Close.

Evaluation will commence by confirming a Proponent's Proposal does not take exception to any of the final form of Commercial Terms as issued by Manitoba Hydro prior to Submission Close. If a Proposal does take exception, it will automatically be ranked after those Proposals that take no exception.

Proposals will be evaluated by a committee established for that purpose by Manitoba Hydro. The size and composition of, and appointments to, the evaluation committee is at Manitoba Hydro's sole discretion. The evaluation committee has the authority to establish its own methods and procedures for the review, evaluation and scoring of Proposals. The evaluation committee may be assisted by and consult with various technical consultants and advisors, including engineering, financial, legal and other consultants and advisors. The advisors will assist the evaluation committee by reviewing Proposals with respect to their general compliance with the Request, with the Technical and Schedule Requirements, and with the Commercial Terms. If, in undertaking this review the advisors identify deficiencies or deviations from the Technical and Schedule Requirements or Commercial Terms they will advise the evaluation committee.

In its evaluation and scoring of Proposals, the evaluation committee may consider any and all reports, comments and recommendations from and by the advisors in

relation to any and all parts of the Proposals. Without limiting the ability of the evaluation committee to establish its own procedures for the review, evaluation and scoring of Proposals, the evaluation committee may utilize the advisors in any way that the evaluation committee at its sole discretion considers will be of assistance to the evaluation committee. In evaluating Proposals, the evaluation committee can take into account the results of reference checking of Proponents, their team members and their key personnel, as well as the experience of evaluation committee members and advisors with the Proponent, its team members and their key personnel. Final scoring of each Proposal will be performed by the evaluation committee.

Manitoba Hydro reserves the right, in its sole discretion, to complete its evaluation of Proposals earlier than the anticipated timeframe or to extend the completion of the evaluation period beyond the specified timeframe without notification to Proponents unless the specified date of award of the General Civil Works Contract will be significantly impacted.

Upon completion of evaluations, Proponents will be notified as to the outcome.

Evaluations will be based on the total economic impact of the Proponent's Proposal to the Keeyask Generating Station Project ("Best Value"). Best Value will be calculated by adjusting the Proponent's Initial Target Price (increasing or decreasing) by various factors, identified below:

(a) Proponent's GA&O percentage identified at Form of Proposal Section 22 – Contractor's Fee Components
(b) Proponent's Profit percentage identified at Form of Proposal Section 22 – Contractor's Fee Components
(c) Proponents' Construction Methodology – the Proponent's proposed detailed methodology to complete the General Civil Works as well as the Proponent's value engineering proposal and schedules will be evaluated to ensure the Proponent's labour and equipment productivity and all schedule durations (critical and non-critical path) are realistic and achievable.
(d) Early In-Service Benefit per Unit (up to a maximum of 1 year) = $100,000/day/unit for the Proponent's proposed in-service dates for each Unit as compared to the unit in-service dates shown in Manitoba Hydro's Proposed Construction Schedule in **Appendix I** set out in Part 1 of this Request.
(e) Late In-Service Penalty per Unit = $200,000/day/unit for the Proponent's proposed in-service dates for each Unit as compared to the unit in-service dates shown in Manitoba Hydro's Proposed Construction Schedule in **Appendix I** set out in Part 1 of this Request.
(f) Quantity of Peak Craft Dorms Adjustment = $52,728/craft room required by the Proponent above the craft rooms proposed to be made available by Manitoba Hydro in the Keeyask Camp as set out at Form of Proposal Section 27 - Contractor's Camp Requirements.

(g) Quantity of Peak Supervisor Dorms Adjustment = $124,062/supervisor room required by the Proponent above the supervisor rooms proposed to be made available by Manitoba Hydro in the Keeyask Camp as set out at Form of Proposal Section 27 - Contractor's Camp Requirements.

(h) Camp Operating Cost Adjustment = number of Proponent's proposed person days set out in Form of Proposal Section 26 – Estimated Total Labour Force multiplied by $135/day/person

(i) Financing Adjustment – The Proponent's proposed cash flow as set out at Form of Proposal Section 24 – Cash Flows will be adjusted to 2013 dollars at Manitoba Hydro's real weighted cost of capital (5.40%)

(j) Proponent's Cost of a one year Purchaser imposed delay as set out at Form of Proposal Section 34 – Delay Cost.

(k) Sensitivity Analysis of Changes to Quantities - Manitoba Hydro will add the impact of cost changes associated with quantity adjustments to various structures.

(l) Escalation Adjustment = The total cost of the Proponent's proposed escalation mechanism in 2013 dollars as set out at Form of Proposal Section 23 – Escalation Methodology.

(m) Adjustments to the ECI Team – Manitoba Hydro will add team members to the Proponent's Proposed ECI team, as required, to ensure the Proponent's team will deliver Phase I of the General Civil Works successfully.

(n) Adjustments to the Site Project Team – Manitoba Hydro will add team members to the Proponent's proposed site construction team, as required, to ensure the Proponent's team will deliver Phase II of the General Civil Works successfully.

(o) All things being reasonably equal, Manitoba Content will be considered in the evaluation of Proposals received.

(p) Sensitivity analysis of proposed changes to the Burntwood/Nelson Agreement.

(q) Proponent's requirements for additional electrical supplies as set out at Form of Proposal Section 29 – Power Requirements.

(r) Results of the Proponent Interviews pursuant to Section 5.8 of these Instructions to Proponents, with the methodology and amount of any price adjustment for the results of interviews determined internally within Manitoba Hydro prior to the review and evaluation of Proposals.

(s) Breakage fee as proposed by the Contractor as set out in Form of Proposal Section 34A – CONTRACT BREAKAGE FEE FOR TERMINATION FOR CONVIENIENCE.

5.8 Amendments/Further Information/Clarifications

After Submission Close, a Proponent may only submit further documentation or information in response to specific requests for clarification or additional information from Manitoba Hydro. Any such requests for clarification or additional information may be made orally or in writing, and may result from

meetings with the Proponent, including during the interview with a Proponent on its Proposal.

During evaluation of Proposals Manitoba Hydro reserves the right to request and consider from a Proponent such additional, missing, incomplete or other information or documentation as Manitoba Hydro considers appropriate in order to fully understand and evaluate the technical and financial merits of the Proposal. Manitoba Hydro may also convene further meetings with one or more Proponents to address any such additional information that may be provided in response to such a request and take the results into account in its evaluation and ranking of Proposals.

Following the ranking of Proposals, Manitoba Hydro reserves the right to request and require a Proponent as a condition of continuing such negotiations to amend its Proposal, which amendments shall be submitted in accordance with Section 37 WITHDRAWAL/AMENDMENT OF PROPOSAL of these Instructions to Proponents.

In respect of any and all matters in this Section 5.8, Manitoba Hydro shall have no duty or obligation to advise any other Proponent of any of the same, or to request them to provide additional information or to vary their Proposals as a result of any of the same.

5.9 Proponent Interviews

After Submission Close, a one day interview will be scheduled for each Proponent, its team members and key personnel with Manitoba Hydro, at a time and location to be determined by Manitoba Hydro.

The agenda and procedure for the interview is at the sole discretion of Manitoba Hydro and may include some or all aspects of the Proponent's Proposal and such other matters as Manitoba Hydro considers appropriate to understand the Proposal and to assess the background, experience and abilities of the Proponent, its team members and key personnel.

During the interview, each Proponent will be invited to make a short presentation to highlight key aspects of its Proposal. The presentation will be limited to the materials submitted in the Proposal.

The interview will include a question and answer period as well as a general discussion of the Keeyask Project and the Proponent's Proposal. Manitoba Hydro may at its discretion direct specific questions to particular individuals and/or hold separate interviews with specific representatives responsible for discrete parts of the Proposal (such as environmental, QA and QC, labour plan, benefits to First Nations, etc.) to assist Manitoba Hydro to better understand those parts of the

Proponent's Proposal and any specific commitments that may be made by the Proponent in its Proposal.

In evaluating and scoring the results of the interview Manitoba Hydro will give preference to the Proponent and its team members in whom Manitoba Hydro has through the interview gained the highest confidence in their understanding of the Project, that they will meet environmental, safety, QA, QC, labour, First Nations and other objectives, and in their ability to successfully complete the General Civil Works Contract on schedule to the contract requirements and at the lowest overall cost to Manitoba Hydro. Manitoba Hydro will also give preference to such other factors as it considers appropriate to distinguish the results of one interview from another, including:

(a) Focus and relevance of the presentation.
(b) Execution and management philosophy.
(c) Demonstrated ability to provide significant value during provision of the Phase I services.
(d) Corporate culture and commitment to safety, environmental protection and QA/QC.
(e) Extent to which the team demonstrates to Manitoba Hydro that they have a clear understanding of the environmental protection expectations of regulatory authorities and Manitoba Hydro, and their actual experience with the relevant regulatory authorities for projects in the Province of Manitoba.
(f) How well the team functioned during the interview as an indication of the cohesiveness of the team and how well it will as an integrated, cohesive team successfully manage construction and other issues that may arise during execution of the contract.
(g) The nature and types of questions, if any, asked by representatives of the Proponent and the extent to which they demonstrate their understanding of the Project.
(h) Responses by the representatives of the Proponent team to questions from Manitoba Hydro.
(i) Extent to which commitment to management, planning and organization is demonstrated.
(j) Responses to questions arising out of reference checking.

Depending on the information provided during the interviews, Manitoba Hydro may on its own initiative check further references to confirm information provided during the interview and take the results into account in its evaluation and scoring of Proposals.

If, during the interview, Manitoba Hydro obtains specific information which relates to a specific submission requested by this Request that is evaluated separately, Manitoba Hydro may also take that information into account in evaluating that part of the Proposal. Manitoba Hydro will use its own discretion

and judgement in considering how to address potential overlap between the scoring of individual submittal requirements and the scoring of the results of the Proponent interview.

5.10 Negotiation Process

Following the evaluation of Proposals, Manitoba Hydro intends to select its preferred Proponent, in order of the ranking of Proposals, to commence final negotiations, if any; however, notwithstanding the timelines set out below, Manitoba Hydro without obligation or liability to any Proponent shall be free to terminate negotiations with any Proponent at any time and enter into negotiations with its next preferred Proponent.

Such negotiations are intended to deal strictly with matters arising from evaluation of the Proponent's Proposal. This may include with respect to the Proponent's proposed plans, strategies, schedules and other matters proposed, including possible modifications to the Proponent's Initial Target Price for performance of the General Civil Works. The intention is to finalize the most promising plan and schedule for performance of the General Civil Works to be included in the final form of General Civil Works Contract. Commercial Terms shall not be subject to negotiation during this period.

Manitoba Hydro expects to be in a position to finalize the General Civil Works Contract with its preferred Proponent commencing **January 7, 2014**. All terms, conditions, technical requirements and supporting documents of the General Civil Works Contract must be finalized between the parties by **January 21, 2014**. Given this short time frame for finalizing the contract, if it appears to Manitoba Hydro that extensive negotiations may be required or if in Manitoba Hydro's sole discretion sufficient progress towards finalizing the contract is not progressing as quickly and on terms acceptable to Manitoba Hydro as Manitoba Hydro requires, Manitoba Hydro will terminate discussions and negotiations with its preferred Proponent and begin negotiations with the Proponent who placed second in the evaluation.

During this period, Manitoba Hydro intends to conduct any discussions and negotiation required with respect to any selected Proposals through an intensive and condensed process. Such process will require a selected Proponent to make its commercial, technical and legal representative(s) with sufficient decision-making authority available in Winnipeg on a dedicated basis during this period as may be required to discuss and conclude a final General Civil Works Contract within the timelines specified by Manitoba Hydro.

5.11 Requirement for Contract

Manitoba Hydro and its preferred Proponent must evidence any agreement to proceed with and to perform the General Civil Works by the execution of a formal written agreement. Unless and until such a formal written agreement is executed,

there shall be no legal or other binding obligations created on the part of either party with respect to the General Civil Works or any matter related to the General Civil Works or this Request.

A draft form of the General Civil Works Contract documents is set out in Part 2 of this Request. In addition, those relevant parts of or extracts from the successful Proponent's Proposal that Manitoba Hydro at its discretion requires to be included in the General Civil Works Contract shall be incorporated into the final form of General Civil Works Contract (referred to as the "Contractor's Submission" in the General Civil Works Contract documents), as well as any modifications agreed to by Manitoba Hydro and its preferred Proponent during their discussions and negotiations.

5.12 Manitoba Hydro Privilege/Discretion

Notwithstanding any industry or trade custom or past practices of Manitoba Hydro to the contrary, Manitoba Hydro does not represent that it will necessarily, and Manitoba Hydro shall not be obliged to, accept any Proposal, accept the lowest priced Proposal, or be precluded from accepting any Proposal or other offer or negotiating further in respect of any Proposal submitted. Manitoba Hydro reserves the right, and the Proponent acknowledges and agrees by submitting a Proposal in response to this Request that Manitoba Hydro has the right to reject any or all Proposals, for any reason, or to negotiate or accept any Proposal which Manitoba Hydro in its sole discretion deems advantageous to itself.

Manitoba Hydro reserves the right in its sole discretion to:

(a) modify this Request, or extend the Submission Close, at any time;
(b) accept, waive or reject any non-compliance or irregularity including, without limitation, the right to accept, waive or reject non-compliance or irregularity with the proposal process and/or the submission requirements of this Request, even if such non-compliance would otherwise render the Proposal void or incapable at law of consideration or acceptance;
(c) cancel this Request for any reason whatsoever, either before or after the Submission Close and regardless of whether or not any Proposals have been received;
(d) re-issue a request for proposals or other procurement process for all or any part of the General Civil Works referred to in this Request, at any time, including after the Submission Close; or
(e) if all Proposals are rejected, negotiate the proposed General Civil Works Contract with any Proponent or with anyone else with whom Manitoba Hydro wishes to negotiate for the General Civil Works, and for a price and on terms and conditions acceptable to Manitoba Hydro.

6 SCHEDULE OF PROPOSAL AND AWARD PROCESS

Manitoba Hydro anticipates the following schedule with respect to the evaluation and negotiation process contemplated in Section 5 PROPOSAL EVALUATION PROCESS:

Description of Schedule Item	Date
Issuance of Request for Proposal 016203	June 11, 2013
Proponent's Notification of Representatives to attend Mandatory Site Meeting	June 11, 2013
Submittal of signed Joint Venture Agreement, if applicable and Form of Proposal Section 33 – Project Site Visit	July 15, 2013
Mandatory Meetings	June 27 to July 20, 2013
Proponent's Submission of Proposed Mandatory Revisions to Commercial Terms	July 26, 2013
Proponent's Submission of Proponent's Requested Revisions to Commercial Terms	August 16, 2013
Re-Issuance of Commercial Terms of draft General Civil Works Contract by Manitoba Hydro	August 23, 2013
Proponent's Submission of Proposed Changes to the Technical and Schedule Requirements and Form of Proposal Section 29 – Power Requirements	August 30, 2013
Proponent's Submission of further Proposed Mandatory Revisions to Commercial Terms	September 6, 2013
Manitoba Hydro's Notification to Proponent of Acceptable Changes to the Technical and Schedule Requirements for Proposal Purposes	September 24, 2013
Manitoba Hydro's issuance of final Commercial Terms of draft General Civil Works	November 1, 2013
Submittal of Form of Proposal Section 14A indicating confirmation of Commercial Terms.	November 25, 2013
Submission Close for Receipt of Proposals	December 5, 2013
Presentations/Interviews with Selected Proponents	December 16-20, 2013
Manitoba Hydro's Review of Proposals Complete (approximate)	January 3, 2014
Commencement of Negotiations with Preferred Proponent	January 7, 2014
Mandatory Completion of Negotiations with Preferred Proponent	January 21, 2014
Negotiations with Second Ranked Proponent, if required	January 22- February 4, 2014
Proposed Award of General Civil Works Contract	March 4, 2014

The above dates are subject to change at any time in Manitoba Hydro's sole discretion.

7 PROJECT BACKGROUND

Manitoba Hydro is a Crown Corporation and the Province of Manitoba's major energy utility. The majority of electricity is produced by hydroelectric generating stations having a total capacity of approximately 5000 MW. In order to continue to provide a highly reliable supply of power at low cost, Manitoba Hydro continuously plans for future sources of generation. More information on Manitoba Hydro including the corporate strategic plan and potential future projects, including the Keeyask Project, can be found on our website at www.hydro.mb.ca.

As described in detail below, the Keeyask Project will consist of the proposed hydroelectric generating station and related works, including all dams, dykes, channels, excavations and roads which, if built, will contribute approximately 695 megawatts to Manitoba Hydro's integrated power system.

On May 29, 2009, Cree Nation Partners (consisting of Tataskweyak Cree Nation and War Lake First Nation), York Factory First Nation, Fox Lake Cree Nation and Manitoba Hydro signed the Joint Keeyask Development Agreement (the "JKDA") regarding potential development of the Keeyask Project. The JKDA sets out the terms and conditions upon which the Keeyask Hydropower Limited Partnership, of which the above parties are limited partners, shall proceed with the development of the Keeyask Project. The JKDA document is available on Manitoba Hydro's website.

The Keeyask Project is comprised of the Keeyask Generating Station Project and the Keeyask Infrastructure Project.

The Keeyask Infrastructure Project has been reviewed and approved by the appropriate federal and provincial authorities. It includes construction of a 25 kilometre two-lane, all-weather gravel road (North Access Road), the Looking Back Creek bridge, the Start-Up Camp near the junction of PR280 and the North Access Road, the site preparation and the sewer and water for the Main Camp and all the camp support facilities and equipment. Environmental Act License No. 2952 was received for the Keeyask Infrastructure Project work on March 8, 2011.

The proposed Keeyask Generating Station Project is comprised of the development of the generating station itself including all temporary and permanent structures needed for the generation and transmission of electricity as well as additional temporary and permanent infrastructure required to support construction and operation of the generating station. The Keeyask Generating Station Project has not yet received approval from applicable federal and

provincial authorities. Such approvals are anticipated to be received on approximately June 27, 2014. No final decision has been made by Manitoba Hydro to proceed with the Keeyask Generating Station Project.

Manitoba Hydro is contracted by the Keeyask Hydropower Limited Partnership to act as project manager to complete the planning, design and engineering and to construct and commission the proposed Keeyask Project including the General Civil Works. If built, the Keeyask Project will be constructed in a manner similar to other hydroelectric generation projects, pursuant to a variety of large and small contracts. Manitoba Hydro has final decision-making authority with respect to all matters arising out of the negotiation and contract award of the General Civil Works and management and oversight of any contract resulting therefrom.

8 PROJECT STATUS

Activities to complete the environmental assessment for the Keeyask Generating Station Project have been completed. The results of the assessment are documented in an environmental impact statement (EIS) that was submitted to Manitoba Conservation and Water Stewardship and to the Canadian Environmental Assessment Agency on July 6, 2012 and a cooperative Federal-Provincial environmental review is currently underway. There will be an environmental protection plan developed for project implementation with which compliance by the General Civil Works Contractor will be required.

Conceptual engineering is near completion with a hand off to the ECI Team for detailed engineering design and construction contract development planned for March, 2014. Many design and arrangement aspects of the structures have been frozen during the conceptual design process for utilization in the environmental licensing process. There will, as a result, be limits on future opportunity to alter certain preliminary design concepts.

The Keeyask Infrastructure Project, including the North Access Road, a 500 person Camp and initial development of the work area, is scheduled to be complete in June of 2014.

9 SITE LOCATION AND ACCESS

The proposed Keeyask Project is located in northern Manitoba on the Nelson River, at the base of Gull Rapids, 185 km northeast of Thompson, Manitoba (the "Site").

9.1 Transportation

This section outlines some of the transportation considerations in the Thompson/Gillam area at the Site. This information is provided as reference only and in no way reflects all transportation considerations and limitations between the General Civil Works Contractor's facilities and Thompson, Manitoba. It shall be the General Civil Works Contractor's responsibility to identify any and all such considerations and limitations that may apply to its ability to deliver and perform the General Civil Works.

The Site is only accessible by road. It is anticipated that the General Civil Works Contractor will transport its labour, work, materials, equipment and supplies to Site entirely by road through Thompson or a combination of road and railway through Thompson and/or Gillam. As outlined in the following sections, there are limitations for both roadway and railway transportation.

9.1.1 Road

The Site is accessible by road from both Thompson and Gillam. The transportation distance to the Site is approximately 210 km and 145 km respectively. Both routes use portions of Provincial Road (PR) 280, which links Thompson and Gillam. PR 280 is a class A-1 Highway. Manitoba Hydro's 24 km long North Access Road links PR 280 with the Site. The North Access Road will be a privately controlled road during construction of the Keeyask Project and will be constructed to meet Manitoba Infrastructure and Transportation Department's ("MIT") A-1 Highway specification.

The maximum oversize load that can be transported on PR 280 is determined by bridges and culverts. Table 1 below identifies specific bridge locations and the corresponding restriction. The route between Thompson and Gillam also has numerous culvert locations which may have a weight restriction. These locations will likely require special consideration by MIT. The General Civil Works Contractor will need to account for the time needed to obtain all necessary transportation permits in its delivery schedule in order to meet the applicable dates set out in the General Civil Works Contract Schedule.

Table 1: Oversize Load Limits

Description	Distance From Thompson	Distance From Gillam	Limiting Factor	Details
Bridge at Burntwood River	0 km	300 km	Controlled by other bridges on route from Thompson to Site	
Bridge at Odei	50 km	250 km	Width Below	Four Span

Description	Distance From Thompson	Distance From Gillam	Limiting Factor	Details
River			Guard Rail (0.66m) 7.35 m Width Above Guard Rail (0.66m) 7.84 m Height 7.3 m	96.16 m (L) x 8.68 m (w) Concrete I-Girder and Steel Truss Bridge
Bridge at Assean River	150 km	150 km	Width Below Guard Rail (0.66m) 7.35 m Width Above Guard Rail (0.66m) 7.84 m Height 7.3 m	Single Span 49.53 m (L) x 8.52 m (w) Steel Truss Bridge
Turn Off to North Access Road	187	113		
Bridge at North Moswakot River	205 km	95 km	Width 10.70 m Height - none	Single Span 28.103 m (L) x 10.70 m (w) Concrete I-Girder Bridge
Bridge Deck at Long Spruce Generating Station	270 km	30 km	Width 8.20m Height - none	Generating Station Deck, Structure restricts width on one side

9.1.2 Rail

The city of Thompson and the town of Gillam have rail access via the Hudson Bay Railway (HBR) which is owned and operated by Omnitrax. This rail line is connected to the CN rail network at The Pas, Manitoba. The General Civil Works Contractor may be able to make arrangements with Omnitrax to transport items from its facilities to Thompson or Gillam by rail, then transport to the Site by truck.

Even if items are transported to Thompson by road it may be advantageous to transport oversize items from Thompson to Gillam by railway due to limitations on PR 280.

Off-loading from rail and reloading onto truck trailer equipment for transportation to the Site will be the responsibility of the General Civil Works Contractor. Neither Thompson nor Gillam siding has a gantry system. The General Civil Works Contractor would be required to arrange for a crane to transfer equipment/materials from rail to truck. Alternatively, the General Civil Works Contractor may investigate establishing a temporary siding location at the junction of the HBR and highway PR 280, which is approximately 100 km in distance from the Site. This would require consultation with and approval by MIT.

9.1.3 Air

There are two airports that can reasonably service the Site. One in the City of Thompson and one in the Town of Gillam.

(a) The Thompson airport has two runways:

i) 06/24 is a 1,768 meter (5,800 ft) long by 46 meter (150 ft) wide asphalt surface. This runway is equipped with an ILS precision approach.
ii) 15/33 is a 1,547 meter (5,077 ft) long by 30 meter (100 ft) wide gravel/asphalt surface. This runway has a non-precision approach.

The airport has a terminal and is subject to landing and parking fees dictated by the operating authority.

Information on this airport is available at: www.thompsonairport.ca

(b) The Gillam airport has one runway:

i) 5/23 is a 1,535 meter (5,034 ft) long by 46 meter (150 ft) wide gravel surface. This runway has a non-precision approach.

The airport has a terminal and is subject to landing and parking fees dictated by the operating authority.

Information on this airport is available at:

http://www.navcanada.ca/ContentDefinitionFiles/Publications/AeronauticalInfoProducts/CanadianAirportCharts/CanadianAirportCharts_current.pdf

10 PROPOSED NON-TRADITIONAL PROJECT DELIVERY MODEL

A challenge facing Manitoba Hydro with respect to achieving optimal project execution is its goal of completing detailed design for the principal structures in time to promptly start construction of the General Civil Works on June 27, 2014 when authorizations are expected to be in place.

Furthermore, Manitoba Hydro generally shares growing national and international industry interest in pursuing better, faster, less costly and less adversarial project delivery methods. Traditional design-bid-build models can fragment owner planning, consultant design and contractor construction processes with little or no early opportunity to collaboratively harness the talents, knowledge, experience and insights of primary project participants to optimize value for the owner, opportunity for incentives, fair compensation to the General Civil Works Contractor, reduce waste and maximize efficiencies.

Manitoba Hydro seeks, through early primary participant involvement on the Keeyask Generating Station Project, the opportunity to collaboratively assess and mitigate risks in a manner that will align primary participant success with project success as well as to determine any additional scope of work items and appropriately allocate responsibility for risks arising out such work items.

11 MANITOBA HYDRO'S EARLY CONTRACTOR INVOLVEMENT PROJECT DELIVERY MODEL - OVERVIEW

Manitoba Hydro has therefore developed its own Early Contractor Involvement (ECI) model for execution of Phase I and Phase II of the Keeyask Generating Station Project which is intended to provide:

(a) the greatest opportunity to achieve a start of construction on June 27, 2014;
(b) early contractor involvement;
(c) formation of a collaborative team for the early planning and the detailed design phase of the Keeyask Generating Station Project to:
    i) address constructability including methods and sequencing;
    ii) contribute value engineering inputs to the detailed design process;
    iii) provide early schedule inputs;
    iv) assess and mitigate construction risks;
    v) provide the General Civil Works Contractor insight into to design requirements to allow for a faster start without a steep learning curve; and;

vi) allow the General Civil Works Contractor to develop key aspects of a comprehensive construction management plan prior to start of construction.

Success in Phase I of the Keeyask Generating Station Project is expected to result in a Best-for-Project, well defined detailed design that contemplates and allows for all of the specific means and methods to be employed by the General Civil Works Contractor in the performance of the General Civil Works.

This methodology is also intended to assist the Project Designer to optimize its talents, and to provide all primary participants in the Keeyask Generating Station Project with a clear understanding of, and opportunity to effectively manage project risks.

The early involvement of a capable and experienced General Civil Works Contractor is intended to result in a thorough understanding of the design of the General Civil Works, a complete development of a sound schedule and comprehensive safety, environmental and construction plans. Additionally, the early involvement of the General Civil Works Contractor will allow for integration into the local communities and the province to maximize the use of the local labour pool, subcontractors and material suppliers.

The activities in Phase I and Phase II may overlap as these are not considered finish-start activities.

12 PHASE I – EARLY CONTRACTOR INVOLVEMENT TEAM

12.1 ECI Team Members

Manitoba Hydro has already engaged the Project Designer. To optimize opportunities for the success of all primary participants in the Keeyask Generating Station Project, Manitoba Hydro now seeks to select a well experienced civil contractor to join Manitoba Hydro and the Project Designer and be the third of three primary members of the Early Contractor Involvement Team for Phase I of the Keeyask Generating Station Project.

12.2 Required Commitments and Agreements

12.2.1 Early Contractor Involvement Services Obligations

As part of the General Civil Works Contract, the General Civil Works Contractor shall be required to comply with the Early Contractor Involvement Services tasks, deliverables and obligations set out in the ECIS Obligations Terms and Conditions of Agreement of the General Civil Works Contract documents (the "ECIS Obligations"). The Proponent is encouraged to read the ECIS Obligations to gain a detailed understanding of the responsibilities and commitments that will

be required of the General Civil Works Contractor in Phase I of the Keeyask Generating Station Project.

The General Civil Works Contractor will be required to provide the ECIS Obligations in a collaborative manner through its approved representatives identified, dedicated and assigned by the General Civil Works Contractor to provide the skills, knowledge and relevant construction related experience necessary to its effective participation in the ECI Team.

The ECIS Obligations will conclude when the detailed design of the Keeyask Generating Station Project is complete and when the General Civil Works Contractor has completed all other tasks and deliverables identified as part of its ECIS Obligations.

Phase I of the Keeyask Generating Station Project and the corresponding ECIS Obligations may overlap with Phase II of the Keeyask Generating Station Project.

12.2.2 Early Contractor Involvement Team Agreement

The General Civil Works Contractor will be asked to collaborate on the preparation and be party to an Early Contractor Involvement Team Agreement (the "ECI Team Agreement") that will outline the understanding of the roles, responsibilities and commitments that will be required of all parties to complete the deliverables of the ECIS Obligations during Phase I of the Keeyask Generating Station Project. Participation in the development of the ECI Team Agreement will be a task of the General Civil Works Contractor as set out in the ECIS Obligations.

The Phase I ECI Team Agreement among Manitoba Hydro, the Project Designer, and the General Civil Works Contractor may be modified to accommodate more or different parties being added, and the term extended to promote further collaboration and efficiency through to the end of Phase II of the Keeyask Generating Station Project.

In the event of conflict between the ECI Team Agreement and the General Civil Works Contract, the terms, conditions, indemnities, liabilities and other provisions of the General Civil Works Contract shall govern and take precedence.

13 PHASE II – CONSTRUCTION

As outlined in this Request and in the draft General Civil Works Contract, it is Manitoba Hydro's intent for the General Civil Works Contractor to implement the deliverables produced during ECI to construct to completion the General Civil Works for the Keeyask Generating Station.

In Phase II, Manitoba Hydro will be prime contractor for purposes of The Workplace Safety and Health Act of Manitoba, and as the project manager, will be responsible for overall project management ultimately responsible for safety at the Site. Manitoba Hydro will employ staff to:

(a) monitor construction activities and progress;
(b) monitor the General Civil Works Contractor's quality control program;
(c) coordinate interfaces between various work packages of Other Contractors and the work of the General Civil Works Contractor;
(d) coordinate the interfaces between the General Civil Works Contractor and the Project Designer;
(e) manage change;
(f) manage the Keeyask Generating Station Project comprehensive schedule;
(g) monitor overall project progress;
(h) enforce compliance with the safety and environmental programs; and,
(i) operate the camp facilities and maintain the Keeyask Project's access roads.

The General Civil Works Contractor will be responsible for all construction activities related to its scope of work as set out in the General Civil Works Contract, including ensuring its work meets the quality standards established in the specifications and drawings, compliance with the interface requirements of the Keeyask Generating Station Project Comprehensive Schedule, and overall construction management of its forces and scope of work. Further, the General Civil Works Contractor will also be responsible for developing and ensuring compliance with its own site-specific safety plan and site-specific environmental management plans, which shall conform to and comply with all requirements of Manitoba Hydro's overall safety plan and environmental management plan for the Keeyask Generating Station Project (or with the General Civil Works Contractor's own requirements whenever its own requirements are more stringent than those of Manitoba Hydro).

The Project Designer will provide technical support during construction, including any design changes, design all value engineering proposals, and maintain Manitoba Hydro's 3D Project Models for the General Civil Works.

14 SCHEDULE OF THE WORK

Manitoba Hydro has identified the following key milestone dates for the General Civil Works for purposes of this Request:

Contract Award	March 4, 2014
Commence Phase I ECIS Obligations	April 1, 2014
Receipt of Environmental Approvals	June 27, 2014
Commence Phase II Construction of General	June 27, 2014

Civil Works	
Completion of Phase I (approximate)	August 2015
First Concrete	May 2016
First Unit In-service Date	November 2019

The above dates are subject to change at any time in Manitoba Hydro's sole discretion.

15 KEEYASK GENERATING STATION CONSTRUCTION SCHEDULE

Manitoba Hydro's construction schedule for the Keeyask Generating Station Project (the "Construction Schedule") is attached to this Part 1 as **Appendix I**. The Construction Schedule will be used to procure and commit other contractors and suppliers to perform aspects of the Keeyask Generating Station Project outside the scope of the General Civil Works.

The Proponent shall prepare an independent construction schedule for the General Civil Works. The objective is to enhance the Construction Schedule with emphasis on net cost savings to Manitoba Hydro, reduced schedule risk for the overall Keeyask Generating Station Project and advanced in-service dates. The Proponent shall include such schedule in its Proposal. Items that must be included in the Proponent's independent construction schedule include:

(a) Mobilization to Site not earlier than June 27, 2014
(b) In-stream work restriction for sturgeon spawning of May 15 to July 15 of every year
(c) Adherence to all durations shown in Manitoba Hydro's Construction Schedule as "by others"
(d) Manitoba Hydro supplied equipment and all work "by others" not to be advanced by more than 12 months
(e) First Concrete not before May 1, 2016

16 PHASE I – DETAILED SCOPE OF EARLY CONTRACTOR INVOLVEMENT OBLIGATIONS

16.1 Detailed Scope of Phase I ECIS Obligations

The detailed scope of the ECIS Obligations required for Phase I of the Keeyask Generating Station Project is set out in the ECIS Obligations Terms and Conditions of Agreement of the General Civil Works Contract.

16.2 ECI Team Member Requirements

The General Civil Works Contractor's representatives designated to participate in the ECI Team during Phase I of the Keeyask Generating Station Project, at a minimum, must meet the following requirements:

(a) a senior member of the Proponent's executive to serve as its representative as a member of the ECI Leadership Team during Phase I as will be provided for in the ECI Team Agreement; and
(b) other designees able to work collaboratively in the ECI Team to provide design assist services on a timely basis and produce the required Phase I deliverables in accordance with the requirements of the ECIS Obligations.

Given their knowledge of the work and participation in the constructability reviews and value engineering, as the ECI Obligations wind down it is contemplated that the senior member and other designees of the General Civil Works Contractor on the ECI Team will transition to the General Civil Works Contract team and be resident at site or in Winnipeg, Manitoba for the execution of the General Civil Works Contract. Proposals should include the Proponent's comments on this and describe how it proposes this transition to take place.

The General Civil Works Contractor will assign named, dedicated personnel to participate as and when required in the collaborative, co-located ECI Team at 500 Portage Avenue, Winnipeg Manitoba, to provide the requisite experience, skills, knowledge and appropriate civil contractor expertise in the areas of:

- Constructability (including river management, site logistics, material processing, earthen structures, rock blasting and excavation, concrete structures, electrical and mechanical installation)
- Construction management plan (including environmental protection plan, safety management plan and quality plan)
- Scheduling
- Estimating
- Risk assessment
- Labour relations

The General Civil Works Contractor will be required to assign additional personnel as required by the ECI Leadership Team and contemplated by the ECIS Obligations to facilitate timely performance of the tasks, deliverables and initiatives developed and undertaken by the ECI Team in Phase I.

16.3 Proposal Submission Requirements for Phase I

The Proponent shall submit completed Form of Proposal Sections 1 to 12 outlining all of the requested information.

The Proponent's Form of Proposal Section 4 – Phase I - ECIS Basis for Compensation shall include the following information:

(a) Mandatory:
  i) All-inclusive rates (exclusive of GST) for each of its representatives proposed to be dedicated to fulfill the ECIS Obligations in Phase I, such that the only additional cost will be Proponent's expenses for direct costs without mark-up only for office furniture, equipment, supplies, courier charges and long distance telephone charges; and,
  ii) An estimate of the expenses (with a complete and exhaustive list of the categories of expenses) for the General Civil Works Contractor's ECI team required to work in Winnipeg from April of 2014 until August of 2015. Note Manitoba Hydro will supply office space in the Project Designer's building at no charge. Space available includes 1333 sq ft. with 6 offices and a reception area and a second area of 1473 sq ft. with 5 offices, a reception area and two small rooms. This includes basic rental only and all costs for furniture, equipment and operation of an office are to be included in the Proponent's expenses.

(b) At the Proponent's Option:
  i) An alternate method and amount of compensation (such as a fixed price) for the ECIS Obligations. If a Proponent elects an option other than an all-inclusive fixed price for completion of all ECIS Obligations, the Proposal shall provide a comprehensive and detailed full breakdown of all fees, costs, overheads, multipliers, expenses and other charges, together with a detailed estimate and estimated total of all compensation to be paid under this option.

Proposed mandatory rates and/or fees or any alternative proposal shall be stated in Canadian currency and shall include all profit, GA&O, customs duties, surcharges, insurance premiums, permit and licence fees, workers' compensation and vacation pay assessments, relocation benefits, living out allowances, multipliers and all other payroll benefits.

17 PHASE II – DETAILED SCOPE OF GENERAL CIVIL WORKS

The scope of Phase II construction of the General Civil Works will include two different types of work:

(a) Material and Equipment Supply, Construction and Installation by the General Civil Works Contractor; and
(b) Materials and Equipment supplied by Manitoba Hydro and Installed by the General Civil Works Contractor.

The General Civil Works will be coordinated by the General Civil Works Contractor through Manitoba Hydro (as Project Manager) with materials and equipment supplied and installed by Other Contractors and Manitoba Hydro itself.

17.2 Material and Equipment Supply, Construction and Installation by the General Civil Works Contractor

The description of this work listed below is provided as a general overview. A detailed scope and requirements of this work are provided in the Technical Specification and the balance of the General Civil Works Contract documents.

(a) Infrastructure
- i) Construction and maintenance of certain roads and infrastructure
- ii) Preparation and maintenance of the General Civil Works Contractor's work area
- iii) Development of General Civil Works Contractor's site offices
- iv) Extension of a construction power service from Manitoba Hydro's provided locations
- v) Supply and installation of materials test lab
- vi) Rock quarry and impervious material borrow, materials management program
- vii) Handling, transporting and storage of certain of Manitoba Hydro's materials and equipment at the Site
- viii) Supplying of certain services to Manitoba Hydro and to other contractors
- ix) Construction and maintenance of the causeways to the impervious and granular deposits N-5 and G-3
- x) Demobilization of General Civil Works Contractor's site office, work areas, lab, and equipment

(b) River Management
- i) Construction, maintenance and removal of Stage I and Stage II cofferdams and associated dewatering works
- ii) Stage I cofferdams construction and maintenance
  - (1) Quarry cofferdam
  - (2) North channel rock groin
  - (3) Powerhouse cofferdam
  - (4) North channel cofferdam
  - (5) Island cofferdam
  - (6) Spillway cofferdam
  - (7) Central dam cofferdam
  - (8) Central dam rock groin
- iii) Stage II cofferdams construction and maintenance
  - (1) Island cofferdam
  - (2) South dam upstream cofferdam

(3) South dam downstream cofferdam
(4) Powerhouse tailrace summer level cofferdam

(c) Powerhouse Complex, Spillway, Transitions and Walls, Dams and Dykes Construction
- i) Excavation of overburden and rock for structures and channels, foundation preparation for earth dam and dykes and concrete structures
- ii) Construction of earth fill dams and dykes
- iii) Supply of cement
- iv) Supply and production of aggregates and rock fill products
- v) Supply and installation of reinforcement steel
- vi) Concrete production and construction of concrete structures including supply and installation of the embedded materials
- vii) Supply and installation of precast concrete beams and wall panels
- viii) Supply and installation of miscellaneous steel such as anchors, highway guardrail, gratings, ladders, handrails, etc.
- ix) Supply and installation of superstructure steel
- x) Supply and installation of wall cladding, roof decking, roofing and flashing
- xi) Supply and installation of station elevators
- xii) Pre-commissioning and commissioning assistance for plant in service

(d) Electrical and Mechanical balance of plant, including, but not limited to:
- i) Fire suppression system equipment and piping (including transformer deluge component)
- ii) Station domestic water system equipment and piping
- iii) Station sanitary sewage system equipment and piping
- iv) Station drainage system equipment and piping (including oil/water separation capabilities)
- v) Compressed air system equipment and piping
- vi) HVAC system equipment and ducting (including controls)
- vii) Raceways, tray, conduit, and associated cable/wiring support hardware
- viii) Grounding and bonding for electrical and communication systems
- ix) MV Electrical distribution equipment and cabling
- x) LV electrical distribution equipment and cabling
- xi) Diesel generator sets and associated equipment
- xii) Battery banks and associated equipment
- xiii) Lighting system (including controls)
- xiv) Communications system equipment and cabling (including data and voice)
- xv) Paging system
- xvi) Electronic safety and security system (including CCTV and alarm)
- xvii) Fire detection and alarm system

xviii) Oil storage and handling systems
xix) Pressure and level instrumentation system
xx) Unit control and monitoring system
xxi) Generator and transformer protection system
xxii) Supply and installation of electrical/mechanical equipment
xxiii) Supply and installation of permanent power and communication lines and appurtenances

17.3 Materials and Equipment Supplied by Manitoba Hydro and Installed by the General Civil Works Contractor

The description of the materials and equipment listed below is provided as a general overview of the items to be supplied by Manitoba Hydro and installed by the General Civil Works Contractor. A detailed scope and requirements of this work are provided in the Technical Specification and the balance of the General Civil Works Contract documents.

(a) Motor Control Centers
(b) Medium Voltage Station Service Equipment
(c) Generator Circuit Breakers
(d) Isolated Phase Bus
(e) Spillway Standby Power Supply
(f) Black Start Standby Power Supply
(g) 600V Switchgear and Switchboard
(h) Generator/Transformer Protective Relaying Equipment
(i) Unit Control and Monitoring System
(j) Trashracks
(k) Intake Bulkhead Gates
(l) Draft Tube Gates
(m) Spillway Stoplogs

Manitoba Hydro's materials and equipment will be supplied to the General Civil Works Contractor at a location agreed to between the Engineer and General Civil Works Contractor within the limits of Work Area A. The transfer point shall be on the delivery vehicle and the General Civil Works Contractor is then wholly responsible for the items from that point until a final completion certificate for the General Civil Works is issued. This includes but is not limited to offloading, handling, transportation, disposal of all packing materials and storage requirements.

17.4 Materials and Equipment Supplied and Installed by Other Contractors and/or Manitoba Hydro

Manitoba Hydro will itself or through Other Contractors supply and install the following materials and equipment identified with respect to the work at the Site and such materials and equipment shall not form part of the General Civil Works under the General Civil Works Contract.

(a) Main camp, catering, first aid, camp maintenance and security services
(b) Turbine and generators
(c) Exciters
(d) Governors
(e) Intake gates, guides and hoists
(f) Spillway gates, guides, hoists, bridges, towers, cladding and gate and gain heaters
(g) Powerhouse crane
(h) Draft tube crane
(i) Spillway stop-log monorail crane
(j) Intake monorail crane
(k) Transmission lines and towers
(l) 138kV disconnects and lightning arrestors
(m) Generator step-up transformers

18 PROPOSAL SUBMISSION REQUIREMENTS FOR PHASE II

18.1 General

The Proponent shall submit completed Form of Proposal Sections 13 to 37 outlining all of the requested information.

18.2 Contract Compensation

Manitoba Hydro seeks in this procurement process to extend fair and balanced opportunities for risk/reward to the General Civil Works Contractor through a Cost Reimbursable, Fee and Target Price form of contract.

The proposed General Civil Works Contract will be administered on an "open book" basis for payment of actual costs for the construction of the General Civil Works while providing an opportunity for the General Civil Works Contractor to earn a fair profit with no hidden profits or undisclosed mark-ups carried in the costs to be reimbursed.

As a result, the compensation under the General Civil Works Contract has been structured to call for the following:

(a) The Proponent is to submit in the applicable Form of Proposal pages its estimate of probable costs to construct and complete the General Civil Works based upon the Proponent's preferred construction methodology and schedule;
(b) The total cost estimate submitted by the General Civil Works Contractor shall be the Initial Target Price for the construction of the General Civil Works;

(c) In accordance with the General Specification and Terms and Conditions of Payment of the General Civil Works Contract, the Initial Target Price may be adjusted during the course of construction of the General Civil Works;

(d) The General Civil Works Contractor's Fee will be comprised of two (2) parts and shall be calculated as follows:

i) Profit – The Proponent is to propose in Form of Proposal Section 22 - Contractor's Fee Components the percentage that will set the Contractor's Profit Percentage that will be applied to the Final Target Price for the Phase II construction of the General Civil works as outlined in the General Specification and the Terms and Conditions of Payment of the General Civil Works Contract.

ii) General Administration and Overhead (GA&O) – The Proponent is to propose in Form of Proposal Section 22 - Contractor's Fee Components the Contractor's GA&O Percentage that will be applied to the Actual Cost of the Phase II construction of the General Civil Works as outlined in the General Specification and the Terms and Conditions of Payment of the General Civil Works Contract;

(e) The Actual Cost of the construction of the General Civil Works will be tracked and the General Civil Works Contractor will be reimbursed for all costs that are certified by the Engineer to be properly incurred in the construction of the General Civil Works in accordance with the General Civil Works Contract;

(f) Upon completion of construction of the General Civil Works and a Final Accounting, Manitoba Hydro and the General Civil Works Contractor will share in any shared savings or cost overruns as outlined in the Terms and Conditions of Payment of the General Civil Works Contract.

18.3 Initial Target Price Breakdown

The Proponent shall complete Form of Proposal Section 21 - Initial Target Price Breakdown that provides the basis of its Initial Target Price for each ITEM in the Bill of Quantities, Prices and Target Price Estimate. One (1) copy of this breakdown shall be provided as a print of the Proponent's estimating software, with details to the level as identified in **Appendix II Sample Level of Detail for Initial Target Price Breakdown** and one copy of the information shall be provided in an excel format matching the categories defined in **Appendix III Excel Format for Initial Target Price Breakdown** set out in Part 1 of this Request.

The Proponent shall list and define all abbreviations and organize the breakdown in an easy to follow manner that links all component costs or cost elements to each ITEM. Include summaries for all plant, materials, and labour. The Proponent should use the following groupings when preparing its cost estimate.

Prices shall be divided into three (3) main categories, namely direct costs, indirect costs and contingency.

Broad guidelines for the groupings are:

(a) Direct costs apply to all ITEMS with the exception of ITEM 01 10 05 Indirects. Direct costs shall include:
- i) Mobilization/demobilization including the transportation and set-up of equipment, the initial construction of long term access roads and the initial purchase and set-up (including all electrical/sewage/water and communication connections) of all storage areas, offices and shops.
- ii) Permanent Materials
- iii) Supplies (consumable materials and temporary materials, small tools and supplies) except as noted in indirects below
- iv) Equipment ownership and operational costs
- v) Craft labour
- vi) Subcontracts

(b) Indirect costs shall include;
- i) Project management
- ii) Safety (meetings, material, equipment, reporting)
- iii) Environment (equipment, subcontractors, materials, monitoring and reporting)
- iv) Staff (engineering, supervisory and non-supervisory staff)
- v) Training
- vi) Quality Control
- vii) Contractor's Plant including;
  - (1) Operation and maintenance of shop/warehouse/office facilities identified above
  - (2) Rental/purchase and operation/maintenance of office/lunch/wash trailers at the construction site
  - (3) Temporary construction roads/ramps/laydown areas
  - (4) Project equipment (not attributable to any one ITEM)
  - (5) Fuel depot and explosive magazine
  - (6) Survey equipment and supplies
- viii) Site Administration and Overheads
  - (1) Office costs (including furnishings, hardware, software, IT support, stationary, phone, internet, radios, photos)
  - (2) Travel (flights, taxi, hotel, meals, mileage)
  - (3) Fixed business costs
  - (4) Performance security (all types)
  - (5) Finance expenses
- ix) Variable Costs
  - (1) Professional consulting services
  - (2) Licenses, permits and fees

(3) Administration of Burntwood/Nelson Agreement labour agreement
(4) Insurance
(5) Taxes

(c) Contingency shall include:
i) Job contingent costs matching the value developed in the Proponent's Risk Matrix in Form of Proposal Section 28 - Contingency.

The sum of the direct costs, indirect costs and contingency established in the Proponent's Proposal, will set the Initial Target Price for the construction of the General Civil Works and shall only be modified as outlined in the General Specification and Terms and Conditions of Payment of the General Civil Works Contract.

During negotiations with a preferred Proponent, Manitoba Hydro reserves the right to require the preferred Proponent to provide such additional detail, pricing and backup documentation as Manitoba Hydro may require for the preferred Proponent to convincingly demonstrate to Manitoba Hydro that all direct costs, indirect costs and contingencies for completion of the General Civil Works has been included in the Initial Target Price.

19 DESIGN INFORMATION AND DATA FOR PROPONENTS

19.1 Design Information

The following 3D Project Models are included in the Appendices of the General Civil Works Contract:
(a) Powerhouse Complex;
(b) concrete construction joints in the Powerhouse Complex;
(c) Stage I Cofferdams; and
(d) the overall topography of the area.

The model information is prepared in Bentley Navigator V8 and the Proponent will need to utilize this software package, or another software package that can interact with an i.dgn file format, to undertake a quantity take-off and prepare a construction methodology.

The Appendices also include drawings of the Keeyask structures and reference drawings with details from other projects.

The reference drawings illustrate details that have not yet been through final design but will illustrate the intent that the Project Designer will follow for many of the miscellaneous items in the scope of General Civil Works.

19.2 Data for Proponents

Various investigations have been performed at the Site. Results are summarized in the Data for Proponents set out in the Appendices of the General Civil Works Contract.

19.3 Communication with Turbine Generator Manufacturer

Although some Proponents have expressed interest in contacting Manitoba Hydro's turbine-generator manufacturer for the Keeyask Generating Station Project, Manitoba Hydro has determined that such communications would not be useful for this procurement process. Therefore, Manitoba Hydro advises Proponents that such communications with Voith Hydro Inc. shall not be permitted during the procurement process set out in this Request and Voith Hydro Inc. has been advised to decline requests for discussions with any Proponent.

If any specific information is required by a Proponent from Voith Hydro Inc. in order for that Proponent to submit its complete and best Proposal, the Proponent shall submit its information request to Manitoba Hydro in writing, together with the reasons why such information is required. Manitoba Hydro at its sole discretion will consult with Voith Hydro Inc. as to the availability and timing for obtaining such information. If readily available within a reasonable time period, the information will be made available to such Proponents.

19.4 Concrete Mix Design

The Proponent shall use the concrete mix designs provided in Appendix IV Keeyask Concrete Mix Design set out in Part 1 of this Request in the completion of its Proposal. The rock shown in drawing 7-00195-DE-01210-0004 as highly reactive cannot be used as aggregate for any of the concrete mixes priced by the Proponent in its Proposal.

Following award of the General Civil Works Contract, the General Civil Works Contractor will develop concrete mix designs as set out in the ECIS Obligations Terms and Conditions of Agreement. Sourcing of highly reactive rock for concrete coarse aggregates during Phase I ECIS Obligations will be permitted provided the Contractor's concrete mix design complies with the technical requirements for each of the concrete types as set out in the Technical Specification of the General Civil Works Contract.

Any changes to the concrete mix designs resulting from the Contractor's Phase I ECIS Obligations which are acceptable to Manitoba Hydro will be documented in an Extra Work Order and the Target Price for the Work adjusted accordingly.

20 PERFORMANCE SECURITY

For the duration of the Phase I ECIS Obligations of the General Civil Works Contract, the General Civil Works Contractor will be required to provide Manitoba Hydro with performance security in the form of a letter of credit, in form and with content prescribed by Manitoba Hydro, in the amount of $10,000,000.00.

On the first day of the 19th month after the signing of the General Civil Works Contract, the value of the letter of credit shall be increased to a total value of $100,000,000.00. On October 1 of the year following the placement of 250,000 cubic metres of concrete, the letter of credit will be lowered to $50,000,000 which shall remain in place until the issuance of the final completion certificate for the General Civil Works.

Please see the Terms and Conditions of Payment of the General Civil Works Contract set out in Part 2 of this Request for detailed requirements for the above letters of credit.

21 THE BUILDERS' LIENS ACT

Section 3(3) of The Builders' Liens Act (Manitoba) excludes contracts with Manitoba Hydro respecting hydro-electric generating stations from the application of that Act. Accordingly, Manitoba Hydro will not retain a builders' lien holdback from payments made under the General Civil Works Contract.

22 HYDRO PROJECT MANAGEMENT ASSOCIATION (ASSOCIATION)

It will be necessary for the General Civil Works Contractor to become a member of this Association which is described further in the General Specification of the General Civil Works Contract, and all Subcontractors must become Contractor Associate Members. The Proponent will be required to sign a membership application for the Association as set out at Form of Proposal Section 35 – Hydro Projects Management Association.

A copy of the current Constitution for the Association is included in the Appendices of the General Civil Works Contract.

Before submitting its Proposal, the Proponent should obtain from the Association complete information concerning the Association. The contact person at the Association is:

Mr. Jason Peterson

Acting Managing Director
Hydro Projects Management Association
Telephone: (204) 360-7960
Email: jpeterson@hydro.mb.ca

23 PROJECT LABOUR AGREEMENT

Proponents are advised that the Keeyask Project and the construction of the General Civil Works are subject to the provisions of the Burntwood/Nelson Agreement (BNA) described further in the General Specification of the General Civil Works Contract documents set out in Part 2 of this Request.

The Proponent may obtain from the Association complete information on the current terms and provisions of the BNA, the most recent copy of which is available at http://www.hydro.mb.ca/projects/bna_agreement.pdf. This is the collective agreement under which most labour costs for the construction of the General Civil Works will be payable.

If, prior to Submission Close, the BNA is amended, an addendum to this Request will be issued.

The Proponent shall complete Form of Proposal Section 32 – Potential Changes to the Burntwood/Nelson Agreement outlining any potential changes to the existing agreement that it requests the HPMA attempt to negotiate and the potential Initial Target Price or schedule impact that would result if negotiations were successful. The Proponent acknowledges that its requested changes may not be acceptable to the HPMA or, even if considered desirable by the HPMA, may not be successfully negotiated by the HPMA on the Proponent's behalf.

Certain Letters of Agreement (LOAs) to the BNA are specific to the Wuskwatim Project and do not apply to the Keeyask Project. The Wuskwatim specific LOAs are as follows: 4,12,13,15, 16, 17, 18, 19, 20, 21, 22 and 24. There is no LOA 14.

24 REQUIREMENTS FOR ON-THE-JOB TRAINING

Manitoba Hydro seeks to provide on-the-job training opportunities for contractor employees in accordance with the BNA for its major Northern projects and wishes to explore such possibility for the Keeyask Project, including with respect to the construction of the General Civil Works.

The Proponent is therefore requested to provide in Form of Proposal Section 12 – ECI Methodology for On-the-Job Training, sufficient information of its proposal to develop an on-the-job training plan for the construction of the General Civil Works. References and examples of successful implementation of on-the-job

training plans for comparable projects with similar objectives should be included in the submission and will be taken into account by Manitoba Hydro in the evaluation of the Proposal.

Manitoba Hydro's standard requirements for on-the-job training include:

(a) For designated (apprenticable) trades as set out in the BNA, the number of apprentices employed by any contractor shall be at least the minimum set out in the BNA, and
(b) For non-designated trades as set out in the BNA, the number of trainees employed by any contractor shall not be greater than the maximum as set out in the BNA.

Any on-the-job training opportunities agreed to by Manitoba Hydro and the General Civil Works Contractor shall be set out in the General Civil Works Contract.

25 MANITOBA BUSINESS INVOLVEMENT

25.1 Manitoba Business Involvement - General

Manitoba Hydro encourages and expects any Proponent to actively promote the participation of Manitoba Business, Northern Manitoba Business and Northern Manitoba Aboriginal Business in the construction of the General Civil Works.

"Manitoba Business" is a business which is registered to do business in the Province of Manitoba, and the firm, or its principals, maintains in Manitoba on a continuous basis, the facilities, equipment and staff necessary to perform the work required, or to manufacture, or assemble, or supply, such work.

"Northern Manitoba Business" is a Manitoba Business that is located in the area north of the Manitoba Aboriginal and Northern Affairs Boundary Map set out in the BNA.

"Northern Aboriginal Business" (including an Aboriginal joint venture) means a Manitoba Business:
(a) that is at least 51% owned by an Aboriginal resident(s) or organization(s); and,
(b) that is based in or whose Aboriginal owner has resided within the Northern Affairs Boundary for a cumulative period of 5 years or more.

Manitoba Hydro's decision as to whether any subcontractor or supplier is a Manitoba Business, a Northern Manitoba Business or a Northern Aboriginal Business shall be final.

25.2 Bid Depository

Keeyask Cree Nations and **KCN Businesses**** are or are perceived to be privy to **Insider Information** so are necessarily precluded from directly or indirectly submitting bids or proposals in any **Open Competitive Tendering** process undertaken by Manitoba Hydro for work related to the planning or construction of the **Keeyask Project**, including the General Civil Works which is the subject of this Request.

Prior to award of a General Civil Works Contract, all such KCN parties are further precluded from communicating directly with Proponents who contemplate responding to this Request. Pursuant to the Joint Keeyask Development Agreement (JKDA), Manitoba Hydro has, however, established a Bid Depository mechanism to permit **Keeyask Cree Nations** and/or **KCN Businesses** to submit *sub-contract bids* for consideration by Proponents submitting a Proposal in response to this Request.

All Proponents and any **Keeyask Cree Nation** or **KCN Business** submitting a sub-contract bid to the Bid Depository shall adhere to the following principles and operational requirements:

(a) a **Keeyask Cree Nation** or **KCN Business** shall be prohibited from engaging in discussions or other communications, directly or indirectly, with any Proponent in relation to a proposed or actual sub-contract bid to be submitted to the Bid Depository for consideration. A breach of this requirement or the requirements in paragraph (g) below by a Proponent shall be grounds for Manitoba Hydro, in its sole discretion, to disqualify a Proponent from further participation in this procurement process at any time upon Manitoba Hydro becoming aware of such a breach;

(b) any sub-contract bid submitted to the Bid Depository shall be available for public review, namely, for release by Manitoba Hydro to the Proponents for this Request who request same;

(c) whether a Proponent proposing to submit or submitting a Proposal for the General Civil Works decides to request release of sub-contract bids from the Bid Depository shall be in such Proponent's sole discretion and such Proponent is neither directed nor obligated to do so;

(d) a **Keeyask Cree Nation** or **KCN Business** shall be required to submit its sub-contract bid to the Bid Depository seven (7) days in advance of the Submission Close date for Proposals under this Request in order to have such sub-contract bids considered by Proponents when preparing their Proposals. To ensure the timing of receipt of such sub-contract bids and consideration of such sub-contract bids by interested Proponents, sub-contract bids shall be submitted in electronic format to

KeeyaskPurchasing@hydro.mb.ca. See Section 1 INVITATION of the Instructions to Proponents for sub-contract bid closing times which will apply. Sub-contract bids submitted after the specified time shall not be made available for consideration by Proponents;

(e) Proponents interested in reviewing sub-contract bids submitted to the Bid Depository shall contact the Purchasing Department representative noted in Section 29 ENQUIRIES of the Instructions to Proponents prior to the closing time specified in Section 1 INVITATION for receipt by the Bid Depository of sub-contract bids. Within two (2) hours of closing of the Bid Depository or as soon as practicable thereafter, each Proponent who has expressed an interest in reviewing the **Keeyask Cree Nation** or **KCN Business** sub-contract bids received, if any, shall be provided by Manitoba Hydro with an electronic copy of such bids;

(f) The onus shall be on the **Keeyask Cree Nation** or **KCN Business** to clearly identify the scope of the Work which they offer to perform, and each sub-contract bid submitted to the Bid Depository shall set out the rates or fixed price for which the **Keeyask Cree Nation** or **KCN Business** offers to perform the sub-contract work if selected by a successful Proponent;

(g) The successful Proponent may only communicate, directly or indirectly, with any **Keeyask Cree Nation** or **KCN Business** who has submitted a sub-contract bid to the Bid Depository after a contract for the General Civil Works has been awarded; and,

(h) The terms of any subcontract entered into between the successful Proponent for the General Civil Works and any **Keeyask Cree Nation** or **KCN Business** who has submitted a sub-contract bid to the Bid Depository shall be as mutually agreed to by such parties.

25.3 Post-Award Sub-Contract List

Proponents are further advised that a listing of Keeyask Cree Nations and KCN Businesses who have registered with Manitoba Hydro as available to do sub-contract work on the Keeyask Generating Station Project will be provided by Manitoba Hydro to the successful Proponent within ten (10) days of any award of a contract for the General Civil Works.

**NOTE: Bolded terms used in this Section 25 have the meaning ascribed to them in the JKDA which is available for review on Manitoba Hydro's website at:

http://www.hydro.mb.ca/projects/keeyask/jkd_agreement.shtml

26 MANITOBA CONTENT

All things being reasonably equal, preference shall be given to Proposals which maximize Manitoba Content. For the purposes of this Section, "Manitoba Content" means benefits that provide a positive economic impact to the Province of Manitoba such as manufacturing, labour, materials or transportation provided by Manitoba Businesses, Northern Manitoba Businesses or Northern Manitoba Aboriginal Businesses.

27 CONTRACT AWARD

The following events must occur before Manitoba Hydro will be in a position to proceed with Phase II construction of the General Civil Works pursuant to any General Civil Works Contract awarded:

(a) Receipt by Manitoba Hydro of all approvals and/or licences required under any federal or provincial legislation to proceed with the construction and operation of the Keeyask Generating Station Project, including construction of the General Civil Works;
(b) Receipt by Manitoba Hydro of any required Order-In-Council;
(c) That no deficiency notice shall have been delivered to Manitoba Hydro in respect of the licence for the Keeyask Generating Station Project which has not been resolved;
(d) That there is no order or injunction entered in any action or proceeding in any court of competent jurisdiction, or by any governmental authority having jurisdiction over the enforcement of the applicable laws, making illegal or prohibiting the development of the Keeyask Generating Station Project;
(e) That Manitoba Hydro shall own, or be entitled to own, or have a lease or other authorization to enter the lands upon which the Keeyask Generating Station Project, including the General Civil Works, is to be constructed and will be performed; and
(f) That Manitoba Hydro has received confirmation from its internal financial advisors that the economics of the Keeyask Project and the financial ability of Manitoba Hydro to pay for the Keeyask Project as a whole have not adversely changed between award of the General Civil Works Contract and the date the above conditions have been satisfied.

In the interim period prior to the occurrence of the above events, Manitoba Hydro is prepared to enter into a General Civil Works Contract with the Proponent, if successfully negotiated, upon certain conditions. The General Civil Works Contract shall be a firm commitment to proceed with the Phase I ECIS Obligations while recognizing that proceeding with Phase II construction of the General Civil Works will be conditional upon the events listed above, the

satisfaction or waiver of which by Manitoba Hydro shall be evidenced by the issuance of a Notice to Proceed by Manitoba Hydro to the General Civil Works Contractor for the Phase II construction of the General Civil Works. The Notice to Proceed shall be the General Civil Works Contractor's authorization to commence and proceed with the Phase II construction of the General Civil Works in accordance with the General Civil Works Contract.

The Proponent is advised that the signing of a contract for the General Civil Works is subject to Manitoba Hydro Board approval. The Board of Directors may, in its unfettered discretion, and for any reason whatsoever, withhold such approval.

28 CONFLICT OF INTEREST - DECLARATION OR DISCLOSURE REQUIREMENT

The Proponent represents by submission of its Proposal that it has read the definition of Conflict of Interest included on Form of Proposal Section 2 – Conflict of Interest Declaration/Disclosure and, in accordance with the Declaration included on that page, either is free of any such Conflict of Interest, or, if such an Interest does exist or may arise prior to completion of any General Civil Works Contract awarded to the Proponent hereunder, then the Proponent is, in good faith, to disclose the nature and extent of the real or apparent Conflict of Interest in reasonable detail in the Proponent's Proposal. The Proponent may propose a cure for the disclosed Conflict of Interest in its Proposal, which may include the Proponent's proposed means to mitigate and minimize to the greatest extent practicable such Conflict of Interest. The Proponent shall submit such additional information to Manitoba Hydro as Manitoba Hydro may require to consider the Conflict of Interest.

Manitoba Hydro at its sole discretion reserves the right to waive in writing any and all potential or actual Conflicts of Interest, whether arising out of existing business relationships or otherwise. Any waiver may be upon such terms and conditions as Manitoba Hydro at its discretion may require to satisfy itself that the Conflict of Interest has been appropriately managed, mitigated and minimized, including requiring the Proponent and affected entities to put into place such policies, procedures, measures and other safeguards as may be required by and be acceptable to Manitoba Hydro at its discretion to mitigate the impact of such conflict or existing business relationship. Without limiting the generality of the foregoing, Manitoba Hydro may at its discretion require the Proponent or member of the Proponent team to substitute a new person or entity for the person or entity giving rise to the conflict or has the existing business relationship. Proponents are encouraged to bring all such potential Conflicts of Interest and existing business relationships to the attention of Manitoba Hydro prior to the submission of Proposals so that Manitoba Hydro may be able to advise them of whether a

waiver will be granted and, if so, the terms and conditions (if any) that may be imposed by Manitoba Hydro as a condition of granting a waiver.

If Manitoba Hydro is not satisfied that a Proponent has not adequately disclosed a Conflict of Interest or has not implemented a cure or mitigation protocol that fully mitigates such Conflict of Interest, Manitoba Hydro at its sole discretion may notify the Proponent that it has been disqualified from submitting a Proposal or, if a Proposal is received, reject that Proposal without further or any consideration.

Proponents are advised that Manitoba Hydro has retained the law firms Fasken Martineau DuMoulin LLP (Fasken) and Borden Ladner Gevais LLP (BLG) to provide legal advice on all aspects of this Request and the Keeyask Generating Station Project, including all documents referenced or incorporated into the Request, the negotiation and drafting of any contracts which may result therefrom, general advice on claims and issues arising out of administration and performance of the proposed contract, and all matters or disputes in connection therewith.

By responding to this Request, the Proponent confirms that no conflict exists or will be created as a result of its response to this Request or, if a conflict exists, the Proponent has waived the business or legal conflict, as applicable. If the Proponent is a former client or existing client of either Fasken or BLG, then, by responding to this Request the Proponent consents to Fasken and BLG having acted, and continuing to act, for and on behalf of Manitoba Hydro in respect of this Request and any resulting contract or related matter. For greater clarity, by responding to this Request, the Proponent expressly acknowledges that it is waiving any and all conflicts of any nature whatsoever, including legal or business conflicts, which may now or hereafter exist as a result of either Fasken or BLG having acted, and continuing to act, for and on behalf of the Manitoba Hydro in respect of this Request and any resulting contract or related matter.

29 ENQUIRIES

Enquiries concerning this Request are to be in writing, using the PROPOSAL CLARIFICATION FORM attached to this Part 1 as **Form I**, sent by fax or email only to:

Ms. Lucena Scanlon
Purchasing Department
Manitoba Hydro
P.O. Box 1287
Winnipeg, Manitoba
R3C 2Z1, Canada
FAX: (204) 360-3061

E-mail: lscanlon@hydro.mb.ca

Enquiries should be submitted no later than **November 15, 2013**. Enquiries received after that date and time may at Manitoba Hydro's discretion not be considered and/or answered.

Where a Proponent seeks clarification of this Request in respect of its internal intellectual property or proprietary business information, Manitoba Hydro shall not release such information to other Proponents; however, Manitoba Hydro reserves the right to notify other prospective Proponents of:

(a) Updates or changes to this Request involving correction of errors or ambiguities identified by one or more Proponents;

(b) deviations from any particular constraint or requirement set forth in this Request, as a result of a request for deviation from one or more Proponents that Manitoba Hydro, in its sole discretion, deems acceptable; and

(c) enquiries from a Proponent not involving its intellectual property or proprietary business information that Manitoba Hydro deems necessary or advisable to communicate to other prospective Proponents.

A Proponent shall not be entitled to rely on any response or interpretation or information received in respect of an enquiry unless that response or interpretation was provided via an addendum to this Request.

30 ADDENDA

Manitoba Hydro reserves the right, at any time, to issue addenda changing this Request.

31 ADDITIONAL INFORMATION

If the Proponent requires additional information or explanation concerning any apparent or possible conflict between any of the Instructions to Proponents, the General Specification, the Terms and Conditions of Payment, the ECIS Obligations Terms and Conditions of Agreement, the Technical Specification, Appendices, including the Purchaser's Drawings and Data for Proponents, or any other data furnished or obtained relating to the General Civil Works, the Proponent shall submit a written request for such additional information, explanation or clarification to Manitoba Hydro in accordance with Section 29 ENQUIRIES. Manitoba Hydro reserves the right to issue addenda to this Request if Manitoba Hydro at its sole discretion in response to such requests.

32 FORM OF PROPOSAL

32.1 General Requirements

The Proponent is requested to use the Form of Proposal included in this Request.

The Proponent is requested to provide all information and data requested therein, together with any other information or data that may be requested in this Request. If any Form of Proposal page is found to have insufficient space, the Proponent is requested to attach a sheet or sheets immediately after the applicable page.

The Proponent is encouraged to include in its Proposal thorough and sufficient information concerning matters under consideration. The Proponent shall be responsible for ensuring that its Proposal contains all elements of requested and required information for evaluation purposes.

If the Proponent is uncertain as to the proper manner of completing the Form of Proposal, Manitoba Hydro will, upon request, answer any enquiries relating thereto.

32.2 Responses to Request for Pre-Qualification Deemed Incorporated into Proposals

In addition, all information provided by a Proponent in its Information Package submitted in response to Manitoba Hydro's Request for Pre-Qualification 016122 Keeyask Generating Station Project - General Civil Works shall be deemed incorporated in the Proponent's Proposal and shall be available to Manitoba Hydro for consideration in its evaluation and ranking of Proposals. In its Proposal, the Proponent shall identify to Manitoba Hydro any updates or revisions to any information in its Information Package to ensure such information remains current and correct as of the date of its Proposal submission.

33 LANGUAGE

The Proposal must be prepared and submitted in the English language, including the Form of Proposal and all other submissions requested by this Request.

34 SIGNING OF PROPOSALS

A Proponent is requested to execute its Proposal disclosing the proper legal name of each separate legal entity involved and the office of each individual signing on behalf of each such separate legal entity.

A Proponent which is comprised of more than one legal entity, such as a joint venture or consortium of corporations, is to identify its duly appointed leader in its Proposal.

Where more than one legal entity combines to form a Proponent, all such entities shall be jointly and severally bound by the Proposal submitted, and any resulting General Civil Works Contract awarded.

Manitoba Hydro may require evidence of the authority of any person purporting to sign a Proposal on behalf of a person, firm or corporation, whether as principal, agent or attorney.

35 EVIDENCE OF PROPONENT'S ABILITY, EXPERIENCE, CAPITAL AND PLANT

Manitoba Hydro may require the Proponent to furnish evidence, in addition to any provided by the Proponent in its Proposal, satisfactory to Manitoba Hydro, that the Proponent has the ability, experience, capital and plant required to undertake and perform the General Civil Works successfully, and complete it within the time specified.

Manitoba Hydro may inspect any plant and /or facilities that the Proponent proposes to use for performance of the General Civil Works.

36 VALIDITY OF PROPOSED PRICES

The price proposed for each ITEM or Sub-ITEM in the Proponent's Proposal shall be a reasonable price for such ITEM or Sub-ITEM in the judgment of Manitoba Hydro. The Proponent is requested to propose unit prices and/or estimated costs for the General Civil Works that are not materially unbalanced.

If Manitoba Hydro considers any unit prices and/or estimated costs are materially unbalanced, Manitoba Hydro reserves the right to take this into account in its evaluation of Proposals, including in performing sensitivity analyses of the effect of same on the final cost of the Work. Further, if Manitoba Hydro considers any unit prices, separate price items, multipliers, contingencies or allowances to be excessive, to reflect unbalanced pricing, or to not reasonably reflect the actual cost to the preferred Proponent, Manitoba Hydro during negotiation and finalization of a proposed General Civil Works Contract with that Proponent reserves the right to require the preferred Proponent to describe the Proponent's understanding of the scope of work for those items, and to justify and substantiate to Manitoba Hydro's satisfaction the reasonableness of the proposed unit prices, separate price items, multipliers, contingencies and allowances prior to and as a condition of any award of the General Civil Works Contract. If Manitoba Hydro

thereafter, and prior to award of the General Civil Works Contract, is not satisfied with their reasonableness, Manitoba Hydro at its sole discretion may delete the scope of work to which they apply from the General Civil Works Contract and, instead, contract with Other Contractors to perform that deleted scope of work. In such case, the Initial Target Price for the General Civil Works Contract will be adjusted by deleting the compensation estimated by the Proponent in its Proposal for that deleted scope of work.

37 WITHDRAWAL/AMENDMENT OF PROPOSAL

A Proponent may withdraw its Proposal prior to, or after, the time and date of closing of this Request without penalty. If a Proponent withdraws its Proposal after Submission Close, Manitoba Hydro will not entertain any further submission or proposal from the Proponent until after Manitoba Hydro has either attempted to negotiate and award the General Civil Works Contract with all Proponents who did not withdraw their Proposals, or has cancelled this Request and rejected all Proposals because in Manitoba Hydro's subjective opinion no viable or acceptable Proposal was received.

A Proponent may amend its Proposal at any time prior to Submission Close.

The Proponent should take note that Manitoba Hydro will consider a Proposal submitted prior to Submission Close to be the best available offer from the Proponent. After Submission Close, unless and except submitted in response to a written request by Manitoba Hydro for clarification or additional information during the evaluation of Proposals, no amendments to a Proposal will be taken into account in the evaluation, scoring and ranking of Proposals to identify the preferred Proponent.

If the Proponent is ranked and identified as the preferred Proponent, the Proponent may amend its Proposal at any time prior to award of the General Civil Works Contract to the Proponent. However, if such amendment is not in response to a request for clarification, additional information or changes by Manitoba Hydro, and if such amendment (in content or timing) is not considered acceptable to Manitoba Hydro at its sole discretion, then Manitoba Hydro reserves the right to immediately terminate further negotiations with that Proponent.

Upon any withdrawal of a Proposal or upon written request for an amendment to its Proposal by Manitoba Hydro, a Proponent is requested to provide Manitoba Hydro with written notice of withdrawal or of amendments it is prepared to offer, as applicable, via fax or letter (which letter may be in PDF format as an attachment to an email) as follows:

(a) Any withdrawal/amendment of a Proposal should clearly identify the title of this Request and the designated individual set out in Section 29 ENQUIRIES of these Instructions to Proponents.

(b) If the withdrawal/amendment is to be mailed, it should be mailed to the Purchasing Department, Manitoba Hydro, P.O. Box 1287, Winnipeg, Manitoba, R3C 2P4, Canada.

(c) If the withdrawal/amendment is to be delivered by hand, it should be brought to the Mailroom, Ground Floor, 360 Portage Avenue, Winnipeg, Manitoba, R3C 0G8, Canada.

(d) If the withdrawal/amendment is to be faxed, it should be faxed to the designated individual at his/her fax number set out in Section 29 ENQUIRIES of these Instructions to Proponents.

(e) If the withdrawal/amendment is to be emailed, it should be in the form of a letter that is converted to PDF format and attached to the email, sent to the designated individual at the following email address: lscanlon@hydro.mb.ca.

(f) A withdrawal or amendment of a Proposal must be signed in accordance with Section 34 SIGNING OF PROPOSALS of these Instructions to Proponents and be on the Proponent's letterhead.

38 PROPONENT'S EXPENSES AND HONORARIUM

38.1 Proponent's Expenses

The Proponent is solely responsible for all costs and expenses incurred in preparing its Proposal and in relation to the Mandatory Meetings (other than the arrangements specifically set out in Section 4 of these Instructions to Proponents to be provided by Manitoba Hydro), presentations, meetings, interviews, discussions, negotiations or otherwise in respect of this Request and shall have no claim against Manitoba Hydro with respect to such costs or expenses in any event.

38.2 Honoraria

In consideration for the time and effort expended by a Proponent who submits a responsive Proposal, fully completed with all of the information requested in this Request in a comprehensive manner, which takes no exceptions or qualifications to the Commercial Terms, and which is considered by Manitoba Hydro to have been compiled with attention to the principles and objectives expressly and implicitly set out in this Request to the level and standard expected from an experienced, skilled and knowledgeable general civil contractor submitting a

comprehensive competitive proposal capable of acceptance to form a contract, an honorarium of up to $300,000.00 per Proponent will be paid.

Determination of whether to pay some, part, all or none of the potential honorarium amount to a given Proponent shall be determined by Manitoba Hydro, in its sole discretion, based upon its own assessment of the completeness and good faith consideration that was afforded to the planning, completeness and scheduling aspects of the Proposal submitted.

Distribution of any honoraria will be made within thirty (30) days after the later of the award of the General Civil Works Contract to a Proponent and, if none is awarded, the date Manitoba Hydro cancels the Request. The following are conditions precedent to the payment by Manitoba Hydro of any honoraria to a Proponent:

(a) receipt by Manitoba Hydro of a comprehensive Proposal prior to Submission Close that is substantially in compliance with all requirements of this Request and takes no exceptions or qualifications to the Commercial Terms;

(b) the Proposal must not be withdrawn or cancelled by the Proponent prior to award of a General Civil Works Contract or cancellation of this Request, and has not been amended after the Submission Close to such an extent that it materially increases the Initial Target Price or other compensation to the General Civil Works Contractor, or substantially increases the risks to be borne by Manitoba Hydro under that contract; and

(c) receipt by Manitoba Hydro of an "Acknowledgement of Payment and General Release" from the Proponent, in a form and with content acceptable to Manitoba Hydro, and pursuant to which the Proponent also consents to the use by Manitoba Hydro in the General Civil Works Contract of any cost savings, value engineering, ideas, concepts, strategies and other information submitted by the Proponent (other than the prices and multipliers in the Proposal) if the Proponent is not the preferred Proponent and awarded the General Civil Works Contract.

39 WAIVER AND RELEASE

By submitting a Proposal, the Proponent acknowledges Manitoba Hydro's rights under this Request and absolutely waives any right, or cause of action against Manitoba Hydro, its officers, directors, employees and/or agents by reason of Manitoba Hydro's failure to accept the Proposal submitted by the Proponent, whether such right or cause of action arises in contract (including fundamental breach), negligence, bad faith, or otherwise.

Except for payment of the honoraria, if any, by Manitoba Hydro to Proponents pursuant and subject to Section 38.2 HONORARIA, and without limiting but in addition to any and all other waivers and releases elsewhere in this Request, Manitoba Hydro, Keeyask Hydropower Limited Partnership and their affiliates, and each and all of their respective officers, employees, consultants, agents, successors and assigns (the "Manitoba Releasees"), shall not under any circumstances whatsoever, including whether pursuant to or arising out of or in connection with contract, tort, statutory duty, law, equity or otherwise, and including any actual or implied custom of the trade or duty of fairness, be responsible or liable to a Proponent or to anyone else for any costs, expenses, loss of opportunities, claims, losses, damages or liabilities (collectively and individually "Claims") incurred or suffered by a Proponent or them, as a result of, arising out of, or related in any way to any one or more of: this Request (including addenda issued to this Request); Manitoba Hydro's Request for Pre-Qualification 016222 - General Civil Works Keeyask Generating Station Project (or any submission in response thereto); any Proposal submitted in response to this Request; failure of Manitoba Hydro to receive the Proposal prior to the Submission Close; submission of Proposals by new Proponents to replace one or more original Proponents or by a Proponent who has reconstituted itself into a different legal entity or with additional or different members after the date this Request is issued; the preparation, negotiation, acceptance or rejection of any Proposal, whether a conforming or non-conforming Proposal (or whether such non-conformances would otherwise render the submission as void or otherwise incapable at law of being a Proposal) and whether received by Manitoba Hydro prior to or after the Submission Close; the rejection of a Proponent or anyone else; reliance by a Proponent on any information or documents obtained or not obtained by that Proponent from Manitoba Hydro; the cancellation, suspension or termination of this Request; or the postponement, suspension or cancellation of the General Civil Works Contract or the Keeyask Project.

Each Proponent, by submission of a Proposal, shall be conclusively deemed to and shall:

(a) waive and release the Manitoba Releasees and each of them from and against any and all Claims; and

(b) be bound by all disclaimers and limitations of liability contained in this Request, including any addenda, and in any information provided by or through Manitoba Hydro.

It is a fundamental condition of this Request, and Proponents by their submission of a Proposal shall be conclusively deemed to agree, that each and all of the Manitoba Releasees shall be entitled to and receive the benefit of all disclaimers and limitations of liability in this Request in favour of Manitoba Hydro.

40 CONFIDENTIALITY

Proponents shall comply with the Confidentiality Agreement executed by Proponents prior to and as a condition of receiving this Request.

Proposals, and all information submitted by Proponents to Manitoba Hydro shall become the property of Manitoba Hydro upon their submission.

Manitoba Hydro will use reasonable efforts to maintain the confidentiality of Proposals but only so far as the consultation, evaluation, scoring, ranking and negotiation of Proposals will allow, and subject to the following:

(a) internal requirements of Manitoba Hydro to inform Keeyask Hydropower Limited Partnership and the Government of the Province of Manitoba, to the extent that Manitoba Hydro is required to report to them on general details of Proposals received in response to this Request, the progress of negotiations, and the award (if any) of the General Civil Works Contract;

(b) information which the Proponent considers confidential or proprietary but is lawfully in the public domain at the time of disclosure by the Proponent to Manitoba Hydro;

(c) information which was in Manitoba Hydro's possession prior to receipt of the information from the Proponent, and for which Manitoba Hydro was not under an obligation of confidence to the Proponent;

(d) information lawfully obtained by Manitoba Hydro from a third party without restriction of disclosure, provided such third party was at the time of disclosure under no obligation of secrecy with respect to such information; and

(e) information that Manitoba Hydro is legally compelled pursuant to applicable law or by an order or judgment of a court of competent jurisdiction to disclose, reveal or surrender to a third party, in which case Manitoba Hydro will disclose only that portion of the confidential or proprietary information received from a Proponent that is legally required.

41 NO LOBBYING

It is the intent of this Request that Manitoba Hydro be allowed to evaluate, score and rank Proposals on their merits, and negotiate and award the General Civil Works Contract, all free from political interference, external pressures and attempts to influence the evaluation, scoring and ranking of Proposals.

It is a fundamental condition of this Request that Proponents and Proponent team members shall not, in relation to the Keeyask Project or this Request, engage in any form of political or other lobbying whatsoever to attempt to influence the outcome of this Request or the evaluation and ranking of Proposals. Other than through the contact person identified in Section 29 ENQUIRIES or within meetings and teleconferences contemplated between Proponents and Manitoba Hydro as specified in this Request, in relation to the Keeyask Project, the proposed General Civil Works Contract, this Request and any Proposal, no person shall attempt to communicate or communicate, directly or indirectly, with any representative of Manitoba Hydro, Keeyask Hydropower Limited Partnership (or its partners or any of their respective affiliates), or any director, officer, employee, agent, consultant or representative of any of the foregoing, or with any Minister or Deputy Minister or other representative of the Province of Manitoba, before or after the Submission Close, including:

(a) Commenting on or attempting to influence views on the merits of the Proponent's Proposal(s) in preference to Proposals of other Proponents.

(b) Influencing, or attempting to influence, through outside pressures, the evaluation, scoring and ranking by Manitoba Hydro's evaluation committee of Proposals or the identification of the preferred Proponent, or in connection with any negotiations between Manitoba Hydro and the preferred Proponent.

(c) Promoting the Proponent or its interests in the proposed General Civil Works Contract or any other aspect of the Keeyask Project in preference to that of other Proponents.

(d) Criticizing any aspects of the Request, Form of General Civil Works Contract, Commercial Terms or the General and Technical Requirements in a manner which may give the Proponent a competitive or other advantage over other Proponents.

(e) Criticizing the Proposals of other Proponents.

In the event of any lobbying, communication or attempts in contravention of the foregoing to influence the outcome of this Request:

i) Manitoba Hydro at its sole discretion may at any time, but will not be required to, reject the Proposal submitted by that Proponent without further consideration and, at Manitoba Hydro's sole discretion, either terminate that Proponent's participation in the Request or submission of a Proposal or any subsequent stages of the implementation of the Keeyask Project, or impose such conditions on that Proponent's continued participation in the Proposal competition and implementation of the Keeyask Project

as Manitoba Hydro at its sole discretion may consider in the public interest or otherwise appropriate.

ii) If as a result Manitoba Hydro at its sole discretion rejects the Proposal from that Proponent, or terminates that Proponent's continued participation in the Proposal competition process or any subsequent stages of the implementation of the Keeyask Project, the Proponent shall not be entitled to or receive any part of the honorarium under Section 38 PROPONENT'S EXPENSES AND HONORARIUM.

iii) Manitoba Hydro will be entitled to retain and, if Manitoba Hydro so elects, use the ideas, concepts and other information (other than prices and multipliers) from that Proponent's Proposal, or from any other information submitted by that Proponent, after award of the General Civil Works Contract to its preferred Proponent.

42 COORDINATION OF PUBLIC ANNOUNCEMENTS AND PUBLICITY

To ensure that all publicity originating from or directed to Proponents and their team members is fair and accurate and will not inadvertently or otherwise influence the evaluation of Proposals, the outcome of the Request or implementation of the Keeyask Project, all publicity in relation to the Keeyask Project, including communications with the press, the media and the public, by or from Proponents or their team members (or their respective directors, officers, employees, consultants and agents) shall be coordinated with and are subject to the prior written approval of Manitoba Hydro, which may be withheld in Manitoba Hydro's sole discretion.

No press releases shall be issued by any Proponent or any of its team members in relation to the Request or Keeyask Project without first submitting same to Manitoba Hydro for review and approval.

Proponents shall promptly notify Manitoba Hydro of requests for information or interviews from the press and media, receive the approval of Manitoba Hydro to respond and coordinate any responses to such requests with Manitoba Hydro.

The intent of these requirements is that all responses to information requests and to interviews shall be approved, reviewed and coordinated in advance with Manitoba Hydro to ensure responses and interviews provide fair and accurate release of information in a coordinated fashion. Proponents shall use all reasonable efforts to ensure all of its members and others associated with the Proponent comply with these requirements.

END OF INSTRUCTIONS TO PROPONENTS

INSTRUCTIONS ON HOW TO ELECTRONICALLY COMPLETE THE FORM OF PROPOSAL PAGES (*PRINT THIS PAGE AS A GUIDE*)

Important: Macro Security level to Medium

1. To see all the gray shaded fields to be completed, you must have **Field shading** on **Always** by selecting the **Tools** menu, then the **Options** submenu, selecting the **View** tab and then selecting **Always** in the drop down menu just beneath **Field shading**. Click **OK**. In Word 2010, select the **File** menu, select the **Options** submenu, and under the heading **Show Document Content** scroll to the item **Field shading** and select Always.

2. To navigate between gray shaded fields, press the **Tab** (or **Down Arrow**) key, **Shift+Tab** or **Page Down** button. Alternatively, you can go directly to the desired field with your mouse. Use the **Ctrl+Tab** keys to insert tabs within a field or column.

3. **Before you begin completing this Form of Proposal electronically, save this document under another filename.** The first field to be completed in the Form of **Proposal** is **your full legal company name.** When you print your completed Form of **Proposal**, your full legal company name will print automatically inside the header of every Form of **Proposal** page.

4. All Proponent's typed prices, data and information are pre-formatted in **Courier** font to distinguish them from the Purchaser's fixed text.

5. Certain fields have been limited to a maximum number of rows or characters that you can type. If the space provided is insufficient, open the document titled "Additional Form of Proposal doc" provided. The additional Form of Proposal pages may completed electronically and when printed, be **inserted** immediately after the associated Form of Proposal page and should be numbered alphanumerically, e.g., Form of Proposal Page # **14, Additional Form of Proposal Page #14A**, **14B**, etc.

6. Certain fields without drop-down selection features require the date to be typed in as Month/Day/Year in full, e.g., April 5, 2013. For checkboxes, click inside the YES □ or NO □ to check OR uncheck the desired box.

7. After you are satisfied with your electronic completion of the Form of Proposal, save the document and print the Form of Proposal pages. Sign the form manually before submitting it.

NOTE: Text search should be done on the Acrobat .pdf document provided.

KEEYASK GENERATING STATION
GENERAL CIVIL WORKS
REQUEST FOR PROPOSAL 016203

FORM OF PROPOSAL 016203

Ms. Lucena Scanlon
Purchasing Department
Manitoba Hydro
2nd Floor - 360 Portage Avenue
Winnipeg, Manitoba R3C 0G8
Canada

COMPANY INFORMATION

This Proposal is submitted by: _____
(name of the Proponent)

hereinafter called the "Proponent", a company or other legal entity duly registered to carry on business in:

_____

having its head office at: _____
(number, street)

_____
(city/town, province/state, postal/zip code, country)

( ) - ( ) -
(telephone) (FAX number)

The Proponent's Contact Person for all communication with respect to this Proposal: :

_____
(Name & Title)

_____
(number, street)

_____
(city/town, province/state, postal/zip code, country)

( ) - ( ) -
(telephone) (FAX number)

SECTION 1 - LEGAL STRUCTURE

The Proponent is to:

(a) List all the parties/members/principals involved (including all individual legal names and addresses) in the submission of its Proposal, including jurisdiction of incorporation and location of closest offices in Canada. Such parties/members/principals shall reflect those same parties/members/principals which submitted an Information Package in response to Manitoba Hydro's Request for Pre-Qualification 016222 General Civil Works – Keeyask Generating Station Project:

(b) Indicate the services/activities/work to be provided by each respective member of the Proponent in the performance of the General Civil Works Contract:

(c) Describe the proposed participation and responsibility of each member of the Proponent in the performance of the General Civil Works Contract, including an organizational structure:

(d) Identify the member and its individual representative who shall be the Leader and principal contact person for the Proponent (as set out as the "Contact Person" on Form of Proposal page 1) for purposes in all dealings with Manitoba Hydro in relation to this Request prior to and following the Submission Close up to the award of the General Civil Works Contract, if any, to the Proponent.

If a joint venture or consortium, provide the Proponent's detailed process for the resolution of disputes that may arise between the parties to its joint venture or other partnering arrangement including how Manitoba Hydro will be kept informed of such disputes and how such disputes will be managed to ensure there is no impact to the performance or completion of the General Civil Works Contract.

If a joint venture or consortium, provide the Proponent's detailed plan for resolution of performance issues of individual members that may arise during the performance of the General Civil Works Contract. The Proponent shall include a no-fault provision within its joint venture or consortium agreement.

(e) If more than one legal entity is involved in this Proposal, confirm below, that all members of the Proponent are aware that they shall be jointly and severally responsible for all obligations, responsibilities and matters arising under this Request or in relation to the Proponent's Proposal or in any General Civil Works Contract which may be awarded to the Proponent:

Yes ☐ No ☐

(f) If applicable, attach a signed copy of the Proponent's joint venture or consortium agreement regarding the Proponent's submission of a Proposal and performance of the General Civil Works Contract, if awarded to the Proponent. Include resolutions of each of the constituent parties authorizing the creation of the business arrangement. **NOTE: This must be provided to Manitoba Hydro on or before July 15, 2013.**

(g) Attach evidence that the Proponent is registered to do business in the Province of Manitoba.

SECTION 2 - CONFLICT OF INTEREST DECLARATION / DISCLOSURE

By signature below of its duly authorized representative and all joint venture and consortium members, the Proponent (including all members comprising the Proponent), hereby declares that it is not now, nor does it anticipate becoming involved in any Conflict of Interest defined for this Declaration as follows:

> "Conflict of Interest" means a pecuniary interest of the Proponent in any third party or of any third party in the Proponent which may or could appear to compromise or impair the Proponent's objective, good faith performance of its duties under the General Civil Works Contract, if awarded to the Proponent. Third parties in this context shall include but not be limited to the intended owner of the Keeyask Project, the Keeyask Hydropower Limited Partnership, any of its actual or intended Limited Partners, and the Proponents who pre-qualified for participation in this Proposal for the General Civil Works."

Declared by the duly authorized representative of the Proponent in that behalf, this _____ day of _____ , 2013

_____
(Insert Legal Name of Proponent Above)

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

DISCLOSURE OF CONFLICT OF INTEREST

Where a Conflict of Interest as defined above does exist or may arise prior to completion of any General Civil Works Contract awarded to the Proponent hereunder, then the Proponent shall disclose the nature and extent of the real or apparent Conflict of Interest in reasonable detail below.

The Proponent may also propose a cure for the disclosed Conflict of Interest.

SECTION 3 – INTENTIONALLY LEFT BLANK

SECTION 4 - PHASE 1 – ECIS BASIS FOR COMPENSATION

The Proponent shall include the following information:

Mandatory: All-inclusive hourly rates (exclusive of GST) for each of its representatives proposed to be dedicated to provide the ECIS Obligations in Phase I; and,

An estimate of the expenses for the Contractor's ECI team required to work in Winnipeg from April of 2014 until August of 2015.

At the Proponent's Option: In addition and not in lieu of the above, Proponent's may also include a proposed alternate method and amount of compensation (such as a fixed fee) for the ECIS Obligations.

> Proposed mandatory rates and/or fees or any alternative proposal shall be stated in Canadian currency and shall include all profit, GA&O, customs duties, surcharges, insurance premiums, permit and licence fees, workers' compensation and vacation pay assessments, relocation benefits, living out allowances, multipliers and all other payroll benefits.

SECTION 5 - ECI TEAM

The Proponent is to provide an organization chart with its proposed ECI Team staff, alternate staff, and their resumes for performance of the ECIS Obligations and participation on Manitoba Hydro's ECI Team, including on the ECI Leadership Team. Please include a substitute for all positions. If anyone will not be physically located in Winnipeg and committed full time to the ECIS Obligations, provide details of their availability and the percentage of time during each month that they will be dedicated exclusively to the ECIS Obligations. In addition, describe the proposed organization structure, indicating interfaces with Manitoba Hydro team members.

Name	Position Title	Previous Experience

SECTION 6 - ECI METHODOLOGY FOR THE ENVIRONMENTAL PROTECTION PLAN

The Proponent is to provide an outline of the steps that will be undertaken during Phase I ECIS Obligations to utilize the Keeyask Generating Station Environmental Protection Plan and integrate this information into the Proponent's Environmental Protection Plan to create innovative strategies, specifically for in-stream work for implementation during Phase II construction of the General Civil Works.

SECTION 7 - ECI METHODOLOGY FOR A PROJECT SPECIFIC QUALITY CONTROL MANAGEMENT PLAN

The Proponent is to provide an outline of the steps that will be undertaken during Phase I ECIS Obligations to create the detailed particulars of a Quality Control Management Plan for implementation during Phase II construction of the General Civil Works.

SECTION 8 - ECI METHODOLOGY FOR A CONTRACT SCHEDULE

The Proponent is to provide an outline of the steps that will be undertaken during Phase I ECIS Obligations to modify the Proponent's submitted independent construction schedule into a full Contract Schedule for Phase II construction of the General Civil Works.

SECTION 9 - ECI METHODOLOGY FOR A COST CONTROL MANAGEMENT SYSTEM

The Proponent is to provide an outline of the steps that will be undertaken during Phase I ECIS Obligations to create the Cost Control Management System to track, monitor and forecast the Actual Cost of the Works throughout the performance of Phase II construction of the General Civil Works.

SECTION 10 - ECI METHODOLOGY FOR STAFF AND CRAFT LABOUR ATTRACTION AND RETENTION

The Proponent is to provide an outline of the steps that will be undertaken during Phase I ECIS Obligations to successfully attract and retain the required staff and craft labour for Phase II construction of the General Civil Works.

SECTION 11 - ECI METHODOLOGY FOR A PROJECT SPECIFIC RISK MANAGEMENT PLAN

The Proponent is to provide an outline of the steps that will be undertaken during Phase I ECIS Obligations to identify, monitor and mitigate risk throughout the Phase II construction of the General Civil Works.

SECTION 12 - ECI METHODOLOGY FOR ON-THE-JOB TRAINING

The Proponent is to provide an outline of the steps that will be undertaken during Phase I ECIS Obligations to prepare an On the Job Training Plan for implementation in Phase II construction of the General Civil Works.

SECTION 13 - PROJECT CHANGE PROPOSALS

The Proponent is to provide details on any scope, schedule or material changes to the Technical and Schedule Requirements of the General Civil Works Contract that it desires Manitoba Hydro to consider for approval **on or before August 30, 2013**. Manitoba Hydro will review all information and inform the Proponent **on or before September 24, 2013** of any of the Proponent's proposed changes to the Technical and Schedule Requirements that are approved to be included in the Proponent's final Proposal to be provided at Submission Close.

SECTION 14 - COMMERCIAL TERMS CHANGE PROPOSALS

The Proponent is to provide details on any Commercial Terms set out in the General Civil Works Contract documents that would (a) prevent the Proponent from entering into a General Civil Works Contract with Manitoba Hydro ("Proponent's Mandatory Revisions"), or (b) which if agreed to by Manitoba Hydro would provide significant cost or schedule benefits to Manitoba Hydro ("Proponent's Requested Revisions").

For any such items, the Proponent shall also submit its proposed modifications including revised contractual language. The Proponents' Mandatory Revisions shall be submitted in writing **on or before July 26, 2013**. The Proponent's Requested Revisions shall be submitted **on or before August 16, 2013**.

SECTION 14A - CONFIRMATION OF COMMERCIAL TERMS

On or before November 25, 2013, the Proponent shall complete and submit this Section 14A via email to lscanlon@hydro.mb.ca.

Yes ☐ The Proponent is prepared to enter a General Civil Works Contract with Manitoba Hydro on the Commercial Terms as issued on November 1, 2013 if it is the successful Proponent

No ☐ The Proponent is not prepared to enter into a General Civil Works Contract with Manitoba Hydro on the Commercial Terms as issued on November 1, 2013 and therefore will not proceed to submit a Proposal.

SECTION 15 - CONSTRUCTION MANAGEMENT TEAM

The Proponent is to provide an organization chart with its proposed Construction Management Team (to the level of Superintendant/Supervisor) and their resumes for Phase II construction of the General Civil Works. Please include a substitute for all positions. Also include the names and contact details for owner representatives on the last three projects in which each person was actively involved in a similar position.

Name	Position Title	Previous Experience and Contact Names and Details for Reference Checking

SECTION 16 - METHODOLOGY

The Proponent is to provide details on its proposed methodology to complete Phase II construction of the General Civil Works including:

(a) Temporary Infrastructure - (office, shops, warehouses, access roads, ramps, electrical distribution, etc)

(b) Main Plant – (equipment fleet, concrete batch plant, material processing spread, crane requirements, etc)

(c) Materials Utilization – (material balance for all excavated/borrowed materials)

(d) Draft Tube Form Details (number, material, buy or build on site, manufacturing and delivery time etc)

(e) Construction details for cofferdams, dewatering, rock and unclassified excavation, concrete structures, dams and dykes, electrical and mechanical items

(f) Details of work to be self performed or subcontracted.

(g) All other details that will demonstrate the means and methods proposed to be utilized by the Proponent to successfully complete the Phase II construction of the General Civil Works.

(h) A complete material handling and disposal plan, including how material will be hauled from excavations to temporary stockpiles, to processing areas and to waste disposal areas, including such things as size and weight of construction equipment, and cycle time for trucks. Also provide a flow chart showing excavations, temporary stockpiles, processing for concrete aggregate and other construction material requirements, and locations of disposal areas for materials.

(i) Details of how Proponent will ensure all work under the General Civil Works Contract is coordinated with the work of all Other Contractors and Manitoba Hydro for the balance of the Keeyask Project so as to minimize delays, interferences and extra costs to Manitoba Hydro.

SECTION 17 - CONSTRUCTION SCHEDULE

The Proponent is to provide an independent construction schedule for the Phase II construction of the General Civil Works that meets the requirements as outlined in Section 3.1 General Requirements of the General Specification and includes:

(a) Mobilization to Site not earlier than June 27, 2014
(b) In-Stream work restriction for sturgeon spawning of May 15 to July 15 of every year.
(c) Adherence to all durations shown in Manitoba Hydro's Construction Schedule as "by others".
(d) Manitoba Hydro supplied equipment and all work "by others" not to be advanced by more than 12 months.
(e) First Concrete not before May 1, 2016

The Proponent's independent construction schedule is to be submitted digitally in .pdf and .xer format.

SECTION 18 - EQUIPMENT RATES

The Proponent shall provide construction equipment rates (in 2013$) for all operated, stationary and fixed pieces of equipment with a purchase price of greater than $20,000 that are required to perform the Phase II construction of the General Civil Works. These rates are intended to be used as a basis for progressing payment for Actual Costs. Construction equipment having a purchase price of less than $20,000 shall not be rented but purchased and charged to Manitoba Hydro as part of the Cost of the Work at the direct cost actually paid by the General Civil Works Contractor to the seller of that equipment. Rates shall be a genuine estimate of the Proponent's Actual Cost (as such term is defined in the General Civil Works Contract) to operate the equipment. **Rates shall not include operator labour, any amount to reflect the Contractor's Profit Percentage, Contractor's GA & O Percentage or any other markups.** Rates shall include an allowance for wear, tear and for any reconditioning that may be required on demobilization of that equipment from the Site as no costs of reconditioning of the equipment will be allowed as a separate Actual Cost. All construction equipment rates will be subject to audit by Manitoba Hydro for the duration of the General Civil Works Contract if awarded to the Proponent.

The Proponent shall include a proposal to invoice the equipment that includes a mechanism such that Manitoba Hydro will not pay more in ownership cost (company rent) than the full actual cash value of the equipment plus any financing and insurance costs, at the time it is brought on Site. Manitoba Hydro is open to a buy/sell option for equipment and only including the operating costs (fuel, oil, grease, repairs) in the equipment rate, however the Proponent must then include the purchase of the equipment in its overall cash flow.

Equipment	Make and Model	Year	Current Value	Quantity	Equipment Rate ($/hr $/week, other)

SECTION 19 - EQUIPMENT RATE DECLARATION

The Proponent represents and warrants that its equipment rates provided in Section 18 of its Proposal are all-inclusive and at cost, and do not include operator labour, any amount to reflect the Contractor's Profit Percentage, Contractor's GA & O Percentage, any hidden profit or any other markups.

The Proponent undertakes to assist Manitoba Hydro in an audit of the equipment rates, as required.

Declared by the duly authorized representative of the Proponent in that behalf, this _____ day of _____ , 2013

_____
Proponent's Name

_____ Per: _____
Witness Name: Name:
Position:

SECTION 20 - BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE

The work covered by each ITEM or SUBITEM is that work described more fully in corresponding sections of the Technical Specification set out in the General Civil Works Contract.

The Proponent shall complete the spreadsheet included in **Form II - Bill of Quantities Excel Spreadsheet** included in Part 1 of this Request.

SECTION 21 - INITIAL TARGET PRICE BREAKDOWN

The Proponent shall provide a complete Initial Target Price breakdown that shows the detailed build up of its estimate for each line Item in its Bill of Quantities set out at Form of Proposal Section 20. One (1) copy of this breakdown shall be provided as a print of the Proponent's estimating software and one copy of the information shall be provided in an excel format matching the categories defined in **Appendix III Excel Format for Initial Target Price Breakdown** to the General Civil Works Contract. All estimate information is to be in 2013$, **with the exception of Craft Labour which shall utilize the 2012 BNA rates.**

SECTION 22 - CONTRACTOR'S FEE COMPONENTS

The Proponent proposes _____ % as the Contractor's GA&O Percentage to be calculated against its Actual Cost of performing the Phase II construction of the General Civil Works and paid as outlined in the Terms and Conditions of Payment if the General Civil Works Contract is awarded to the Proponent.

The Proponent proposes _____ % **(not less than 10%)** as the Contractor's Profit Percentage to be calculated against its Final Target Price for performing the Phase II construction of the General Civil Works and paid as outlined in the Terms and Conditions of Payment if the General Civil Works Contract is awarded to the Proponent.

SECTION 23 - ESCALATION METHODOLOGY

The Proponent shall indicate a methodology to escalate all Items in its Initial Target Price breakdown in the following table format (except Craft Labour which will be escalated as provided for in Subsection 6.1 Escalation Adjustment of the Terms and Conditions of Payment of the General Civil Works Contract).

The methodology shall identify each Item (for example, Equipment Rates) and shall include a mechanism for the proposed escalation (for example, Statistics Canada Machinery and Equipment v53433975). All escalation mechanisms proposed must be a fixed rate or a variable rate from a third party published source. The mechanism shall also outline all of the details on the escalation plan including the dates when the escalation will be calculated, the version of the indices to be used and an example of how the escalation would be calculated.

				Cash Flow in Millions of Dollars 2013$								
Item	Esc Mechanism	2011 Index	2012 Index	2014 $	2015 $	2016 $	2017 $	2018 $	2019 $	2020 $	2021 $	2022 $
Craft Labour	BNA Actual	100	102.5	10.3	40.3	150.6	165.8	116.7	93.6	45.6	20.3	10.5
Equipment Rates	Stats Can V53433975	103.7	106.2	50.6	95.3	168.5	177.3	88.7	61.8	22.3	8.5	.86
Office Equipment	2% fixed	n/a	n/a	.2	.2	.05	.05	.05	.05	.05	0	0

SECTION 24 - CASH FLOWS

The Proponent is to include a summary monthly cash flow of the Initial Target Price for the duration of the Phase II construction of the General Civil Works.

SECTION 25 - SITE INDIRECTS

The Proponent is to include the percentages to be used as a mechanism to calculate the amount of ITEM 01 10 05 a) Indirects for any scope that is added to the Phase II construction of the General Civil Works through an Extra Work Order or Change Order.

For all work undertaken using the Proponent's own forces: _____ %

For all work undertaken by a Subcontractor: _____ %

SECTION 26 - ESTIMATED TOTAL LABOUR FORCE

The Proponent is to provide its estimate of the total labour force it proposes would be used on a month-by-month basis, broken down by each category of trade labour and supervision and the total of all labour and supervision, including those to be employed by the Proponent and by its Subcontractors at the Site for the duration of the Phase II construction of the General Civil Works.

The Proponent shall use the spreadsheet included in **Form III - Excel Format for Site Workforce Forecast** included in Part 1 of this Request.

SECTION 27 – CONTRACTOR'S CAMP REQUIREMENTS

The Proponent is to identify any required additions/deletions to the number of Craft and Supervisor Rooms allotted to the Proponent in the Manitoba Hydro's Camp.

Date	Manitoba Hydro's Allotment for the Proponent		Proponent's Needs	
	Craft	Supervisor	Craft	Supervisor
Jan-June 2014	0	0		
July- Dec 2014	100	15		
Jan-June 2015	100	15		
July- Dec 2015	250	25		
Jan-June 2016	750	75		
July- Dec 2016	1100	75		
Jan-June 2017	1100	75		
July- Dec 2017	1100	75		
Jan-June 2018	800	75		
July- Dec 2018	800	75		
Jan-June 2019	600	75		
July- Dec 2019	600	75		
Jan-June 2020	300	50		
July- Dec 2020	300	50		
Jan-June 2021	300	50		
July- Dec 2021	300	50		

SECTION 28 - CONTINGENCY

The Proponent is to provide the Risk Matrix used to set the required Contingency included in the Proponent's Initial Target Price. At a minimum, the Risk Matrix is to include the columns identified in the sample below. The Contingency section of the Initial Target Price breakdown shall include the full details on the development of the Total Value for each Risk Item.

Risk	**Total Value**	**Probability**	**Risk Value**

SECTION 29 - POWER REQUIREMENTS

The Proponent is to identify any additional power requirements that it desires Manitoba Hydro to consider for approval **on or before September 27, 2013**, above that which is identified in Technical Specification Section 01 51 00 TEMPORARY UTILITIES of the General Civil Works Contract. Proponents are to include a detailed list of loads (by location) that were used in determining the estimated power requirements of the Proponent's facilities.

SECTION 30 - MANITOBA BUSINESS CONTENT EVALUATION

Describe the value of Manitoba Content that would be incorporated into the Work (inputs originating from the Province of Manitoba such as labour, materials, transportation, etc.):

a) Wages to Manitoba Residents

Wages paid to employees who are Manitoba residents are estimated to be $_____ .

b) Manitoba Subcontractors

Portion of the Work To Be Subcontracted	Name And Address Of Subcontractor	Portion of the Work
		%
		%
		%
		%
		%

The above subcontractors shall not be changed without the prior written approval of the Purchaser.

c) Proposed Purchase of Material from Manitoba Companies

Material	Name and Address of Supplier	Portion of the Work
		%
		%
		%
		%
		%

d) Proposed Purchase of Equipment from Manitoba Companies

Equipment	Name and Address of Supplier	Purchase Price ($Cdn)

e) Proposed Leased Equipment from Manitoba Companies

Equipment	Owner	Total Value of Lease ($Cdn)

Provide information regarding any proposed lease agreements (such as length of agreement and terms):

f) Manufacturing from Manitoba Companies

The following are the principal components of the Work, their places of manufacture and/or assembly and percentages of value of the Work:

Component of the Work	**Place of Manufacture and/or Assembly**	**Percentage of Value of the Work**
		%
		%
		%
		%
		%

g) Other Manitoba Content:

Provide any other information regarding proposed Manitoba Content pertinent to the Work:

SECTION 31 – INTENTIONALLY BLANK

SECTION 32 - POTENTIAL CHANGES TO THE BURNTWOOD/NELSON AGREEMENT

The Proponent shall outline any potential changes to the existing Burntwood/Nelson Agreement that it would have the HPMA attempt to negotiate. Please include updated information for Section 16 – Methodology, Section 17 – Construction Schedule, Section – 21 Initial Target Price Breakdown, Section 23 – Escalation Methodology, Section 24 – Cash Flow, Section 26 – Total Labour Force, Section 27 – Camp Requirements and Section 28 – Contingency that would result if negotiations were successful.

SECTION 33 - PROJECT SITE VISIT

The Proponent shall identify a current project site where members of the Keeyask Engineering and Construction Team could visit (**before September 30 2013**) to witness how the Proponent's methodologies are being implemented on an active project of the Proponent. The Proponent shall submit this Section 33 of the Form of Proposal to Manitoba Hydro **on or before July 15, 2013**.

SECTION 34 - DELAY COST

The Proponent shall identify the increase in the Initial Target Price that would be incurred for a delay in the commencement dates of Phase II construction of the General Civil Works (i.e. pursuant to the issuance by Manitoba Hydro of a Notice to Proceed under the General Civil Works Contract) from June 27, 2014 to June 27, 2015.

SECTION 34A – CONTRACT BREAKAGE FEE FOR TERMINATION FOR CONVIENIENCE

The Proponent shall provide a contract breakage fee for termination for convenience. This fee will be paid on a 1.1 linear sliding scale from 100% on Contract signing to 0% once the Actual Cost of the Work is 50% of the Initial Target Price.

$ _____

Printed:

SECTION 35 - HYDRO PROJECTS MANAGEMENT ASSOCIATION

MEMBERSHIP APPLICATION

The undersigned hereby makes application for a Contractor Membership/Contractor Associate Membership in the Hydro Projects Management Association and agrees to accept and abide by the Constitution thereof:

Declared by the duly authorized representative of the Proponent in that behalf, this _____ day of _____ , 2013

_____
(Insert Legal Name of Proponent Above)

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

SECTION 36 – CHANGES TO PROPONENT'S INFORMATION PACKAGE

The Proponent shall identify all changes, if any, to the information set out in its Information Package submitted in response to Manitoba Hydro Request for Pre-Qualification 016222 – Keeyask Generating Station project – General Civil Works. If no changes are indicated below, the Proponent represents and warrants that the information contained in its Information Package remains true and correct as of the date of submission of the Proponent's Proposal.

SECTION 37 - SIGNING PAGE

The Proponent hereby submits a Proposal in response to Manitoba Hydro's Request for Proposal 016203. By signing below, the Proponent certifies and agrees that the information submitted herein is true and correct as of the date of signing, to the best of the Proponent's knowledge and agrees to the terms and conditions set out in this Request.

The Proponent's Proposal will be subject to a Proposal Evaluation Process as set out in the Instructions to Proponents. A formal contract for the Work will be required to be executed between Manitoba Hydro and the Proponent in order for any legal and binding obligations to be created between the parties.

Declared by the duly authorized representative of the Proponent in that behalf, this _____ day of _____ , 2013

_____
(Insert Legal Name of Proponent Above)

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

_____
(Insert Joint Venture Member Legal Name Above)
Per: _____

_____
Witness Signature

_____
Witness Name

_____
Witness Address

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

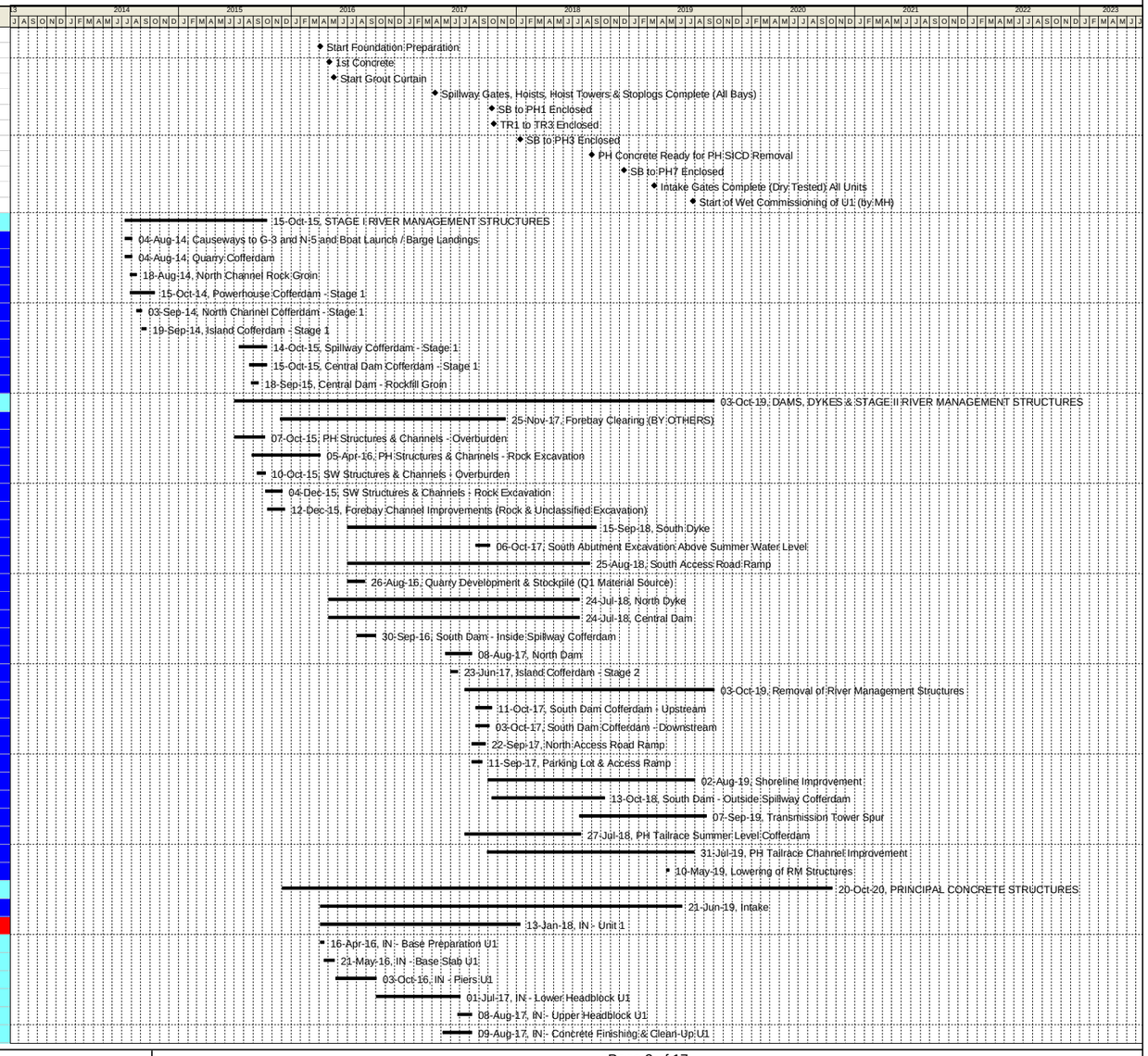
Activity Name	Start	Finish
Keeyask GS - Purchaser's Construction Schedule r2	15-Jun-14	13-Oct-21
SUPPLY & MANUFACTURE	18-Nov-15	02-May-19
KEY MILESTONES - SUPPLY & MANUFACTURE	18-Nov-15	02-May-19
0025 Supply & Manufacture	18-Nov-15	02-May-19
Power Generation Systems	28-May-16	24-May-18
Recieve Eqmnt on Site - Turbine and Generator Anchors		28-May-16
Receive Eqmnt on Site - DC Bus Duct		13-Dec-17
Receive Eqmnt on Site - Governors		18-Jan-18
Receive Eqmnt on Site - Exciters		24-May-18
Electrical Power Systems	25-Nov-15	02-May-19
Receive Eqmnt on Site - Medium Voltage Station Service Eqmnt		25-Nov-15
Receive Eqmnt on Site - Blackstart Standby Power System		13-Jan-16
Receive Eqmnt on Site - 600V Switchgear & Switchboard		24-Feb-16
Receive Eqmnt on Site - Motor Control Centres		13-Apr-16
Receive Eqmnt on Site - Spillway Standby Power Supply Eqmnt		27-Apr-16
Receive Eqmnt on Site - 138KV Surge Arrestors		22-Mar-17
Receive Eqmnt on Site - 138KV Disconnect Switch		22-Mar-17
Receive Eqmnt on Site - Isolated Phase Bus		11-Oct-17
Receive Eqmnt on Site - Generator Circuit Breakers		20-Jun-18
Receive Eqmnt on Site - Generator Step-Up Transformers (U1 to U4)		30-Nov-18
Receive Eqmnt on Site - Generator Step-Up Transformers (U5 to U7)		02-May-19
Instrumentation & Control Systems	18-Nov-15	21-Jun-17
Receive Eqmnt on Site - Generator & Transformer Protective Relaying Epmnt		18-Nov-15
Receive Eqmnt on Site - Unit Control & Monitoring System		26-Nov-15
Receive Eqmnt on Site - Generating Station Communications Eqmnt		23-Dec-15
Receive Eqmnt on Site - Air Gap &Vibration Monitoring		21-Jun-17
Auxiliary Processes & Services Systems	28-Jan-16	22-Aug-18
Receive Eqmnt on Site - Spillway Stoplogs		28-Jan-16
Receive Eqmnt on Site - Intake Trashracks		28-Jan-16
Receive Eqmnt on Site - Draft Tube Gates		28-Jan-16
Receive Eqmnt on Site - Intake Bulkhead Gates		28-Jan-16
Receive Eqmnt on Site - Spillway Embeds, Guide Anchors		04-Feb-16
Receive Eqmnt on Site - Intake Gates & Hoists		24-Mar-16
Receive Eqmnt on Site - Spillway Gates		04-Aug-16
Receive Eqmnt on Site - Powerhouse Cranes		25-Aug-16
Receive Eqmnt on Site - Spillway Bridges, Tower, Monorail		06-Oct-16
Receive Eqmnt on Site - Spillway Hoists		10-Nov-16
Receive Eqmnt on Site - Spillway Monorail Hoist		10-Nov-16
Receive Eqmnt on Site - Draft Tube Crane		25-May-17
Receive Eqmnt on Site - Intake Monorail Crane		22-Aug-18
CONSTRUCTION	15-Jun-14	13-Oct-21
KEY MILESTONES - CONSTRUCTION	15-Jun-14	13-Oct-21
Overall Project	15-Jun-14	13-Oct-21
Main Camp Facility Completed - Phase 1 (500 Persons)		15-Jun-14*
Start Stage 1 Cofferdams (Quarry Cofferdam)	11-Jul-14	
First In-Stream Rock-Fill (Quarry Cofferdam)	16-Jul-14	
Start Earthworks & Powerhouse Excavation	01-Jul-15	
GCC Contractor - Mobilize On Site	01-Jul-14	01-Jul-15
Main Camp Facility Completed - Phase 2 (2000 Persons)		08-Apr-16
South Access Road Ready for GCC Contractor's Use		01-Jul-16
GCC Contractor - Start Demobilization	08-Aug-18	
Unit 1 In Service		13-Nov-19
Unit 2 In Service		18-Dec-19
Unit 3 In Service		31-Jan-20
Unit 4 In Service		02-Mar-20
Unit 5 In Service		20-Apr-20
Unit 6 In Service		22-Jun-20
Unit 7 In Service		19-Aug-20
GCC Contractor - Demobilization Complete		26-Jan-21
Project Complete		13-Oct-21
Principal Concrete Structures	02-Jul-15	25-Jul-19
General	02-Jul-15	25-Jul-19
Install & Commission Concrete Aggregate Processing Plants & Stockpiles	02-Jul-15	28-Aug-15

◆ ◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
Install & Commission Concrete Batch Plant	02-Jul-15	14-Nov-15
Start Foundation Preparation	04-Apr-16	
1st Concrete	03-May-16	
Start Grout Curtain	18-May-16	
Spillway Gates, Hoists, Hoist Towers & Stoplogs Complete (All Bays)		11-Apr-17
SB to PH1 Enclosed		13-Oct-17
TR1 to TR3 Enclosed		18-Oct-17
SB to PH3 Enclosed		13-Jan-18
PH Concrete Ready for PH SICD Removal		31-Aug-18
SB to PH7 Enclosed		15-Dec-18
Intake Gates Complete (Dry Tested) All Units		23-Mar-19
Start of Wet Commissioning of U1 (by MH)	25-Jul-19	
STAGE I RIVER MANAGEMENT STRUCTURES	11-Jul-14	15-Oct-15
Causeways to G-3 and N-5 and Boat Launch / Barge Landings	12-Jul-14	04-Aug-14
Quarry Cofferdam	11-Jul-14	04-Aug-14
North Channel Rock Groin	29-Jul-14	18-Aug-14
Powerhouse Cofferdam - Stage 1	29-Jul-14	15-Oct-14
North Channel Cofferdam - Stage 1	18-Aug-14	03-Sep-14
Island Cofferdam - Stage 1	03-Sep-14	19-Sep-14
Spillway Cofferdam - Stage 1	16-Jul-15	14-Oct-15
Central Dam Cofferdam - Stage 1	18-Aug-15	15-Oct-15
Central Dam - Rockfill Groin	25-Aug-15	18-Sep-15
DAMS, DYKES & STAGE II RIVER MANAGEMENT STRUCTURES	02-Jul-15	03-Oct-19
Forebay Clearing (BY OTHERS)	26-Nov-15	25-Nov-17
PH Structures & Channels - Overburden	02-Jul-15	07-Oct-15
PH Structures & Channels - Rock Excavation	28-Aug-15	05-Apr-16
SW Structures & Channels - Overburden	12-Sep-15	10-Oct-15
SW Structures & Channels - Rock Excavation	10-Oct-15	04-Dec-15
Forebay Channel Improvements (Rock & Unclassified Excavation)	16-Oct-15	12-Dec-15
South Dyke	02-Jul-16	15-Sep-18
South Abutment Excavation Above Summer Water Level	22-Aug-17	06-Oct-17
South Access Road Ramp	02-Jul-16	25-Aug-18
Quarry Development & Stockpile (Q1 Material Source)	02-Jul-16	26-Aug-16
North Dyke	02-May-16	24-Jul-18
Central Dam	02-May-16	24-Jul-18
South Dam - Inside Spillway Cofferdam	01-Aug-16	30-Sep-16
North Dam	15-May-17	08-Aug-17
Island Cofferdam - Stage 2	01-Jun-17	23-Jun-17
Removal of River Management Structures	17-Jul-17	03-Oct-19
South Dam Cofferdam - Upstream	22-Aug-17	11-Oct-17
South Dam Cofferdam - Downstream	22-Aug-17	03-Oct-17
North Access Road Ramp	09-Aug-17	22-Sep-17
Parking Lot & Access Ramp	09-Aug-17	11-Sep-17
Shoreline Improvement	30-Sep-17	02-Aug-19
South Dam - Outside Spillway Cofferdam	12-Oct-17	13-Oct-18
Transmission Tower Spur	24-Jul-18	07-Sep-19
PH Tailrace Summer Level Cofferdam	17-Jul-17	27-Jul-18
PH Tailrace Channel Improvement	28-Sep-17	31-Jul-19
Lowering of RM Structures	01-May-19	10-May-19
PRINCIPAL CONCRETE STRUCTURES	04-Dec-15	20-Oct-20
Intake	04-Apr-16	21-Jun-19
IN - Unit 1	04-Apr-16	13-Jan-18
IN - Base Preparation U1	04-Apr-16	16-Apr-16
IN - Base Slab U1	18-Apr-16	21-May-16
IN - Piers U1	24-May-16	03-Oct-16
IN - Lower Headblock U1	04-Oct-16	01-Jul-17
IN - Upper Headblock U1	24-Jun-17	08-Aug-17
IN - Concrete Finishing & Clean-Up U1	06-May-17	09-Aug-17



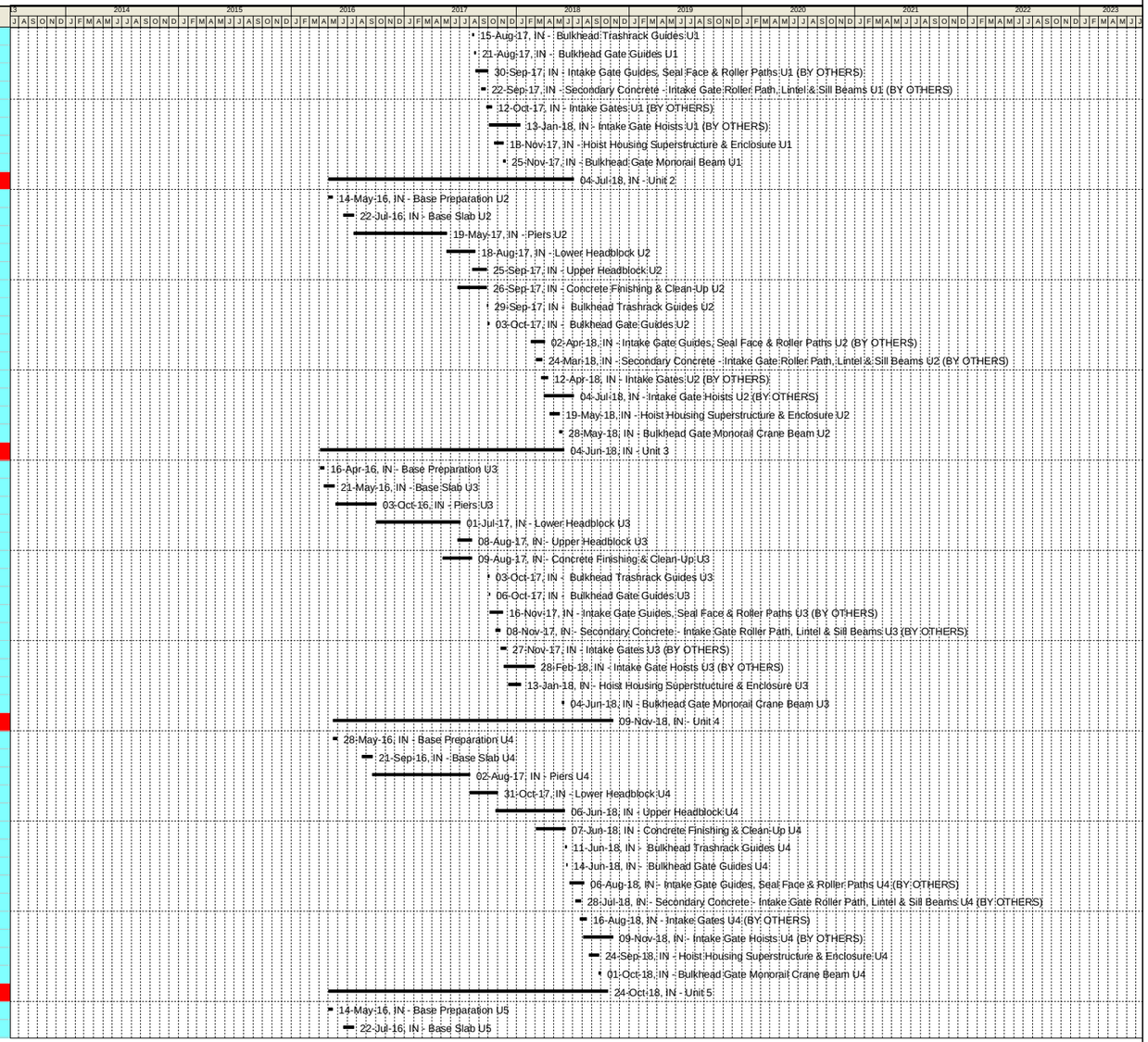
◆ ◆ Milestone

Summary

Manitoba Hydro

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
IN - Bulkhead Trashrack Guides U1	10-Aug-17	15-Aug-17
IN - Bulkhead Gate Guides U1	16-Aug-17	21-Aug-17
IN - Intake Gate Guides, Seal Face & Roller Paths U1 (BY OTHERS)	22-Aug-17	30-Sep-17
IN - Secondary Concrete - Intake Gate Roller Path, Lintel & Sill Beams U1 (BY OTHERS)	09-Sep-17	22-Sep-17
IN - Intake Gates U1 (BY OTHERS)	25-Sep-17	12-Oct-17
IN - Intake Gate Hoists U1 (BY OTHERS)	05-Oct-17	13-Jan-18
IN - Hoist Housing Superstructure & Enclosure U1	20-Oct-17	18-Nov-17
IN - Bulkhead Gate Monorail Beam U1	20-Nov-17	25-Nov-17
IN - Unit 2	02-May-16	04-Jul-18
IN - Base Preparation U2	02-May-16	14-May-16
IN - Base Slab U2	18-Jun-16	22-Jul-16
IN - Piers U2	23-Jul-16	19-May-17
IN - Lower Headblock U2	20-May-17	18-Aug-17
IN - Upper Headblock U2	11-Aug-17	25-Sep-17
IN - Concrete Finishing & Clean-Up U2	23-Jun-17	26-Sep-17
IN - Bulkhead Trashrack Guides U2	27-Sep-17	29-Sep-17
IN - Bulkhead Gate Guides U2	30-Sep-17	03-Oct-17
IN - Intake Gate Guides, Seal Face & Roller Paths U2 (BY OTHERS)	16-Feb-18	02-Apr-18
IN - Secondary Concrete - Intake Gate Roller Path, Lintel & Sill Beams U2 (BY OTHERS)	06-Mar-18	24-Mar-18
IN - Intake Gates U2 (BY OTHERS)	21-Mar-18	12-Apr-18
IN - Intake Gate Hoists U2 (BY OTHERS)	31-Mar-18	04-Jul-18
IN - Hoist Housing Superstructure & Enclosure U2	19-Apr-18	19-May-18
IN - Bulkhead Gate Monorail Crane Beam U2	19-May-18	28-May-18
IN - Unit 3	04-Apr-16	04-Jun-18
IN - Base Preparation U3	04-Apr-16	16-Apr-16
IN - Base Slab U3	18-Apr-16	21-May-16
IN - Piers U3	24-May-16	03-Oct-16
IN - Lower Headblock U3	04-Oct-16	01-Jul-17
IN - Upper Headblock U3	24-Jun-17	08-Aug-17
IN - Concrete Finishing & Clean-Up U3	06-May-17	09-Aug-17
IN - Bulkhead Trashrack Guides U3	30-Sep-17	03-Oct-17
IN - Bulkhead Gate Guides U3	04-Oct-17	06-Oct-17
IN - Intake Gate Guides, Seal Face & Roller Paths U3 (BY OTHERS)	07-Oct-17	16-Nov-17
IN - Secondary Concrete - Intake Gate Roller Path, Lintel & Sill Beams U3 (BY OTHERS)	26-Oct-17	08-Nov-17
IN - Intake Gates U3 (BY OTHERS)	10-Nov-17	27-Nov-17
IN - Intake Gate Hoists U3 (BY OTHERS)	21-Nov-17	28-Feb-18
IN - Hoist Housing Superstructure & Enclosure U3	05-Dec-17	13-Jan-18
IN - Bulkhead Gate Monorail Crane Beam U3	28-May-18	04-Jun-18
IN - Unit 4	16-May-16	09-Nov-18
IN - Base Preparation U4	16-May-16	28-May-16
IN - Base Slab U4	18-Aug-16	21-Sep-16
IN - Piers U4	22-Sep-16	02-Aug-17
IN - Lower Headblock U4	03-Aug-17	31-Oct-17
IN - Upper Headblock U4	24-Oct-17	06-Jun-18
IN - Concrete Finishing & Clean-Up U4	06-Mar-18	07-Jun-18
IN - Bulkhead Trashrack Guides U4	08-Jun-18	11-Jun-18
IN - Bulkhead Gate Guides U4	12-Jun-18	14-Jun-18
IN - Intake Gate Guides, Seal Face & Roller Paths U4 (BY OTHERS)	23-Jun-18	06-Aug-18
IN - Secondary Concrete - Intake Gate Roller Path, Lintel & Sill Beams U4 (BY OTHERS)	11-Jul-18	28-Jul-18
IN - Intake Gates U4 (BY OTHERS)	26-Jul-18	16-Aug-18
IN - Intake Gate Hoists U4 (BY OTHERS)	06-Aug-18	09-Nov-18
IN - Hoist Housing Superstructure & Enclosure U4	23-Aug-18	24-Sep-18
IN - Bulkhead Gate Monorail Crane Beam U4	24-Sep-18	01-Oct-18
IN - Unit 5	02-May-16	24-Oct-18
IN - Base Preparation U5	02-May-16	14-May-16
IN - Base Slab U5	18-Jun-16	22-Jul-16

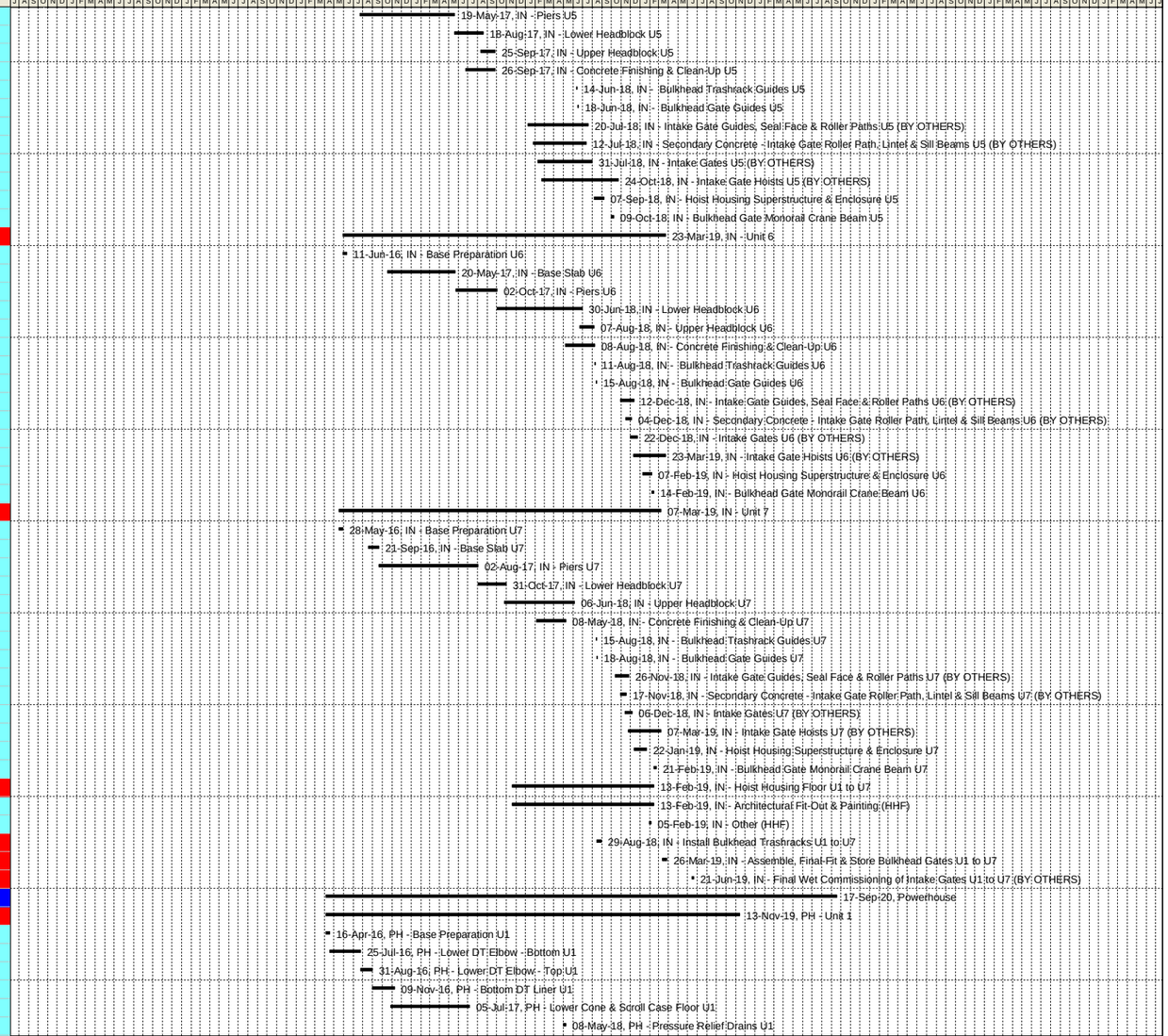


◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
IN - Piers U5	23-Jul-16	19-May-17
IN - Lower Headblock U5	20-May-17	18-Aug-17
IN - Upper Headblock U5	11-Aug-17	25-Sep-17
IN - Concrete Finishing & Clean-Up U5	23-Jun-17	26-Sep-17
IN - Bulkhead Trashrack Guides U5	12-Jun-18	14-Jun-18
IN - Bulkhead Gate Guides U5	15-Jun-18	18-Jun-18
IN - Intake Gate Guides, Seal Face & Roller Paths U5 (BY OTHERS)	08-Jan-18	20-Jul-18
IN - Secondary Concrete - Intake Gate Roller Path, Lintel & Sill Beams U5 (BY OTHERS)	25-Jan-18	12-Jul-18
IN - Intake Gates U5 (BY OTHERS)	09-Feb-18	31-Jul-18
IN - Intake Gate Hoists U5 (BY OTHERS)	20-Feb-18	24-Oct-18
IN - Hoist Housing Superstructure & Enclosure U5	08-Aug-18	07-Sep-18
IN - Bulkhead Gate Monorail Crane Beam U5	01-Oct-18	09-Oct-18
IN - Unit 6	30-May-16	23-Mar-19
IN - Base Preparation U6	30-May-16	11-Jun-16
IN - Base Slab U6	18-Oct-16	20-May-17
IN - Piers U6	23-May-17	02-Oct-17
IN - Lower Headblock U6	03-Oct-17	30-Jun-18
IN - Upper Headblock U6	23-Jun-18	07-Aug-18
IN - Concrete Finishing & Clean-Up U6	07-May-18	08-Aug-18
IN - Bulkhead Trashrack Guides U6	09-Aug-18	11-Aug-18
IN - Bulkhead Gate Guides U6	13-Aug-18	15-Aug-18
IN - Intake Gate Guides, Seal Face & Roller Paths U6 (BY OTHERS)	29-Oct-18	12-Dec-18
IN - Secondary Concrete - Intake Gate Roller Path, Lintel & Sill Beams U6 (BY OTHERS)	15-Nov-18	04-Dec-18
IN - Intake Gates U6 (BY OTHERS)	30-Nov-18	22-Dec-18
IN - Intake Gate Hoists U6 (BY OTHERS)	11-Dec-18	23-Mar-19
IN - Hoist Housing Superstructure & Enclosure U6	08-Jan-19	07-Feb-19
IN - Bulkhead Gate Monorail Crane Beam U6	07-Feb-19	14-Feb-19
IN - Unit 7	16-May-16	07-Mar-19
IN - Base Preparation U7	16-May-16	28-May-16
IN - Base Slab U7	18-Aug-16	21-Sep-16
IN - Piers U7	22-Sep-16	02-Aug-17
IN - Lower Headblock U7	03-Aug-17	31-Oct-17
IN - Upper Headblock U7	24-Oct-17	06-Jun-18
IN - Concrete Finishing & Clean-Up U7	05-Feb-18	08-May-18
IN - Bulkhead Trashrack Guides U7	13-Aug-18	15-Aug-18
IN - Bulkhead Gate Guides U7	16-Aug-18	18-Aug-18
IN - Intake Gate Guides, Seal Face & Roller Paths U7 (BY OTHERS)	12-Oct-18	26-Nov-18
IN - Secondary Concrete - Intake Gate Roller Path, Lintel & Sill Beams U7 (BY OTHERS)	30-Oct-18	17-Nov-18
IN - Intake Gates U7 (BY OTHERS)	14-Nov-18	06-Dec-18
IN - Intake Gate Hoists U7 (BY OTHERS)	24-Nov-18	07-Mar-19
IN - Hoist Housing Superstructure & Enclosure U7	13-Dec-18	22-Jan-19
IN - Bulkhead Gate Monorail Crane Beam U7	14-Feb-19	21-Feb-19
IN - Hoist Housing Floor U1 to U7	20-Nov-17	13-Feb-19
IN - Architectural Fit-Out & Painting (HHF)	20-Nov-17	13-Feb-19
IN - Other (HHF)	29-Jan-19	05-Feb-19
IN - Install Bulkhead Trashracks U1 to U7	16-Aug-18	29-Aug-18
IN - Assemble, Final-Fit & Store Bulkhead Gates U1 to U7	12-Mar-19	26-Mar-19
IN - Final Wet Commissioning of Intake Gates U1 to U7 (BY OTHERS)	15-Jun-19	21-Jun-19
Powerhouse	04-Apr-16	17-Sep-20
PH - Unit 1	04-Apr-16	13-Nov-19
PH - Base Preparation U1	04-Apr-16	16-Apr-16
PH - Lower DT Elbow - Bottom U1	18-Apr-16	25-Jul-16
PH - Lower DT Elbow - Top U1	25-Jul-16	31-Aug-16
PH - Bottom DT Liner U1	31-Aug-16	09-Nov-16
PH - Lower Cone & Scroll Case Floor U1	29-Oct-16	05-Jul-17
PH - Pressure Relief Drains U1	01-May-18	08-May-18



◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

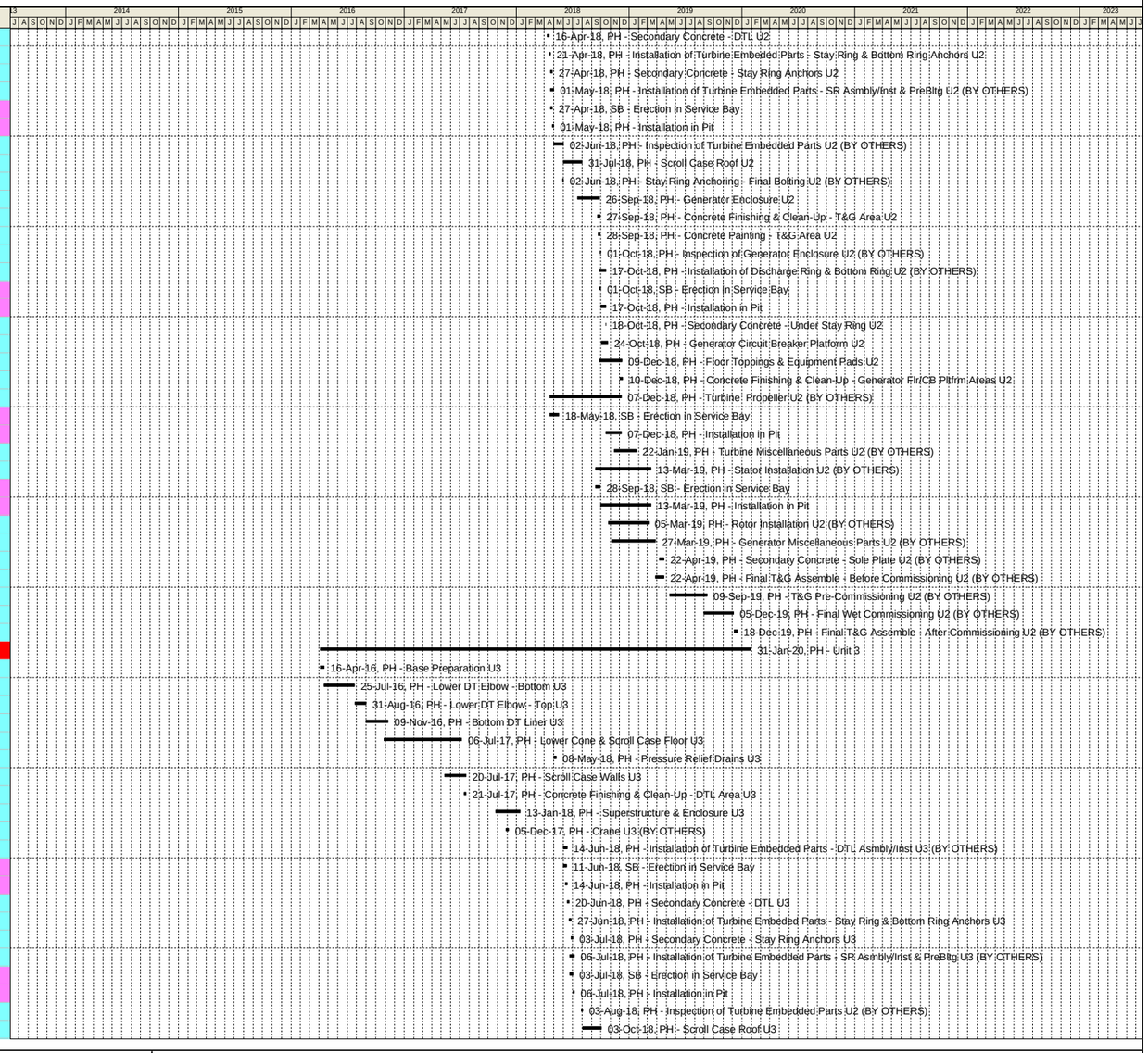
Activity Name	Start	Finish
PH - Scroll Case Walls U1	12-May-17	20-Jul-17
PH - Concrete Finishing & Clean-Up - DTL Area U1	14-Jul-17	21-Jul-17
PH - Superstructure & Enclosure U1	09-Aug-17	13-Oct-17
PH - Crane U1 (BY OTHERS)	06-Sep-17	13-Sep-17
PH - Turbine Pre-Work U1 (BY OTHERS)	18-Aug-17	17-Jan-18
PH - Installation of Turbine Embedded Parts - DTL Asmbly/Inst U1 (BY OTHERS)	17-Jan-18	29-Jan-18
SB - Erection in Service Bay	17-Jan-18	25-Jan-18
PH - Installation in Pit	25-Jan-18	29-Jan-18
PH - Secondary Concrete - DTL U1	29-Jan-18	03-Feb-18
PH - Installation of Turbine Embeded Parts - Stay Ring & Bottom Ring Anchors U1	03-Feb-18	09-Feb-18
PH - Secondary Concrete - Stay Ring Anchors U1	09-Feb-18	15-Feb-18
PH - Installation of Turbine Embedded Parts - SR Asmbly/Inst & PreBltg U1 (BY OTHERS)	08-Feb-18	19-Feb-18
SB - Erection in Service Bay	08-Feb-18	15-Feb-18
PH - Installation in Pit	15-Feb-18	19-Feb-18
PH - Inspection of Turbine Embedded Parts U1 (BY OTHERS)	19-Feb-18	28-Mar-18
PH - Scroll Case Roof U1	28-Mar-18	28-May-18
PH - Stay Ring Anchoring - Final Bolting U1 (BY OTHERS)	20-Mar-18	22-Mar-18
PH - Generator Enclosure U1	11-May-18	20-Jul-18
PH - Concrete Finishing & Clean-Up - T&G Area U1	14-Jul-18	21-Jul-18
PH - Concrete Painting - T&G Area U1	18-Jul-18	25-Jul-18
PH - Inspection of Generator Enclosure U1 (BY OTHERS)	25-Jul-18	27-Jul-18
PH - Installation of Discharge Ring & Bottom Ring U1 (BY OTHERS)	24-Jul-18	11-Aug-18
SB - Erection in Service Bay	24-Jul-18	27-Jul-18
PH - Installation in Pit	27-Jul-18	11-Aug-18
PH - Secondary Concrete - Under Stay Ring U1	11-Aug-18	13-Aug-18
PH - Generator Circuit Breaker Platform U1	20-Jul-18	09-Aug-18
PH - Floor Toppings & Equipment Pads U1	20-Jul-18	02-Oct-18
PH - Concrete Finishing & Clean-Up - Generator Flr/CB Pltfrm Areas U1	26-Sep-18	03-Oct-18
PH - Turbine Propeller U1 (BY OTHERS)	07-Jul-18	04-Oct-18
SB - Erection in Service Bay	07-Jul-18	06-Aug-18
PH - Installation in Pit	13-Aug-18	04-Oct-18
PH - Turbine Miscellaneous Parts U1 (BY OTHERS)	12-Sep-18	06-Nov-18
PH - Stator Installation U1 (BY OTHERS)	10-Jul-18	20-Dec-18
PH - Installation in Pit	27-Jul-18	20-Dec-18
SB - Erection in Service Bay	10-Jul-18	24-Jul-18
PH - Rotor Installation U1 (BY OTHERS)	14-Aug-18	12-Dec-18
PH - Generator Miscellaneous Parts U1 (BY OTHERS)	30-Aug-18	17-Jan-19
PH - Secondary Concrete - Sole Plate U1 (BY OTHERS)	30-Jan-19	12-Feb-19
PH - Final T&G Assemble - Before Commissioning U1 (BY OTHERS)	17-Jan-19	12-Feb-19
PH - T&G Pre-Commissioning U1 (BY OTHERS)	04-Mar-19	26-Jul-19
PH - Final Wet Commissioning U1 (BY OTHERS)	25-Jul-19	31-Oct-19
PH - Final T&G Assemble - After Commissioning U1 (BY OTHERS)	01-Nov-19	13-Nov-19
PH - Unit 2	02-May-16	18-Dec-19
PH - Base Preparation U2	02-May-16	14-May-16
PH - Lower DT Elbow - Bottom U2	16-May-16	11-Oct-16
PH - Lower DT Elbow - Top U2	11-Oct-16	17-May-17
PH - Bottom DT Liner U2	17-May-17	29-Jul-17
PH - Lower Cone & Scroll Case Floor U2	18-Jul-17	22-Sep-17
PH - Pressure Relief Drains U2	01-May-18	08-May-18
PH - Scroll Case Walls U2	01-Aug-17	09-Oct-17
PH - Concrete Finishing & Clean-Up - DTL Area U2	02-Oct-17	10-Oct-17
PH - Superstructure & Enclosure U2	10-Oct-17	13-Dec-17
PH - Crane U2 (BY OTHERS)	07-Nov-17	14-Nov-17
PH - Installation of Turbine Embedded Parts - DTL Asmbly/Inst U2 (BY OTHERS)	28-Mar-18	10-Apr-18
SB - Erection in Service Bay	28-Mar-18	06-Apr-18
PH - Installation in Pit	06-Apr-18	10-Apr-18

◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
PH - Secondary Concrete - DTL U2	10-Apr-18	16-Apr-18
PH - Installation of Turbine Embeded Parts - Stay Ring & Bottom Ring Anchors U2	16-Apr-18	21-Apr-18
PH - Secondary Concrete - Stay Ring Anchors U2	21-Apr-18	27-Apr-18
PH - Installation of Turbine Embedded Parts - SR Asmbly/Inst & PreBltg U2 (BY OTHERS)	20-Apr-18	01-May-18
SB - Erection in Service Bay	20-Apr-18	27-Apr-18
PH - Installation in Pit	27-Apr-18	01-May-18
PH - Inspection of Turbine Embedded Parts U2 (BY OTHERS)	01-May-18	02-Jun-18
PH - Scroll Case Roof U2	02-Jun-18	31-Jul-18
PH - Stay Ring Anchoring - Final Bolting U2 (BY OTHERS)	31-May-18	02-Jun-18
PH - Generator Enclosure U2	17-Jul-18	26-Sep-18
PH - Concrete Finishing & Clean-Up - T&G Area U2	20-Sep-18	27-Sep-18
PH - Concrete Painting - T&G Area U2	21-Sep-18	28-Sep-18
PH - Inspection of Generator Enclosure U2 (BY OTHERS)	28-Sep-18	01-Oct-18
PH - Installation of Discharge Ring & Bottom Ring U2 (BY OTHERS)	27-Sep-18	17-Oct-18
SB - Erection in Service Bay	27-Sep-18	01-Oct-18
PH - Installation in Pit	01-Oct-18	17-Oct-18
PH - Secondary Concrete - Under Stay Ring U2	17-Oct-18	18-Oct-18
PH - Generator Circuit Breaker Platform U2	03-Oct-18	24-Oct-18
PH - Floor Toppings & Equipment Pads U2	26-Sep-18	09-Dec-18
PH - Concrete Finishing & Clean-Up - Generator Flr/CB Pltfrm Areas U2	03-Dec-18	10-Dec-18
PH - Turbine Propeller U2 (BY OTHERS)	19-Apr-18	07-Dec-18
SB - Erection in Service Bay	19-Apr-18	18-May-18
PH - Installation in Pit	18-Oct-18	07-Dec-18
PH - Turbine Miscellaneous Parts U2 (BY OTHERS)	14-Nov-18	22-Jan-19
PH - Stator Installation U2 (BY OTHERS)	14-Sep-18	13-Mar-19
SB - Erection in Service Bay	14-Sep-18	28-Sep-18
PH - Installation in Pit	01-Oct-18	13-Mar-19
PH - Rotor Installation U2 (BY OTHERS)	25-Oct-18	05-Mar-19
PH - Generator Miscellaneous Parts U2 (BY OTHERS)	05-Nov-18	27-Mar-19
PH - Secondary Concrete - Sole Plate U2 (BY OTHERS)	08-Apr-19	22-Apr-19
PH - Final T&G Assemble - Before Commissioning U2 (BY OTHERS)	27-Mar-19	22-Apr-19
PH - T&G Pre-Commissioning U2 (BY OTHERS)	11-May-19	09-Sep-19
PH - Final Wet Commissioning U2 (BY OTHERS)	30-Aug-19	05-Dec-19
PH - Final T&G Assemble - After Commissioning U2 (BY OTHERS)	07-Dec-19	18-Dec-19
PH - Unit 3	04-Apr-16	31-Jan-20
PH - Base Preparation U3	04-Apr-16	16-Apr-16
PH - Lower DT Elbow - Bottom U3	18-Apr-16	25-Jul-16
PH - Lower DT Elbow - Top U3	26-Jul-16	31-Aug-16
PH - Bottom DT Liner U3	31-Aug-16	09-Nov-16
PH - Lower Cone & Scroll Case Floor U3	29-Oct-16	06-Jul-17
PH - Pressure Relief Drains U3	01-May-18	08-May-18
PH - Scroll Case Walls U3	12-May-17	20-Jul-17
PH - Concrete Finishing & Clean-Up - DTL Area U3	14-Jul-17	21-Jul-17
PH - Superstructure & Enclosure U3	24-Oct-17	13-Jan-18
PH - Crane U3 (BY OTHERS)	27-Nov-17	05-Dec-17
PH - Installation of Turbine Embedded Parts - DTL Asmbly/Inst U3 (BY OTHERS)	02-Jun-18	14-Jun-18
SB - Erection in Service Bay	02-Jun-18	11-Jun-18
PH - Installation in Pit	08-Jun-18	14-Jun-18
PH - Secondary Concrete - DTL U3	14-Jun-18	20-Jun-18
PH - Installation of Turbine Embeded Parts - Stay Ring & Bottom Ring Anchors U3	20-Jun-18	27-Jun-18
PH - Secondary Concrete - Stay Ring Anchors U3	27-Jun-18	03-Jul-18
PH - Installation of Turbine Embedded Parts - SR Asmbly/Inst & PreBltg U3 (BY OTHERS)	23-Jun-18	06-Jul-18
SB - Erection in Service Bay	23-Jun-18	03-Jul-18
PH - Installation in Pit	03-Jul-18	06-Jul-18
PH - Inspection of Turbine Embedded Parts U2 (BY OTHERS)	30-Jul-18	03-Aug-18
PH - Scroll Case Roof U3	03-Aug-18	03-Oct-18

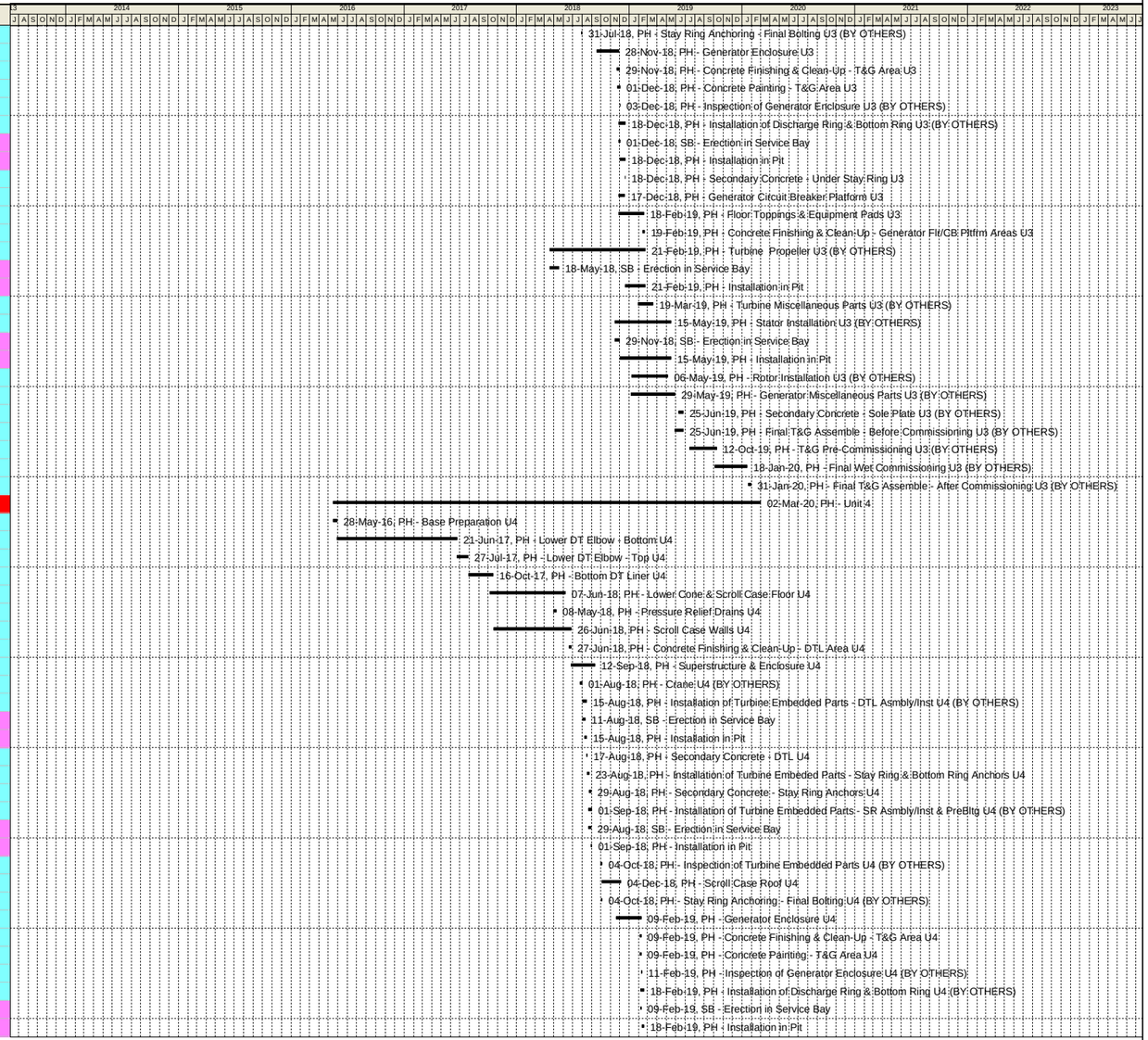


◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
PH - Stay Ring Anchoring - Final Bolting U3 (BY OTHERS)	30-Jul-18	31-Jul-18
PH - Generator Enclosure U3	18-Sep-18	28-Nov-18
PH - Concrete Finishing & Clean-Up - T&G Area U3	22-Nov-18	29-Nov-18
PH - Concrete Painting - T&G Area U3	24-Nov-18	01-Dec-18
PH - Inspection of Generator Enclosure U3 (BY OTHERS)	01-Dec-18	03-Dec-18
PH - Installation of Discharge Ring & Bottom Ring U3 (BY OTHERS)	28-Nov-18	18-Dec-18
SB - Erection in Service Bay	28-Nov-18	01-Dec-18
PH - Installation in Pit	03-Dec-18	18-Dec-18
PH - Secondary Concrete - Under Stay Ring U3	18-Dec-18	18-Dec-18
PH - Generator Circuit Breaker Platform U3	28-Nov-18	17-Dec-18
PH - Floor Toppings & Equipment Pads U3	28-Nov-18	18-Feb-19
PH - Concrete Finishing & Clean-Up - Generator Flr/CB Pltfrm Areas U3	12-Feb-19	19-Feb-19
PH - Turbine Propeller U3 (BY OTHERS)	19-Apr-18	21-Feb-19
SB - Erection in Service Bay	19-Apr-18	18-May-18
PH - Installation in Pit	19-Dec-18	21-Feb-19
PH - Turbine Miscellaneous Parts U3 (BY OTHERS)	29-Jan-19	19-Mar-19
PH - Stator Installation U3 (BY OTHERS)	15-Nov-18	15-May-19
SB - Erection in Service Bay	15-Nov-18	29-Nov-18
PH - Installation in Pit	03-Dec-18	15-May-19
PH - Rotor Installation U3 (BY OTHERS)	08-Jan-19	06-May-19
PH - Generator Miscellaneous Parts U3 (BY OTHERS)	07-Jan-19	29-May-19
PH - Secondary Concrete - Sole Plate U3 (BY OTHERS)	11-Jun-19	25-Jun-19
PH - Final T&G Assemble - Before Commissioning U3 (BY OTHERS)	29-May-19	25-Jun-19
PH - T&G Pre-Commissioning U3 (BY OTHERS)	16-Jul-19	12-Oct-19
PH - Final Wet Commissioning U3 (BY OTHERS)	05-Oct-19	18-Jan-20
PH - Final T&G Assemble - After Commissioning U3 (BY OTHERS)	21-Jan-20	31-Jan-20
PH - Unit 4	16-May-16	02-Mar-20
PH - Base Preparation U4	16-May-16	28-May-16
PH - Lower DT Elbow - Bottom U4	30-May-16	21-Jun-17
PH - Lower DT Elbow - Top U4	21-Jun-17	27-Jul-17
PH - Bottom DT Liner U4	29-Jul-17	16-Oct-17
PH - Lower Cone & Scroll Case Floor U4	05-Oct-17	07-Jun-18
PH - Pressure Relief Drains U4	01-May-18	08-May-18
PH - Scroll Case Walls U4	19-Oct-17	26-Jun-18
PH - Concrete Finishing & Clean-Up - DTL Area U4	20-Jun-18	27-Jun-18
PH - Superstructure & Enclosure U4	27-Jun-18	12-Sep-18
PH - Crane U4 (BY OTHERS)	25-Jul-18	01-Aug-18
PH - Installation of Turbine Embedded Parts - DTL Asmbly/Inst U4 (BY OTHERS)	03-Aug-18	15-Aug-18
SB - Erection in Service Bay	03-Aug-18	11-Aug-18
PH - Installation in Pit	09-Aug-18	15-Aug-18
PH - Secondary Concrete - DTL U4	15-Aug-18	17-Aug-18
PH - Installation of Turbine Embeded Parts - Stay Ring & Bottom Ring Anchors U4	17-Aug-18	23-Aug-18
PH - Secondary Concrete - Stay Ring Anchors U4	23-Aug-18	29-Aug-18
PH - Installation of Turbine Embedded Parts - SR Asmbly/Inst & PreBltg U4 (BY OTHERS)	22-Aug-18	01-Sep-18
SB - Erection in Service Bay	22-Aug-18	29-Aug-18
PH - Installation in Pit	29-Aug-18	01-Sep-18
PH - Inspection of Turbine Embedded Parts U4 (BY OTHERS)	01-Oct-18	04-Oct-18
PH - Scroll Case Roof U4	04-Oct-18	04-Dec-18
PH - Stay Ring Anchoring - Final Bolting U4 (BY OTHERS)	02-Oct-18	04-Oct-18
PH - Generator Enclosure U4	19-Nov-18	09-Feb-19
PH - Concrete Finishing & Clean-Up - T&G Area U4	04-Feb-19	09-Feb-19
PH - Concrete Painting - T&G Area U4	04-Feb-19	09-Feb-19
PH - Inspection of Generator Enclosure U4 (BY OTHERS)	10-Feb-19	11-Feb-19
PH - Installation of Discharge Ring & Bottom Ring U4 (BY OTHERS)	06-Feb-19	18-Feb-19
SB - Erection in Service Bay	06-Feb-19	09-Feb-19
PH - Installation in Pit	11-Feb-19	18-Feb-19



◆ Milestone

Summary

Manitoba Hydro

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

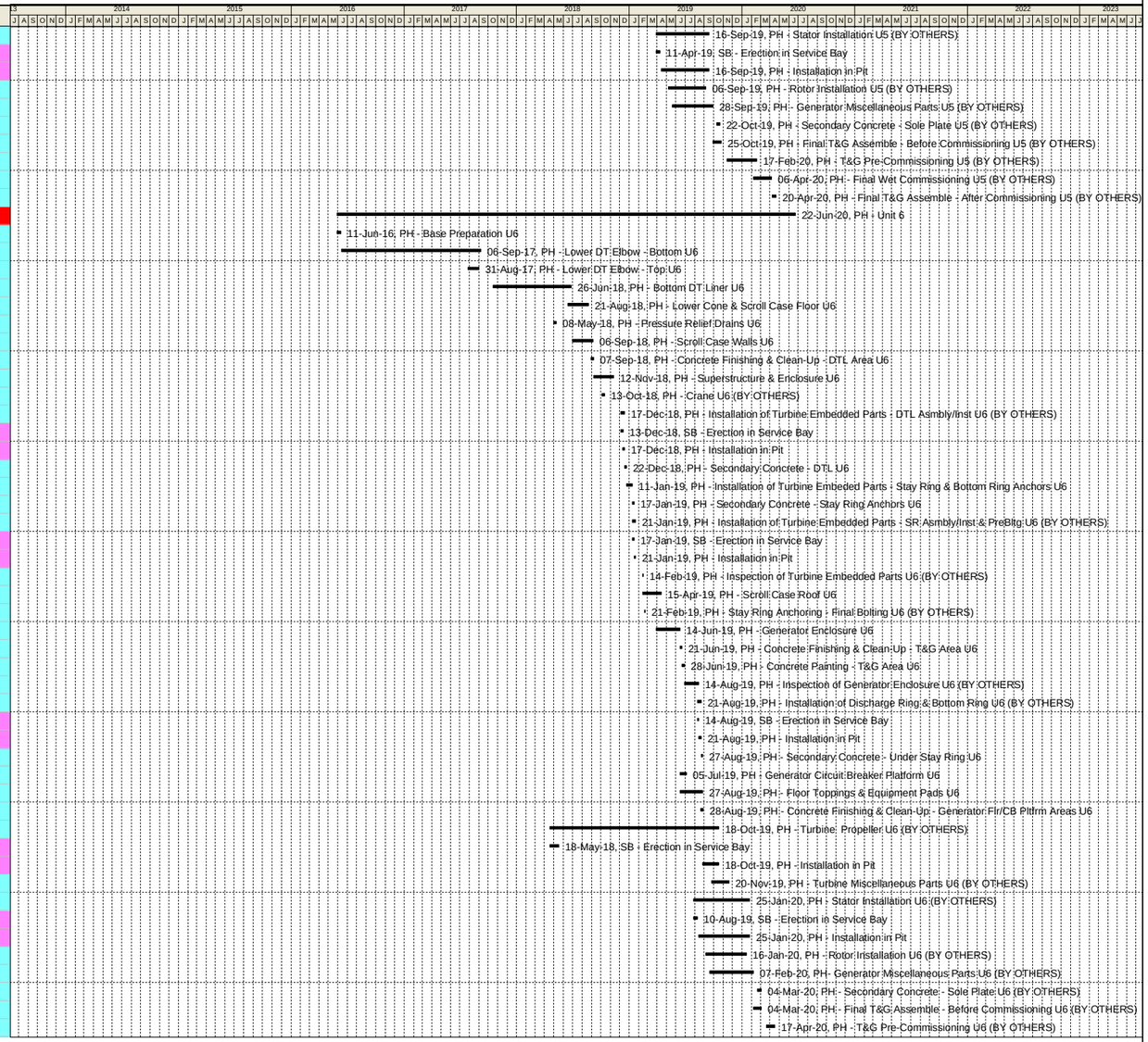
Activity Name	Start	Finish
PH - Secondary Concrete - Under Stay Ring U4	18-Feb-19	04-Mar-19
PH - Generator Circuit Breaker Platform U4	11-Feb-19	01-Mar-19
PH - Floor Toppings & Equipment Pads U4	11-Feb-19	24-Apr-19
PH - Concrete Finishing & Clean-Up - Generator Flr/CB Pltfrm Areas U4	18-Apr-19	25-Apr-19
PH - Turbine Propeller U4 (BY OTHERS)	19-Apr-18	24-Apr-19
SB - Erection in Service Bay	19-Apr-18	18-May-18
PH - Installation in Pit	04-Mar-19	24-Apr-19
PH - Turbine Miscellaneous Parts U4 (BY OTHERS)	30-Mar-19	25-May-19
PH - Stator Installation U4 (BY OTHERS)	24-Jan-19	13-Jul-19
SB - Erection in Service Bay	24-Jan-19	07-Feb-19
PH - Installation in Pit	11-Feb-19	13-Jul-19
PH - Rotor Installation U4 (BY OTHERS)	05-Mar-19	04-Jul-19
PH - Generator Miscellaneous Parts U4 (BY OTHERS)	16-Mar-19	26-Jul-19
PH - Secondary Concrete - Sole Plate U4 (BY OTHERS)	08-Aug-19	17-Aug-19
PH - Final T&G Assemble - Before Commissioning U4 (BY OTHERS)	26-Jul-19	21-Aug-19
PH - T&G Pre-Commissioning U4 (BY OTHERS)	11-Sep-19	16-Dec-19
PH - Final Wet Commissioning U4 (BY OTHERS)	26-Nov-19	18-Feb-20
PH - Final T&G Assemble - After Commissioning U4 (BY OTHERS)	20-Feb-20	02-Mar-20
PH - Unit 5	02-May-16	20-Apr-20
PH - Base Preparation U5	02-May-16	14-May-16
PH - Lower DT Elbow - Bottom U5	16-May-16	07-Oct-16
PH - Lower DT Elbow - Top U5	07-Oct-16	12-May-17
PH - Bottom DT Liner U5	12-May-17	29-Jul-17
PH - Lower Cone & Scroll Case Floor U5	18-Jul-17	22-Sep-17
PH - Pressure Relief Drains U5	01-May-18	08-May-18
PH - Scroll Case Walls U5	01-Aug-17	09-Oct-17
PH - Concrete Finishing & Clean-Up - DTL Area U5	02-Oct-17	10-Oct-17
PH - Superstructure & Enclosure U5	15-May-18	21-Sep-18
PH - Crane U5 (BY OTHERS)	14-Aug-18	22-Aug-18
PH - Installation of Turbine Embedded Parts - DTL Asmbly/Inst U5 (BY OTHERS)	04-Oct-18	17-Oct-18
SB - Erection in Service Bay	04-Oct-18	13-Oct-18
PH - Installation in Pit	11-Oct-18	17-Oct-18
PH - Secondary Concrete - DTL U5	17-Oct-18	23-Oct-18
PH - Installation of Turbine Embeded Parts - Stay Ring & Bottom Ring Anchors U5	23-Oct-18	29-Oct-18
PH - Secondary Concrete - Stay Ring Anchors U5	29-Oct-18	03-Nov-18
PH - Installation of Turbine Embedded Parts - SR Asmbly & PreBltg U5 (BY OTHERS)	27-Oct-18	07-Nov-18
SB - Erection in Service Bay	27-Oct-18	03-Nov-18
PH - Installation in Pit	03-Nov-18	07-Nov-18
PH - Inspection of Turbine Embedded Parts U5 (BY OTHERS)	03-Dec-18	05-Dec-18
PH - Scroll Case Roof U5	05-Dec-18	12-Feb-19
PH - Stay Ring Anchoring - Final Bolting U5 (BY OTHERS)	06-Dec-18	08-Dec-18
PH - Generator Enclosure U5	28-Jan-19	12-Apr-19
PH - Concrete Finishing & Clean-Up - T&G Area U5	06-Apr-19	13-Apr-19
PH - Concrete Painting - T&G Area U5	06-Apr-19	13-Apr-19
PH - Inspection of Generator Enclosure U5 (BY OTHERS)	13-Apr-19	15-Apr-19
PH - Installation of Discharge Ring & Bottom Ring U5 (BY OTHERS)	10-Apr-19	23-Apr-19
SB - Erection in Service Bay	10-Apr-19	13-Apr-19
PH - Installation in Pit	15-Apr-19	23-Apr-19
PH - Secondary Concrete - Under Stay Ring U5	23-Apr-19	29-Apr-19
PH - Generator Circuit Breaker Platform U5	12-Apr-19	02-May-19
PH - Floor Toppings & Equipment Pads U5	01-May-19	12-Jul-19
PH - Concrete Finishing & Clean-Up - Generator Flr/CB Pltfrm Areas U5	06-Jul-19	13-Jul-19
PH - Turbine Propeller U5 (BY OTHERS)	19-Apr-18	19-Jun-19
SB - Erection in Service Bay	19-Apr-18	18-May-18
PH - Installation in Pit	29-Apr-19	19-Jun-19
PH - Turbine Miscellaneous Parts U5 (BY OTHERS)	27-May-19	22-Jul-19

◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
PH - Stator Installation U5 (BY OTHERS)	28-Mar-19	16-Sep-19
SB - Erection in Service Bay	28-Mar-19	11-Apr-19
PH - Installation in Pit	15-Apr-19	16-Sep-19
PH - Rotor Installation U5 (BY OTHERS)	08-May-19	06-Sep-19
PH - Generator Miscellaneous Parts U5 (BY OTHERS)	21-May-19	28-Sep-19
PH - Secondary Concrete - Sole Plate U5 (BY OTHERS)	11-Oct-19	22-Oct-19
PH - Final T&G Assemble - Before Commissioning U5 (BY OTHERS)	28-Sep-19	25-Oct-19
PH - T&G Pre-Commissioning U5 (BY OTHERS)	14-Nov-19	17-Feb-20
PH - Final Wet Commissioning U5 (BY OTHERS)	07-Feb-20	06-Apr-20
PH - Final T&G Assemble - After Commissioning U5 (BY OTHERS)	08-Apr-20	20-Apr-20
PH - Unit 6	30-May-16	22-Jun-20
PH - Base Preparation U6	30-May-16	11-Jun-16
PH - Lower DT Elbow - Bottom U6	13-Jun-16	06-Sep-17
PH - Lower DT Elbow - Top U6	27-Jul-17	31-Aug-17
PH - Bottom DT Liner U6	17-Oct-17	26-Jun-18
PH - Lower Cone & Scroll Case Floor U6	16-Jun-18	21-Aug-18
PH - Pressure Relief Drains U6	01-May-18	08-May-18
PH - Scroll Case Walls U6	30-Jun-18	06-Sep-18
PH - Concrete Finishing & Clean-Up - DTL Area U6	31-Aug-18	07-Sep-18
PH - Superstructure & Enclosure U6	08-Sep-18	12-Nov-18
PH - Crane U6 (BY OTHERS)	05-Oct-18	13-Oct-18
PH - Installation of Turbine Embedded Parts - DTL Asmbly/Inst U6 (BY OTHERS)	05-Dec-18	17-Dec-18
SB - Erection in Service Bay	05-Dec-18	13-Dec-18
PH - Installation in Pit	11-Dec-18	17-Dec-18
PH - Secondary Concrete - DTL U6	17-Dec-18	22-Dec-18
PH - Installation of Turbine Embeded Parts - Stay Ring & Bottom Ring Anchors U6	22-Dec-18	11-Jan-19
PH - Secondary Concrete - Stay Ring Anchors U6	11-Jan-19	17-Jan-19
PH - Installation of Turbine Embedded Parts - SR Asmbly/Inst & PreBltg U6 (BY OTHERS)	10-Jan-19	21-Jan-19
SB - Erection in Service Bay	10-Jan-19	17-Jan-19
PH - Installation in Pit	17-Jan-19	21-Jan-19
PH - Inspection of Turbine Embedded Parts U6 (BY OTHERS)	13-Feb-19	14-Feb-19
PH - Scroll Case Roof U6	14-Feb-19	15-Apr-19
PH - Stay Ring Anchoring - Final Bolting U6 (BY OTHERS)	19-Feb-19	21-Feb-19
PH - Generator Enclosure U6	30-Mar-19	14-Jun-19
PH - Concrete Finishing & Clean-Up - T&G Area U6	14-Jun-19	21-Jun-19
PH - Concrete Painting - T&G Area U6	21-Jun-19	28-Jun-19
PH - Inspection of Generator Enclosure U6 (BY OTHERS)	28-Jun-19	14-Aug-19
PH - Installation of Discharge Ring & Bottom Ring U6 (BY OTHERS)	10-Aug-19	21-Aug-19
SB - Erection in Service Bay	10-Aug-19	14-Aug-19
PH - Installation in Pit	14-Aug-19	21-Aug-19
PH - Secondary Concrete - Under Stay Ring U6	22-Aug-19	27-Aug-19
PH - Generator Circuit Breaker Platform U6	14-Jun-19	05-Jul-19
PH - Floor Toppings & Equipment Pads U6	14-Jun-19	27-Aug-19
PH - Concrete Finishing & Clean-Up - Generator Flr/CB Pltfrm Areas U6	21-Aug-19	28-Aug-19
PH - Turbine Propeller U6 (BY OTHERS)	19-Apr-18	18-Oct-19
SB - Erection in Service Bay	19-Apr-18	18-May-18
PH - Installation in Pit	27-Aug-19	18-Oct-19
PH - Turbine Miscellaneous Parts U6 (BY OTHERS)	25-Sep-19	20-Nov-19
PH - Stator Installation U6 (BY OTHERS)	29-Jul-19	25-Jan-20
SB - Erection in Service Bay	29-Jul-19	10-Aug-19
PH - Installation in Pit	14-Aug-19	25-Jan-20
PH - Rotor Installation U6 (BY OTHERS)	06-Sep-19	16-Jan-20
PH- Generator Miscellaneous Parts U6 (BY OTHERS)	19-Sep-19	07-Feb-20
PH - Secondary Concrete - Sole Plate U6 (BY OTHERS)	20-Feb-20	04-Mar-20
PH - Final T&G Assemble - Before Commissioning U6 (BY OTHERS)	07-Feb-20	04-Mar-20
PH - T&G Pre-Commissioning U6 (BY OTHERS)	21-Mar-20	17-Apr-20

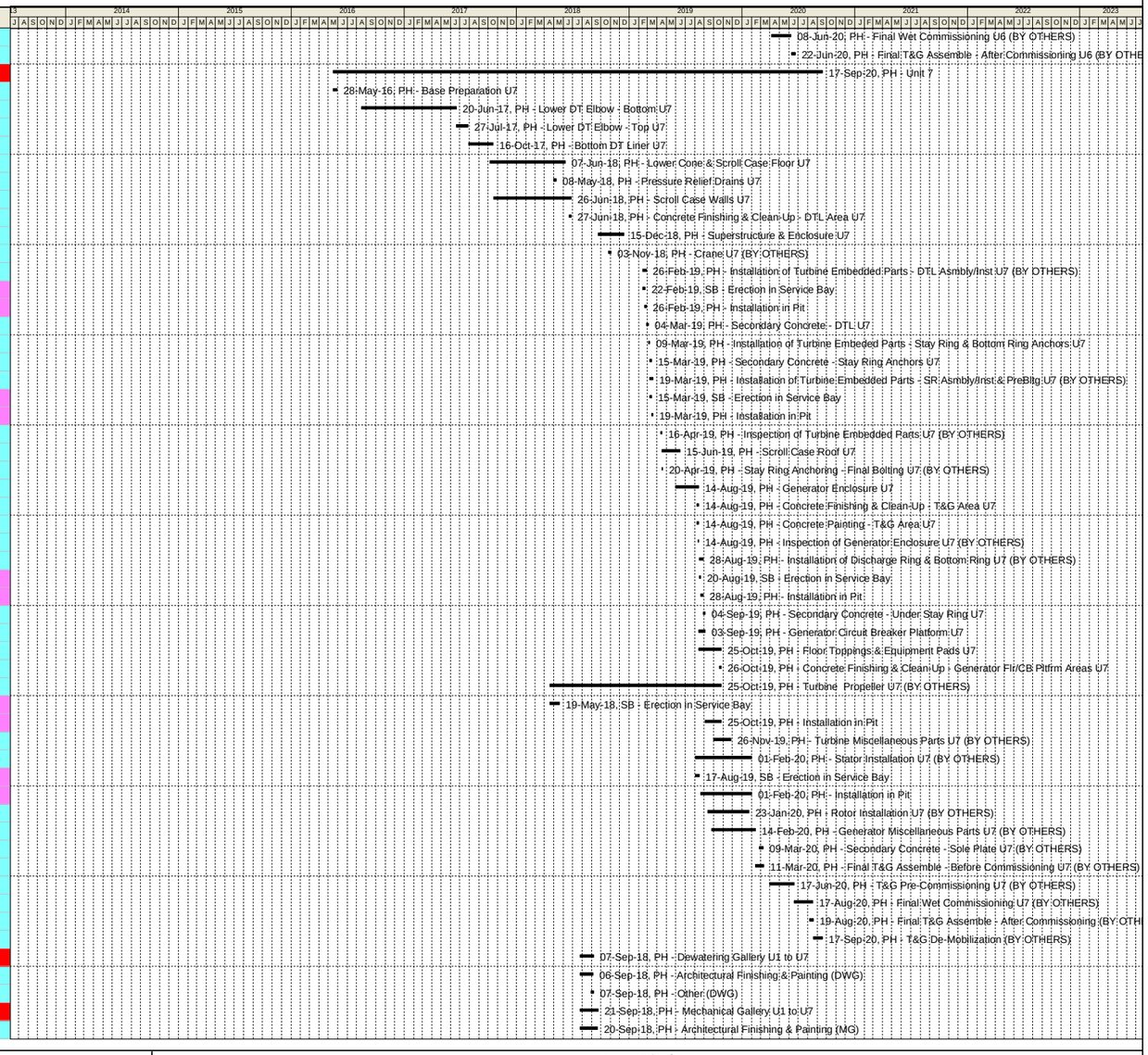


◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
PH - Final Wet Commissioning U6 (BY OTHERS)	07-Apr-20	08-Jun-20
PH - Final T&G Assemble - After Commissioning U6 (BY OTHERS)	10-Jun-20	22-Jun-20
PH - Unit 7	16-May-16	17-Sep-20
PH - Base Preparation U7	16-May-16	28-May-16
PH - Lower DT Elbow - Bottom U7	16-Aug-16	20-Jun-17
PH - Lower DT Elbow - Top U7	20-Jun-17	27-Jul-17
PH - Bottom DT Liner U7	29-Jul-17	16-Oct-17
PH - Lower Cone & Scroll Case Floor U7	05-Oct-17	07-Jun-18
PH - Pressure Relief Drains U7	01-May-18	08-May-18
PH - Scroll Case Walls U7	19-Oct-17	26-Jun-18
PH - Concrete Finishing & Clean-Up - DTL Area U7	20-Jun-18	27-Jun-18
PH - Superstructure & Enclosure U7	22-Sep-18	15-Dec-18
PH - Crane U7 (BY OTHERS)	26-Oct-18	03-Nov-18
PH - Installation of Turbine Embedded Parts - DTL Asmbly/Inst U7 (BY OTHERS)	14-Feb-19	26-Feb-19
SB - Erection in Service Bay	14-Feb-19	22-Feb-19
PH - Installation in Pit	20-Feb-19	26-Feb-19
PH - Secondary Concrete - DTL U7	26-Feb-19	04-Mar-19
PH - Installation of Turbine Embeded Parts - Stay Ring & Bottom Ring Anchors U7	04-Mar-19	09-Mar-19
PH - Secondary Concrete - Stay Ring Anchors U7	09-Mar-19	15-Mar-19
PH - Installation of Turbine Embedded Parts - SR Asmbly/Inst & PreBltg U7 (BY OTHERS)	08-Mar-19	19-Mar-19
SB - Erection in Service Bay	08-Mar-19	15-Mar-19
PH - Installation in Pit	15-Mar-19	19-Mar-19
PH - Inspection of Turbine Embedded Parts U7 (BY OTHERS)	13-Apr-19	16-Apr-19
PH - Scroll Case Roof U7	16-Apr-19	15-Jun-19
PH - Stay Ring Anchoring - Final Bolting U7 (BY OTHERS)	17-Apr-19	20-Apr-19
PH - Generator Enclosure U7	31-May-19	14-Aug-19
PH - Concrete Finishing & Clean-Up - T&G Area U7	07-Aug-19	14-Aug-19
PH - Concrete Painting - T&G Area U7	07-Aug-19	14-Aug-19
PH - Inspection of Generator Enclosure U7 (BY OTHERS)	12-Aug-19	14-Aug-19
PH - Installation of Discharge Ring & Bottom Ring U7 (BY OTHERS)	16-Aug-19	28-Aug-19
SB - Erection in Service Bay	16-Aug-19	20-Aug-19
PH - Installation in Pit	21-Aug-19	28-Aug-19
PH - Secondary Concrete - Under Stay Ring U7	28-Aug-19	04-Sep-19
PH - Generator Circuit Breaker Platform U7	14-Aug-19	03-Sep-19
PH - Floor Toppings & Equipment Pads U7	14-Aug-19	25-Oct-19
PH - Concrete Finishing & Clean-Up - Generator Flr/CB Pltfrm Areas U7	19-Oct-19	26-Oct-19
PH - Turbine Propeller U7 (BY OTHERS)	19-Apr-18	25-Oct-19
SB - Erection in Service Bay	19-Apr-18	19-May-18
PH - Installation in Pit	04-Sep-19	25-Oct-19
PH - Turbine Miscellaneous Parts U7 (BY OTHERS)	01-Oct-19	26-Nov-19
PH - Stator Installation U7 (BY OTHERS)	03-Aug-19	01-Feb-20
SB - Erection in Service Bay	03-Aug-19	17-Aug-19
PH - Installation in Pit	21-Aug-19	01-Feb-20
PH - Rotor Installation U7 (BY OTHERS)	13-Sep-19	23-Jan-20
PH - Generator Miscellaneous Parts U7 (BY OTHERS)	25-Sep-19	14-Feb-20
PH - Secondary Concrete - Sole Plate U7 (BY OTHERS)	27-Feb-20	09-Mar-20
PH - Final T&G Assemble - Before Commissioning U7 (BY OTHERS)	14-Feb-20	11-Mar-20
PH - T&G Pre-Commissioning U7 (BY OTHERS)	30-Mar-20	17-Jun-20
PH - Final Wet Commissioning U7 (BY OTHERS)	17-Jun-20	17-Aug-20
PH - Final T&G Assemble - After Commissioning (BY OTHERS)	08-Aug-20	19-Aug-20
PH - T&G De-Mobilization (BY OTHERS)	19-Aug-20	17-Sep-20
PH - Dewatering Gallery U1 to U7	25-Jul-18	07-Sep-18
PH - Architectural Finishing & Painting (DWG)	25-Jul-18	06-Sep-18
PH - Other (DWG)	30-Aug-18	07-Sep-18
PH - Mechanical Gallery U1 to U7	25-Jul-18	21-Sep-18
PH - Architectural Finishing & Painting (MG)	25-Jul-18	20-Sep-18



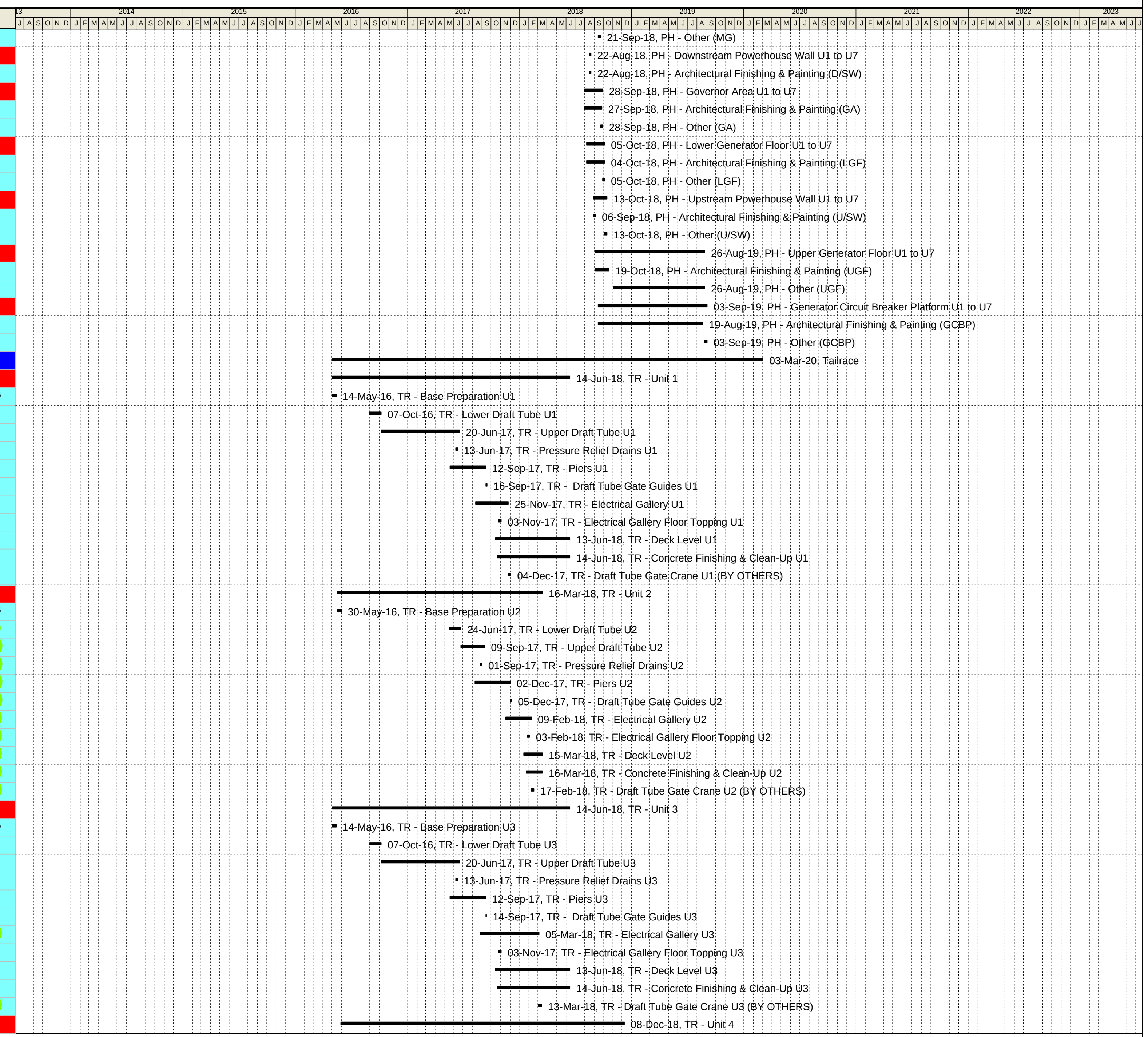
◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Manitoba Hydro

Activity Name	Start	Finish
PH - Other (MG)	14-Sep-18	21-Sep-18
PH - Downstream Powerhouse Wall U1 to U7	15-Aug-18	22-Aug-18
PH - Architectural Finishing & Painting (D/SW)	15-Aug-18	22-Aug-18
PH - Governor Area U1 to U7	01-Aug-18	28-Sep-18
PH - Architectural Finishing & Painting (GA)	01-Aug-18	27-Sep-18
PH - Other (GA)	21-Sep-18	28-Sep-18
PH - Lower Generator Floor U1 to U7	08-Aug-18	05-Oct-18
PH - Architectural Finishing & Painting (LGF)	08-Aug-18	04-Oct-18
PH - Other (LGF)	28-Sep-18	05-Oct-18
PH - Upstream Powerhouse Wall U1 to U7	29-Aug-18	13-Oct-18
PH - Architectural Finishing & Painting (U/SW)	29-Aug-18	06-Sep-18
PH - Other (U/SW)	05-Oct-18	13-Oct-18
PH - Upper Generator Floor U1 to U7	06-Sep-18	26-Aug-19
PH - Architectural Finishing & Painting (UGF)	06-Sep-18	19-Oct-18
PH - Other (UGF)	03-Nov-18	26-Aug-19
PH - Generator Circuit Breaker Platform U1 to U7	13-Sep-18	03-Sep-19
PH - Architectural Finishing & Painting (GCBP)	13-Sep-18	19-Aug-19
PH - Other (GCBP)	26-Aug-19	03-Sep-19
Tailrace	02-May-16	03-Mar-20
TR - Unit 1	02-May-16	14-Jun-18
TR - Base Preparation U1	02-May-16	14-May-16
TR - Lower Draft Tube U1	31-Aug-16	07-Oct-16
TR - Upper Draft Tube U1	07-Oct-16	20-Jun-17
TR - Pressure Relief Drains U1	06-Jun-17	13-Jun-17
TR - Piers U1	19-May-17	12-Sep-17
TR - Draft Tube Gate Guides U1	12-Sep-17	16-Sep-17
TR - Electrical Gallery U1	11-Aug-17	25-Nov-17
TR - Electrical Gallery Floor Topping U1	25-Oct-17	03-Nov-17
TR - Deck Level U1	14-Oct-17	13-Jun-18
TR - Concrete Finishing & Clean-Up U1	21-Oct-17	14-Jun-18
TR - Draft Tube Gate Crane U1 (BY OTHERS)	24-Nov-17	04-Dec-17
TR - Unit 2	16-May-16	16-Mar-18
TR - Base Preparation U2	16-May-16	30-May-16
TR - Lower Draft Tube U2	17-May-17	24-Jun-17
TR - Upper Draft Tube U2	24-Jun-17	09-Sep-17
TR - Pressure Relief Drains U2	25-Aug-17	01-Sep-17
TR - Piers U2	08-Aug-17	02-Dec-17
TR - Draft Tube Gate Guides U2	02-Dec-17	05-Dec-17
TR - Electrical Gallery U2	16-Nov-17	09-Feb-18
TR - Electrical Gallery Floor Topping U2	25-Jan-18	03-Feb-18
TR - Deck Level U2	15-Jan-18	15-Mar-18
TR - Concrete Finishing & Clean-Up U2	22-Jan-18	16-Mar-18
TR - Draft Tube Gate Crane U2 (BY OTHERS)	08-Feb-18	17-Feb-18
TR - Unit 3	02-May-16	14-Jun-18
TR - Base Preparation U3	02-May-16	14-May-16
TR - Lower Draft Tube U3	31-Aug-16	07-Oct-16
TR - Upper Draft Tube U3	07-Oct-16	20-Jun-17
TR - Pressure Relief Drains U3	06-Jun-17	13-Jun-17
TR - Piers U3	19-May-17	12-Sep-17
TR - Draft Tube Gate Guides U3	12-Sep-17	14-Sep-17
TR - Electrical Gallery U3	26-Aug-17	05-Mar-18
TR - Electrical Gallery Floor Topping U3	25-Oct-17	03-Nov-17
TR - Deck Level U3	14-Oct-17	13-Jun-18
TR - Concrete Finishing & Clean-Up U3	21-Oct-17	14-Jun-18
TR - Draft Tube Gate Crane U3 (BY OTHERS)	03-Mar-18	13-Mar-18
TR - Unit 4	30-May-16	08-Dec-18



◆ ◆ Milestone

▬ Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
TR - Base Preparation U4	30-May-16	11-Jun-16
TR - Lower Draft Tube U4	27-Jul-17	02-Sep-17
TR - Upper Draft Tube U4	02-Sep-17	17-Nov-17
TR - Pressure Relief Drains U4	03-Nov-17	10-Nov-17
TR - Piers U4	07-Oct-17	05-Sep-18
TR - Draft Tube Gate Guides U4	07-Aug-18	09-Aug-18
TR - Electrical Gallery U4	21-Jul-18	05-Nov-18
TR - Electrical Gallery Floor Topping U4	20-Oct-18	30-Oct-18
TR - Deck Level U4	09-Oct-18	07-Dec-18
TR - Concrete Finishing & Clean-Up U4	17-Oct-18	08-Dec-18
TR - Draft Tube Gate Crane U4 (BY OTHERS)	03-Nov-18	13-Nov-18
TR - Unit 5	16-May-16	06-Dec-18
TR - Base Preparation U5	16-May-16	28-May-16
TR - Lower Draft Tube U5	12-May-17	19-Jun-17
TR - Upper Draft Tube U5	19-Jun-17	02-Sep-17
TR - Pressure Relief Drains U5	21-Aug-17	26-Aug-17
TR - Piers U5	02-Aug-17	25-May-18
TR - Draft Tube Gate Guides U5	25-May-18	28-May-18
TR - Electrical Gallery U5	09-May-18	28-Nov-18
TR - Electrical Gallery Floor Topping U5	09-Jul-18	17-Jul-18
TR - Deck Level U5	27-Jun-18	27-Aug-18
TR - Concrete Finishing & Clean-Up U5	05-Jul-18	28-Aug-18
TR - Draft Tube Gate Crane U5 (BY OTHERS)	27-Nov-18	06-Dec-18
TR - Unit 6	13-Jun-16	12-Jan-19
TR - Base Preparation U6	13-Jun-16	25-Jun-16
TR - Lower Draft Tube U6	01-Sep-17	07-Oct-17
TR - Upper Draft Tube U6	09-Oct-17	20-Jun-18
TR - Pressure Relief Drains U6	06-Jun-18	13-Jun-18
TR - Piers U6	22-May-18	12-Sep-18
TR - Draft Tube Gate Guides U6	13-Sep-18	14-Sep-18
TR - Electrical Gallery U6	13-Aug-18	21-Dec-18
TR - Electrical Gallery Floor Topping U6	14-Nov-18	23-Nov-18
TR - Deck Level U6	03-Nov-18	11-Jan-19
TR - Concrete Finishing & Clean-Up U6	10-Nov-18	12-Jan-19
TR - Draft Tube Gate Crane U6 (BY OTHERS)	20-Dec-18	08-Jan-19
TR - Unit 7	30-May-16	10-May-19
TR - Base Preparation U7	30-May-16	11-Jun-16
TR - Lower Draft Tube U7	27-Jul-17	02-Sep-17
TR - Upper Draft Tube U7	02-Sep-17	17-Nov-17
TR - Pressure Relief Drains U7	03-Nov-17	10-Nov-17
TR - Piers U7	16-Oct-17	07-Aug-18
TR - Draft Tube Gate Guides U7	07-Aug-18	09-Aug-18
TR - Electrical Gallery U7	21-Jul-18	23-Jan-19
TR - Electrical Gallery Floor Topping U7	19-Sep-18	28-Sep-18
TR - Deck Level U7	08-Sep-18	09-May-19
TR - Concrete Finishing & Clean-Up U7	15-Sep-18	10-May-19
TR - Draft Tube Gate Crane U7 (BY OTHERS)	22-Jan-19	31-Jan-19
TR - Dewatering Gallery U2, U3, U5, U7	24-Nov-18	02-Jan-19
TR - Architectural Finishing & Painting (DWG)	24-Nov-18	22-Dec-18
TR - Other (DWG)	17-Dec-18	02-Jan-19
TR - Oil Water Separator Chamber U4	22-Dec-18	09-Jan-19
TR - Architectural Finishing & Painting (OWSC)	22-Dec-18	08-Jan-19
TR - Other (OWSC)	02-Jan-19	09-Jan-19
TR - Draft Tube Crane Gallery U1 to U7	15-Dec-18	07-Feb-19
TR - Architectural Finishing & Painting (DTCG)	15-Dec-18	29-Jan-19
TR - Other (DTCG)	31-Jan-19	07-Feb-19

◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

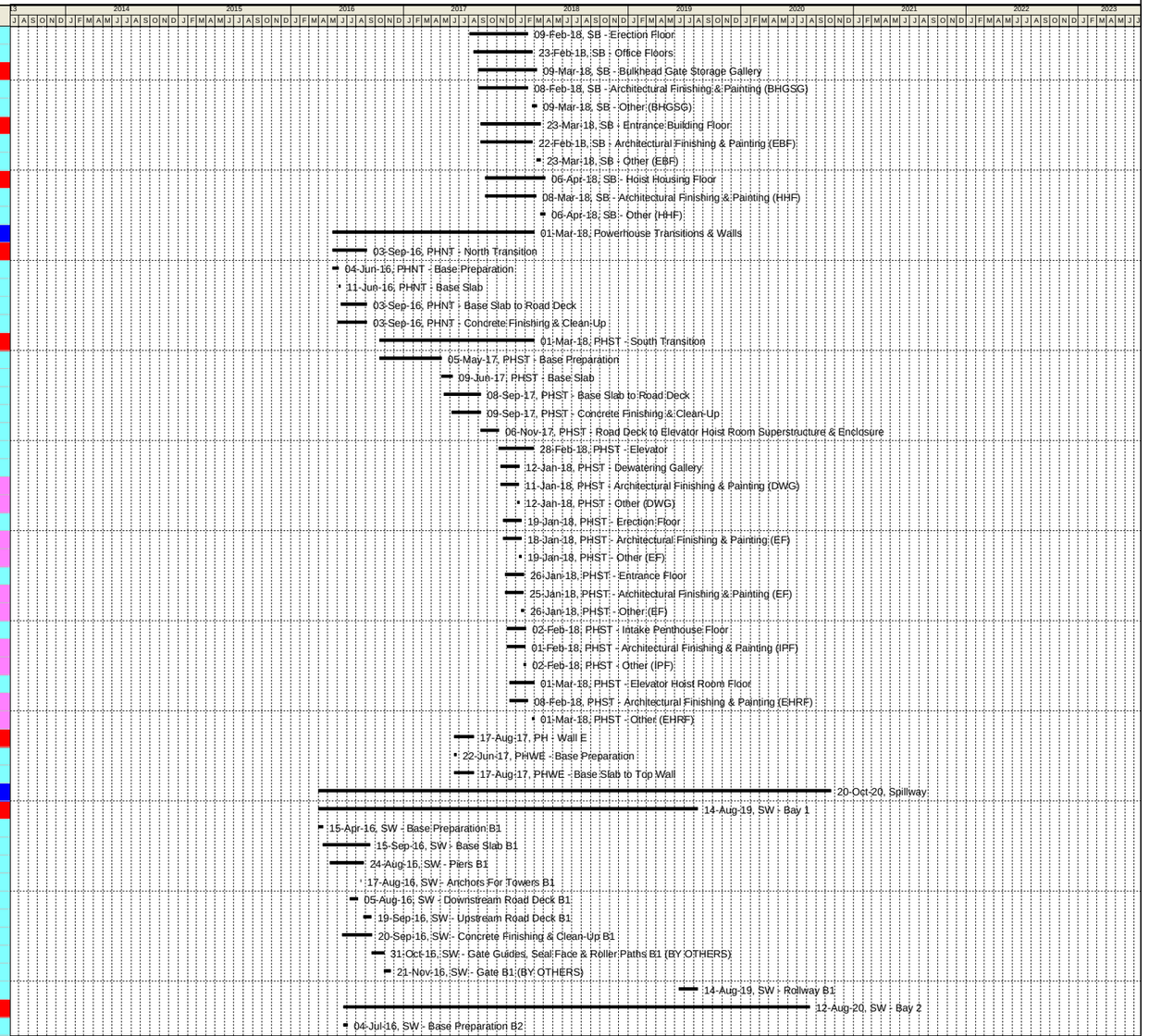
Activity Name	Start	Finish
TR - Electrical Services Gallery U1 to U7	04-Nov-17	14-Feb-19
TR - Architectural Finishing & Painting (ESG)	04-Nov-17	12-Feb-19
TR - Other (ESG)	07-Feb-19	14-Feb-19
TR - Tailrace Deck U1 to U7	16-Mar-18	03-Mar-20
TR - Steel Disconnect Structures U1 / U2	16-Mar-18	21-Jun-18
TR - Steel Disconnect Structures U3 / U4	14-Jun-18	15-Dec-18
TR - Steel Disconnect Structures U4 / U5	28-Aug-18	05-Sep-18
TR - Steel Disconnect Structures U6 / U7	12-Jan-19	17-May-19
TR - Architectural Finishing & Painting (TRD)	12-Feb-19	19-Feb-19
TR - Other (TRD)	25-Feb-20	03-Mar-20
TR - Assemble, Final-Fit & Install Draft Tube Gates U1 to U7	31-Jan-19	07-Feb-19
Service Bay	04-Apr-16	26-Dec-19
SB - Bay 1	04-Apr-16	25-Jan-17
SB - Gravity Section - GS1	15-Apr-16	12-Sep-16
GS1 - Base Preparation	15-Apr-16	17-May-16
GS1 - Base Slab	31-May-16	13-Jun-16
GS1 - Base Slab to Erection Floor	14-Jun-16	26-Aug-16
GS1 - Erection Floor to Road Deck	12-Jul-16	12-Sep-16
SB - Structural Section - SS1	04-Apr-16	13-Oct-16
SS1 - Base Preparation	04-Apr-16	09-May-16
SS1 - Base Slab	10-May-16	30-May-16
SS1 - Base Slab to Erection Floor	31-May-16	05-Sep-16
SS1 - Service Bay Floor Toppings & Equipment Pads	06-Sep-16	13-Oct-16
SB - Concrete Finishing & Clean-Up - Bay 1	10-Jun-16	25-Jan-17
SB - Bay 2	04-Apr-16	27-May-17
SB - Gravity Section - GS2	04-Apr-16	05-Sep-16
GS2 - Base Preparation	04-Apr-16	09-May-16
GS2 - Base Slab	10-May-16	23-May-16
GS2 - Base Slab to Erection Floor	24-May-16	20-Aug-16
GS2 - Erection Floor to Road Deck	05-Jul-16	05-Sep-16
SB - Structural Section - SS2	04-Apr-16	27-May-17
SS2 - Base Preparation	04-Apr-16	09-May-16
SS2 - Rock to Bottom Base Slab	10-May-16	30-Jun-16
SS2 - Base Slab	01-Jul-16	21-Jul-16
SS2 - Base Slab to Erection Floor	22-Jul-16	14-Nov-16
SS2 - Service Bay Floor Toppings & Equipment Pads	21-Oct-16	27-May-17
SB - Concrete Finishing & Clean-Up - Bay 2	06-Sep-16	27-May-17
SB - Erection Floor to Service Bay Superstructure & Enclosure	14-Oct-16	12-Jan-17
SB - Erection Floor to Control Building Superstructure & Enclosure	05-Nov-16	28-Jun-17
SB - Road Deck to Hoist Housing Superstructure & Enclosure	05-Nov-16	14-Jan-17
SB - Main Door	17-Jun-19	23-Aug-19
SB - Bulkhead Gate Monorail Crane Beam	16-Jan-17	28-Jan-17
SB - Bulkhead Gate Monorail Crane (BY OTHERS)	21-Feb-19	12-Mar-19
SB - Powerhouse Crane (BY OTHERS)	17-Nov-16	07-Jan-17
SB - Draft Tube Crane (BY OTHERS)	15-Nov-16	10-Nov-17
SB - Elevators	10-Dec-16	26-Dec-19
SB - Dewatering Gallery	29-May-17	12-Jan-18
SB - Architectural Finishing & Painting (DWG)	29-May-17	11-Jan-18
SB - Other (DWG)	05-Jan-18	12-Jan-18
SB - Lower Basement Floor	21-Jul-17	21-Dec-19
SB - Architectural Finishing & Painting (MEF)	21-Jul-17	08-Feb-18
SB - Other (MEF)	09-Dec-19	21-Dec-19
SB - Upper Basement Floor	07-Jul-17	27-Aug-19
SB - Architectural Finishing & Painting (EEF)	07-Jul-17	25-Jan-18
SB - Other (EEF)	13-Aug-19	27-Aug-19
SB - Control Building	04-Aug-17	23-Feb-18

◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
SB - Erection Floor	04-Aug-17	09-Feb-18
SB - Office Floors	18-Aug-17	23-Feb-18
SB - Bulkhead Gate Storage Gallery	01-Sep-17	09-Mar-18
SB - Architectural Finishing & Painting (BHGSG)	01-Sep-17	08-Feb-18
SB - Other (BHGSG)	23-Feb-18	09-Mar-18
SB - Entrance Building Floor	09-Sep-17	23-Mar-18
SB - Architectural Finishing & Painting (EBF)	09-Sep-17	22-Feb-18
SB - Other (EBF)	09-Mar-18	23-Mar-18
SB - Hoist Housing Floor	23-Sep-17	06-Apr-18
SB - Architectural Finishing & Painting (HHF)	23-Sep-17	08-Mar-18
SB - Other (HHF)	23-Mar-18	06-Apr-18
Powerhouse Transitions & Walls	16-May-16	01-Mar-18
PHNT - North Transition	16-May-16	03-Sep-16
PHNT - Base Preparation	16-May-16	04-Jun-16
PHNT - Base Slab	06-Jun-16	11-Jun-16
PHNT - Base Slab to Road Deck	13-Jun-16	03-Sep-16
PHNT - Concrete Finishing & Clean-Up	02-Jun-16	03-Sep-16
PHST - South Transition	15-Oct-16	01-Mar-18
PHST - Base Preparation	15-Oct-16	05-May-17
PHST - Base Slab	05-May-17	09-Jun-17
PHST - Base Slab to Road Deck	12-May-17	08-Sep-17
PHST - Concrete Finishing & Clean-Up	06-Jun-17	09-Sep-17
PHST - Road Deck to Elevator Hoist Room Superstructure & Enclosure	09-Sep-17	06-Nov-17
PHST - Elevator	06-Nov-17	28-Feb-18
PHST - Dewatering Gallery	13-Nov-17	12-Jan-18
PHST - Architectural Finishing & Painting (DWG)	13-Nov-17	11-Jan-18
PHST - Other (DWG)	05-Jan-18	12-Jan-18
PHST - Erection Floor	20-Nov-17	19-Jan-18
PHST - Architectural Finishing & Painting (EF)	20-Nov-17	18-Jan-18
PHST - Other (EF)	12-Jan-18	19-Jan-18
PHST - Entrance Floor	27-Nov-17	26-Jan-18
PHST - Architectural Finishing & Painting (EF)	27-Nov-17	25-Jan-18
PHST - Other (EF)	19-Jan-18	26-Jan-18
PHST - Intake Penthouse Floor	04-Dec-17	02-Feb-18
PHST - Architectural Finishing & Painting (IPF)	04-Dec-17	01-Feb-18
PHST - Other (IPF)	26-Jan-18	02-Feb-18
PHST - Elevator Hoist Room Floor	11-Dec-17	01-Mar-18
PHST - Architectural Finishing & Painting (EHRF)	11-Dec-17	08-Feb-18
PHST - Other (EHRF)	22-Feb-18	01-Mar-18
PH - Wall E	16-Jun-17	17-Aug-17
PHWE - Base Preparation	16-Jun-17	22-Jun-17
PHWE - Base Slab to Top Wall	16-Jun-17	17-Aug-17
Spillway	01-Apr-16	20-Oct-20
SW - Bay 1	01-Apr-16	14-Aug-19
SW - Base Preparation B1	01-Apr-16	15-Apr-16
SW - Base Slab B1	15-Apr-16	15-Sep-16
SW - Piers B1	09-May-16	24-Aug-16
SW - Anchors For Towers B1	16-Aug-16	17-Aug-16
SW - Downstream Road Deck B1	12-Jul-16	05-Aug-16
SW - Upstream Road Deck B1	24-Aug-16	19-Sep-16
SW - Concrete Finishing & Clean-Up B1	16-Jun-16	20-Sep-16
SW - Gate Guides, Seal Face & Roller Paths B1 (BY OTHERS)	20-Sep-16	31-Oct-16
SW - Gate B1 (BY OTHERS)	31-Oct-16	21-Nov-16
SW - Rollway B1	15-Jun-19	14-Aug-19
SW - Bay 2	20-Jun-16	12-Aug-20
SW - Base Preparation B2	20-Jun-16	04-Jul-16

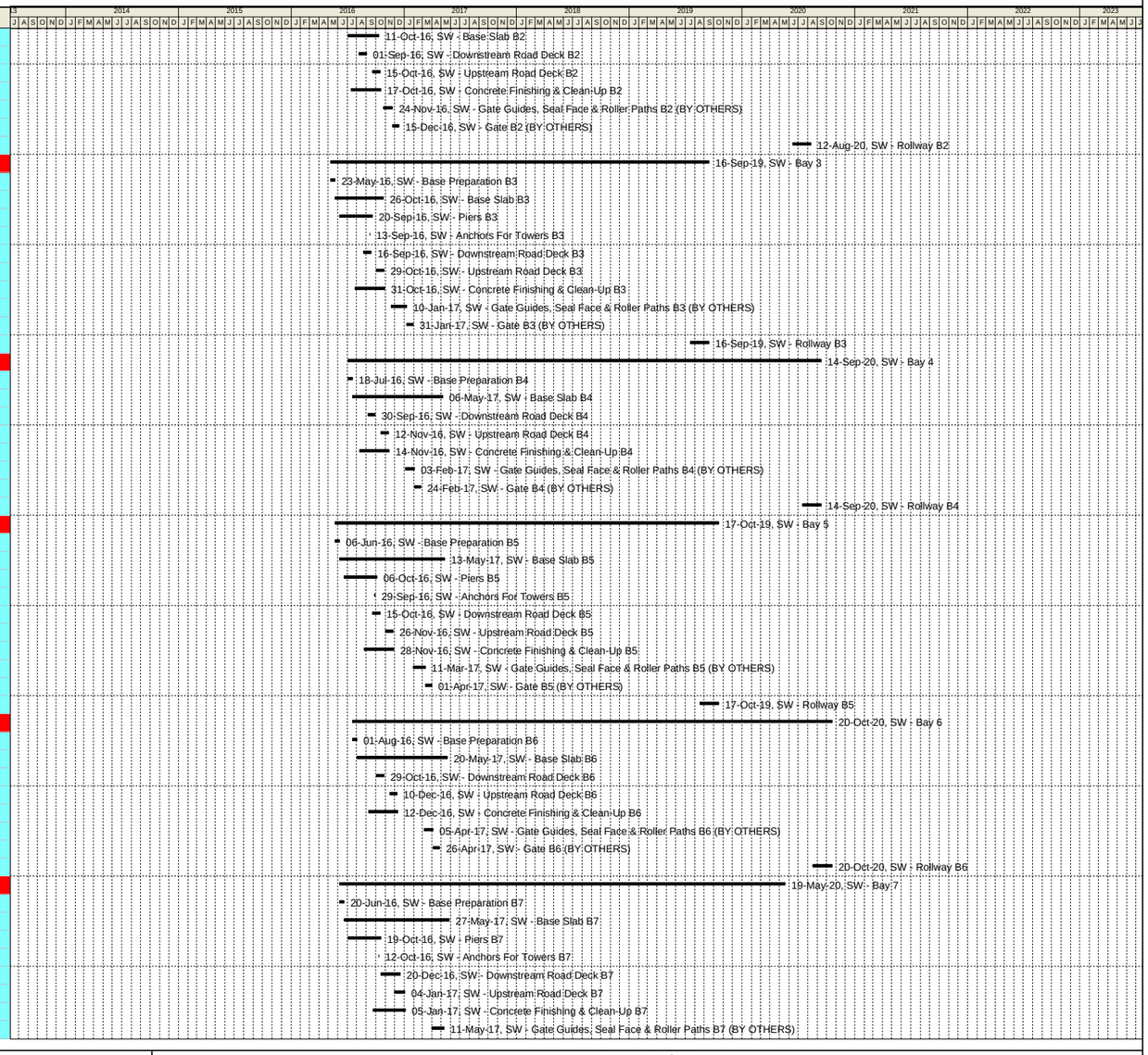


◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
SW - Base Slab B2	04-Jul-16	11-Oct-16
SW - Downstream Road Deck B2	08-Aug-16	01-Sep-16
SW - Upstream Road Deck B2	20-Sep-16	15-Oct-16
SW - Concrete Finishing & Clean-Up B2	13-Jul-16	17-Oct-16
SW - Gate Guides, Seal Face & Roller Paths B2 (BY OTHERS)	27-Oct-16	24-Nov-16
SW - Gate B2 (BY OTHERS)	24-Nov-16	15-Dec-16
SW - Rollway B2	15-Jun-20	12-Aug-20
SW - Bay 3	09-May-16	16-Sep-19
SW - Base Preparation B3	09-May-16	23-May-16
SW - Base Slab B3	23-May-16	26-Oct-16
SW - Piers B3	06-Jun-16	20-Sep-16
SW - Anchors For Towers B3	12-Sep-16	13-Sep-16
SW - Downstream Road Deck B3	22-Aug-16	16-Sep-16
SW - Upstream Road Deck B3	04-Oct-16	29-Oct-16
SW - Concrete Finishing & Clean-Up B3	27-Jul-16	31-Oct-16
SW - Gate Guides, Seal Face & Roller Paths B3 (BY OTHERS)	21-Nov-16	10-Jan-17
SW - Gate B3 (BY OTHERS)	10-Jan-17	31-Jan-17
SW - Rollway B3	17-Jul-19	16-Sep-19
SW - Bay 4	04-Jul-16	14-Sep-20
SW - Base Preparation B4	04-Jul-16	18-Jul-16
SW - Base Slab B4	18-Jul-16	06-May-17
SW - Downstream Road Deck B4	06-Sep-16	30-Sep-16
SW - Upstream Road Deck B4	19-Oct-16	12-Nov-16
SW - Concrete Finishing & Clean-Up B4	10-Aug-16	14-Nov-16
SW - Gate Guides, Seal Face & Roller Paths B4 (BY OTHERS)	06-Jan-17	03-Feb-17
SW - Gate B4 (BY OTHERS)	03-Feb-17	24-Feb-17
SW - Rollway B4	16-Jul-20	14-Sep-20
SW - Bay 5	23-May-16	17-Oct-19
SW - Base Preparation B5	23-May-16	06-Jun-16
SW - Base Slab B5	06-Jun-16	13-May-17
SW - Piers B5	20-Jun-16	06-Oct-16
SW - Anchors For Towers B5	28-Sep-16	29-Sep-16
SW - Downstream Road Deck B5	20-Sep-16	15-Oct-16
SW - Upstream Road Deck B5	02-Nov-16	26-Nov-16
SW - Concrete Finishing & Clean-Up B5	24-Aug-16	28-Nov-16
SW - Gate Guides, Seal Face & Roller Paths B5 (BY OTHERS)	31-Jan-17	11-Mar-17
SW - Gate B5 (BY OTHERS)	11-Mar-17	01-Apr-17
SW - Rollway B5	17-Aug-19	17-Oct-19
SW - Bay 6	18-Jul-16	20-Oct-20
SW - Base Preparation B6	18-Jul-16	01-Aug-16
SW - Base Slab B6	01-Aug-16	20-May-17
SW - Downstream Road Deck B6	04-Oct-16	29-Oct-16
SW - Upstream Road Deck B6	16-Nov-16	10-Dec-16
SW - Concrete Finishing & Clean-Up B6	08-Sep-16	12-Dec-16
SW - Gate Guides, Seal Face & Roller Paths B6 (BY OTHERS)	08-Mar-17	05-Apr-17
SW - Gate B6 (BY OTHERS)	05-Apr-17	26-Apr-17
SW - Rollway B6	17-Aug-20	20-Oct-20
SW - Bay 7	06-Jun-16	19-May-20
SW - Base Preparation B7	06-Jun-16	20-Jun-16
SW - Base Slab B7	20-Jun-16	27-May-17
SW - Piers B7	04-Jul-16	19-Oct-16
SW - Anchors For Towers B7	11-Oct-16	12-Oct-16
SW - Downstream Road Deck B7	19-Oct-16	20-Dec-16
SW - Upstream Road Deck B7	30-Nov-16	04-Jan-17
SW - Concrete Finishing & Clean-Up B7	22-Sep-16	05-Jan-17
SW - Gate Guides, Seal Face & Roller Paths B7 (BY OTHERS)	01-Apr-17	11-May-17



◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
SW - Gate B7 (BY OTHERS)	11-May-17	02-Jun-17
SW - Rollway B7	18-Sep-19	19-May-20
SW - Towers, Hoists & Hoist Housing B1 to B7 (BY OTHERS)	05-Jan-17	05-Jul-17
SW - Stoplog Monorail B1 to B7 (BY OTHERS)	06-Feb-17	03-Apr-17
SW - Test Fit Stoplogs B1 to B7	03-Apr-17	11-Apr-17
Spillway Transitions & Walls	04-Dec-15	21-Dec-18
SW - North Transition	02-May-16	21-Dec-18
SWNT - Base Preparation	02-May-16	21-May-16
SWNT - Base Slab	23-May-16	28-May-16
SWNT - Base Slab to Road Deck	30-May-16	13-Aug-16
SWNT - Road Deck to Superstructure & Enclosure	25-Jul-16	20-Sep-16
SWNT - Concrete Finishing & Clean-Up	12-May-16	15-Aug-16
SWNT - Fire Pump Floor	16-Aug-16	14-Dec-18
SWNT - Architectural Finishing & Painting (FPF)	16-Aug-16	20-Sep-16
SWNT - Other (FPF)	07-Dec-18	14-Dec-18
SWNT - Load Centre/Diesel Generator Floor	21-Sep-16	21-Dec-18
SWNT - Architectural Finishing & Painting (LC/DGF)	21-Sep-16	26-Oct-16
SWNT - Other (LC/DGF)	14-Dec-18	21-Dec-18
SW - Wall B	04-Dec-15	06-Aug-16
SW - Wall C	04-Dec-15	16-Jul-16
SW - South Transition	02-May-16	01-Aug-16
SWST - Base Preparation	02-May-16	21-May-16
SWST - Base Slab	23-May-16	28-May-16
SWST - Base Slab to Road Deck	30-May-16	30-Jul-16
SWST - Concrete Finishing & Clean-Up	26-Jul-16	01-Aug-16
SW - Wall A	04-Dec-15	13-Aug-16
SW - Wall D	04-Dec-15	16-Jul-16
POWER GENERATION SYSTEMS	22-Aug-18	17-Jan-20
Governors (BY OTHERS)	22-Aug-18	10-Jan-20
Exciters (BY OTHERS)	03-Oct-18	17-Jan-20
ELECTRICAL POWER SYSTEMS	03-May-16	06-Apr-20
Embedded Grounding & Exposed Ground Bus	03-May-16	08-Jul-19
Cable Raceways & Support System	07-Sep-16	05-Aug-19
Station DC Distribution System	09-Sep-17	05-Feb-19
Station AC Distribution System	30-Aug-16	05-Feb-19
Medium Voltage Station Service Equipment	04-Nov-17	12-Oct-18
Motor Control Centers	28-Sep-16	05-Feb-19
Lighting System	07-Sep-16	21-Jan-19
Generator Circuit Breakers	20-Dec-18	27-Feb-20
Isolated Phase Bus	18-Nov-17	20-Nov-19
Generator Step-Up Transformers (BY OTHERS)	08-Dec-18	06-Apr-20
Spillway Standby Power Supply Equipment	30-Aug-16	06-Sep-16
Blackstart Standby Power Supply	29-May-17	03-Jun-17
138KV Surge Arrestors & Disconnect Switch	14-Jun-18	05-Sep-18
600V Switchgear & Switchboard	04-Nov-17	24-Jan-18
INSTRUMENTATION & CONTROL SYSTEMS	07-Sep-16	02-Mar-20
Unit Control & Monitoring System	13-Oct-17	16-Jan-20
Station Fire Alarm/Detection System	07-Sep-16	02-Mar-20
Generating Station Communications System	14-Sep-16	04-Mar-19
Generator & Transformer Protective Relaying Equipment	13-Sep-18	07-Nov-19
Air Gap & Vibration Monitoring Equipment (BY OTHERS)	03-Oct-18	30-Nov-19
AUXILIARY PROCESSES & SERVICES SYSTEMS	25-Jul-16	19-Feb-19
Piezometer System	25-Jul-16	30-Jul-16
Unit Dewatering System	24-Oct-17	28-Jan-19
Clearwater Drainage System	04-Jan-17	27-Nov-17
HVAC Distribution System	30-Aug-16	19-Feb-19

◆ Milestone

Summary

KEEYASK GS - PURCHASER'S CONSTRUCTION SCHEDULE GCC RFP r2

Activity Name	Start	Finish
Powerhouse Complex Fire Suppression System	30-Aug-16	15-Jan-19

◆ Milestone
Summary

DIRECT COST REPORT

Activity / Resource	Desc	Quantity Pcs	Quantity Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 31100			Land Item	SCHEDULE: 1 100						
Description = Impervious Fill (Class A) in Stage I C/D			Unit = M3	Takeoff Quan: 22,500.000				Engr Quan: 22,500.000		
Images/Docs Attached										
2100	Load and Haul		Quan: 36,562.50 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
Mar 2011										
'Assumed impervious material will be hauled 1.2 km, one way, from borrow area CL1.										
L&HI	Load & Haul Impervious	140.62	CH	Prod: 260.0000 UH			Lab Pcs: 4.40		Eqp Pcs: 4.40	
8E345	345BL Cat Excavator	1.00	140.63 HR	190.204			26,748			26,748
8T773D	773F Cat Off Hwy. Tr	3.00	421.88 HR	196.532			82,913			82,913
8TP3/4	8TP3/4 Pickup 3/4T-	0.40	56.25 HR	8.181			460			460
OB3	Operator Backhoe < 3	1.00	140.63 MH	22.480	5,044					5,044
OEF	Operating Eng. Forem	0.40	56.25 MH	30.261	2,612					2,612
T1	Teamster Haul Truck	3.00	421.88 MH	22.770	15,236					15,236
$133,014.30	0.0169 MH/M3		618.76 MH	[0.445]	22,893		110,122			133,014
260.0092 Units/Hr *	2,600.0924 Un/Shift		59.0900 Unit/M		0.63		3.01			3.64
2101B	Place Material		Quan: 36,562.50 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
PLA/DE	Placing Crew	243.75	CH	Prod: 150.0000 UH			Lab Pcs: 2.10		Eqp Pcs: 2.10	
8DD9R	D9T Cat Dozer	1.00	243.75 HR	272.374			66,391			66,391
8E345	345BL Cat Excavator	1.00	243.75 HR	190.204			46,362			46,362
8TP3/4	8TP3/4 Pickup 3/4T-	0.10	24.38 HR	8.181			199			199
OB2	Operator Backhoe 3.8	1.00	243.75 MH	25.120	9,618					9,618
OD2	Operator Dozer D5-D	1.00	243.75 MH	22.020	8,586					8,586
OEF	Operating Eng. Forem	0.10	24.38 MH	30.261	1,132					1,132
$132,289.02	0.0140 MH/M3		511.88 MH	[0.376]	19,336		112,953			132,289
150.0000 Units/Hr *	1,500.0000 Un/Shift		71.4279 Unit/M		0.53		3.09			3.62
510000B	Borrow Development/Restoration		Quan: 337.00 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
SB	Stripping Borrow	1.68	CH	Prod: 200.0000 UH			Lab Pcs: 1.20		Eqp Pcs: 1.20	
8DD9R	D9T Cat Dozer	1.00	1.69 HR	272.374			460			460
8TP3/4	8TP3/4 Pickup 3/4T-	0.20	0.34 HR	8.181			3			3
OD2	Operator Dozer D5-D	1.00	1.69 MH	22.020	60					60
OEF	Operating Eng. Forem	0.20	0.34 MH	30.261	16					16
$538.38	0.0060 MH/M3		2.03 MH	[0.159]	75		463			538
200.5952 Units/Hr *	2,005.9524 Un/Shift		166.0101 Unit/M		0.22		1.37			1.60
=====> Item Totals: 31100 - Impervious Fill (Class A) in Stage I C/D										
$265,841.70	0.0503 MH/M3		1,132.67 MH	[1.337]	42,304		223,538			265,842
11.815	22500 M3				1.88		9.94			11.82
BID ITEM = 31200			Land Item	SCHEDULE: 1 100						
Description = Impervious fill (Class A) in Wall Tie-in			Unit = M3	Takeoff Quan: 1,200.000				Engr Quan: 1,200.000		

DIRECT COST REPORT

Activity / Resource	Desc	Quantity Pcs	Quantity Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 33100			Land Item	SCHEDULE: 1			100			
Description = Rockfill (Class C) in Stage I C/D			Unit = M3	Takeoff Quan: 58,000.000			Engr Quan: 58,000.000			
2100	Load and Haul		Quan: 76,560.00 M3	Hrs/Shft: 10.00		Cal 060 WC MB0000				
Mar 2011										
Assumed rock material will be hauled 0.6 km, one way, from quarry BR6.										
L&HR	Load & Haul Rock		276.38 CH	Prod: 277.0000 UH			Lab Pcs: 3.40		Eqp Pcs: 3.40	
8L988	988 Cat Loader	1.00	276.39 HR	199.312			55,088			55,088
8T773D	773F Cat Off Hwy. Tr	2.00	552.78 HR	206.190			113,978			113,978
8TP3/4	8TP3/4 Pickup 3/4T-	0.40	110.56 HR	18.108			2,002			2,002
OEF	Operating Eng. Forem	0.40	110.56 MH	27.984	4,793					4,793
OL2	Operator Loader 3.8-7	1.00	276.39 MH	20.370	9,116					9,116
T1	Teamster Haul Truck	2.00	552.78 MH	22.022	19,401					19,401
$204,377.53	0.0122 MH/M3		939.73 MH	[0.307]	33,310		171,068			204,378
277.0099 Units/Hr *	2,770.0991 Un/Shift		81.4702 Unit/M		0.44		2.23			2.67
2101B	Place Material		Quan: 76,560.00 M3	Hrs/Shft: 10.00		Cal 060 WC MB0000				
PLC/DE	Placing Crew		382.80 CH	Prod: 200.0000 UH			Lab Pcs: 2.10		Eqp Pcs: 2.10	
8DD9R	D9T Cat Dozer	1.00	382.80 HR	272.374			104,265			104,265
8E345	345BL Cat Excavator	1.00	382.80 HR	190.204			72,810			72,810
8TP3/4	8TP3/4 Pickup 3/4T-	0.10	38.28 HR	8.181			313			313
OB3	Operator Backhoe < 3	1.00	382.80 MH	22.480	13,731					13,731
OD2	Operator Dozer D5-D	1.00	382.80 MH	22.020	13,484					13,484
OEF	Operating Eng. Forem	0.10	38.28 MH	30.261	1,778					1,778
$206,380.98	0.0105 MH/M3		803.88 MH	[0.267]	28,993		177,388			206,381
200.0000 Units/Hr *	2,000.0000 Un/Shift		95.2381 Unit/M		0.38		2.32			2.70
2510	Rock Excavation Drilling Quarry		Quan: 51,040.00 M3	Hrs/Shft: 10.00		Cal 060 WC MB0000				
										**Unreviewed
productivity is in BCM per hr										
REDQ	Rock Excavation Drilling Qua		383.75 CH	Prod: 133.0005 UH			Lab Pcs: 5.00		Eqp Pcs: 9.00	
3X40	Drill Bits@107%		51,040.00 LS	0.130			7,100			7,100
3X50	Drill Steel@107%		51,040.00 LS	0.410			22,391			22,391
8CS750	750cfm Air Compress	2.00	767.52 HR	74.387				57,094		57,094
8DAT	Air Track	2.00	767.52 HR	58.520				44,915		44,915
8PEDH4	Discharge Hose 4"	2.00	767.52 HR	0.285				219		219
8PES4	Pump Electric 4"(Sub	2.00	767.52 HR	5.541				4,254		4,254
8TP3/4	8TP3/4 Pickup 3/4T-	1.00	383.76 HR	18.108				6,949		6,949
D	Driller	2.00	767.52 MH	21.810	26,717					26,717
DBF	Driller / Blaster Fore	1.00	383.76 MH	23.991	14,496					14,496
DH	Driller's Helper	2.00	767.52 MH	19.460	24,132					24,132
$208,266.39	0.0375 MH/M3		1,918.80 MH	[0.901]	65,345		29,491	113,431		208,266
133.0033 Units/Hr *	1,330.0326 Un/Shift		26.6000 Unit/M		1.28		0.58	2.22		4.08
2515	Rock Blasting		Quan: 51,040.00 M3	Hrs/Shft: 10.00		Cal 060 WC MB0000				
										**Unreviewed
Mar 2011										

DIRECT COST REPORT

Activity / Resource	Desc	Quantity Pcs	Quantity Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 33100			Land Item	SCHEDULE: 1 100						
Description = Rockfill (Class C) in Stage I C/D			Unit = M3	Takeoff Quan: 58,000.000				Engr Quan: 58,000.000		
'-Assumed 2.5 kg, explosive per m3.										
-Assume one electric cap per hole=270 caps total (@ $18/cap)										
productivity in BCM per hr										
-Assume loading and preparation rate of 0.1 hrs per hole										
-Time to load a blast of 270 holes is 27 hours										
-Total time to load and fire all spillway 6 blasts is 162 hrs										
BLAST	Blasting Crew		212.66 CH	Prod: 240.0000 UH			Lab Pcs: 4.00		Eqp Pcs: 2.00	
3X10	Dynamite@107%	127,600.00	KG	6.500			887,458			887,458
3X20	Blasting Caps@107%	6,624.99	EA	8.500			60,254			60,254
8TFB10	Truck Flatbed 10MT(	1.00 212.67	HR	30.873				6,566		6,566
8TP3/4	8TP3/4 Pickup 3/4T-	1.00 212.67	HR	8.181				1,740		1,740
D	Driller	1.00 212.67	MH	23.480	7,886					7,886
DB	Driller / Blaster	1.00 212.67	MH	23.480	7,886					7,886
DBF	Driller / Blaster Fore	1.00 212.67	MH	25.828	8,564					8,564
DH	Driller's Helper	1.00 212.67	MH	19.958	6,831					6,831
$987,183.88	0.0166 MH/M3		850.68 MH	[0.435]	31,166		947,712	8,306		987,184
240.0075 Units/Hr *	2,400.0752 Un/Shift		59.9991 Unit/M		0.61		18.57	0.16		19.34
2536	Rockfill Selection		Quan: 76,560.00 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
RFS	Rockfill Selection		382.79 CH	Prod: 200.0006 UH			Lab Pcs: 1.20		Eqp Pcs: 3.20	
8GEN4	Diesel Generator 40k	1.00 382.80	HR	16.736				6,407		6,407
8L988	988 Cat Loader	1.00 382.80	HR	237.612				90,958		90,958
8TP3/4	8TP3/4 Pickup 3/4T-	0.20 76.56	HR	8.181				626		626
8VG	Vibratory Grizzly	1.00 382.80	HR	31.074				11,895		11,895
OEF	Operating Eng. Forem	0.20 76.56	MH	30.261	3,556					3,556
OL2	Operator Loader 3.8-7	1.00 382.80	MH	22.020	13,484					13,484
$126,925.66	0.0060 MH/M3		459.36 MH	[0.158]	17,039		109,886			126,926
200.0052 Units/Hr *	2,000.0522 Un/Shift		166.6667 Unit/M		0.22		1.44			1.66
510000B	Borrow Development/Restoration		Quan: 51.00 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
SB	Stripping Borrow		0.20 CH	Prod: 250.3682 UH			Lab Pcs: 1.20		Eqp Pcs: 1.20	
8DD9R	D9T Cat Dozer	1.00 0.20	HR	272.374				54		54
8TP3/4	8TP3/4 Pickup 3/4T-	0.20 0.04	HR	8.181						
OD2	Operator Dozer D5-D	1.00 0.20	MH	22.020	7					7
OEF	Operating Eng. Forem	0.20 0.04	MH	30.261	2					2
$63.66	0.0047 MH/M3		0.24 MH	[0.124]	9			55		64
255.0000 Units/Hr *	2,550.0000 Un/Shift		212.5001 Unit/M		0.17			1.07		1.25
=====> Item Totals:	33100 - Rockfill (Class C) in Stage I C/D									
$1,733,198.10	0.0857 MH/M3		4,972.69 MH	[2.142]	175,861		977,203	580,134		1,733,198
29.883		58000 M3			3.03		16.85	10.00		29.88

DIRECT COST REPORT

Activity / Resource	Desc	Quantity Pcs	Quantity Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 51100			Land Item	SCHEDULE: 1 100						
Description = In-Water O/B Excv - SI C/D			Unit = M3	Takeoff Quan: 120.000			Engr Quan: 120.000			
26205	Disposal/Stockpile		Quan: 120.00 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
										**Unreviewed
D/W	Disposal / Waste Area (1-D9)		0.80 CH	Prod: 150.0000 UH			Lab Pcs: 1.10		Eqp Pcs: 1.10	
8DD9R	D9T Cat Dozer	1.00	0.80 HR	272.374			218			218
8TP3/4	8TP3/4 Pickup 3/4T-	0.10	0.08 HR	8.181			1			1
OD2	Operator Dozer D5-D	1.00	0.80 MH	22.020	28					28
OEF	Operating Eng. Forem	0.10	0.08 MH	30.261	4					4
$250.42	0.0073 MH/M3		0.88 MH	[0.188]	32		219			250
150.0000	Units/Hr * 1,500.0000 Un/Shift		136.3637 Unit/M		0.27		1.82			2.09
=====> Item Totals:	51100 - In-Water O/B Excv - SI C/D									
$1,391.68	0.0433 MH/M3		5.20 MH	[1.182]	199		1,193			1,392
11.597	120 M3				1.66		9.94			11.60
BID ITEM = 60000			Land Item	SCHEDULE: 1 100						
Description = Rock Excavation			Unit =	Takeoff Quan: 0.000			Engr Quan: 0.000			

Images/Docs Attached

There are no activities in this biditem.

BID ITEM = 60010	CLIENT# = 40220		Land Item	SCHEDULE: 126 273 100						
Description = Rock Excavation - Structures for Primary			Unit = M3	Takeoff Quan: 17,000.000			Engr Quan: 17,000.000			
2510	Rock Excavation Drilling low vib		Quan: 17,000.00 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
										**Unreviewed

Mar 2011 - is different rate from other low vib excavation drilling
'-Drilling on 1.24 m c/c, 5 m deep, 75 mm dia.
-Each hole produces 5x1.54=7.7 m3 of rock.
-Powder factor 2.5 kg/m3 = 12 kg/hole.
-Holes per cycle (blast) 270 x 7.7 m3=2079 BCM/blast
-Total volume to drill 2079x6 blasts=12,474 m3
-Drilling rate 20 m/hr, with two rigs 40m'/hr = 61.6 m3/hr
-Production rate adjusted to 61.6x0.83=51.128 m3/hr to reflect rock structure.

RED	Rock Excavation Drilling		333.33 CH	Prod: 51.0000 UH			Lab Pcs: 5.00		Eqp Pcs: 5.00	
3X40	Drill Bits@107%	17,000.00	LS	0.130			2,365			2,365
3X50	Drill Steel@107%	17,000.00	LS	0.410			7,458			7,458
8CS750	750cfm Air Compress	2.00 666.67	HR	64.063				42,709		42,709
8DAT	Air Track	2.00 666.67	HR	55.972				37,315		37,315
8TP3/4	8TP3/4 Pickup 3/4T-	1.00 333.33	HR	8.181				2,727		2,727
D	Driller	2.00 666.67	MH	23.480	24,719					24,719

Activity / Resource	Desc	Pcs	Quantity	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 60010	CLIENT# = 40220	Land Item	SCHEDULE: 126 273 100								
Description = Rock Excavation - Structures for Primary				Unit = M3	Takeoff Quan: 17,000.000				Engr Quan: 17,000.000		
DBF	Driller / Blaster Fore	1.00	333.33	MH	25.828	13,423					13,423
DH	Driller's Helper	2.00	666.67	MH	19.958	21,412					21,412
$152,128.48	0.0980 MH/M3		1,666.67	MH	[2.486]	59,555		9,823	82,751		152,128
51.0005 Units/Hr *	510.0051 Un/Shift		10.2000	Unit/M		3.50		0.58	4.87		8.95
2515	Rock Blasting low vib				Quan: 17,000.00 M3	Hrs/Shft: 10.00		Cal 060 WC MB0000			
**Unreviewed											
Mar 2011											
'-Assumed 2.5 kg, explosive per m3.											
-Assume one electric cap per hole=270 caps total (@ $18/cap)											
-Assume loading and preparation rate of 0.1 hrs per hole											
-Time to load a blast of 270 holes is 27 hours											
-Total time to load and fire all spillway 6 blasts is 162 hrs											
BLAST	Blasting Crew		236.11	CH	Prod: 72.0000 UH		Lab Pcs: 4.00		Eqp Pcs: 2.00		
3X10	Dynamite@107%		42,500.00	KG	6.500		295,588				295,588
3X20	Blasting Caps@107%		2,206.60	EA	8.500		20,069				20,069
8TFB10	Truck Flatbed 10MT(	1.00	236.11	HR	30.873				7,289		7,289
8TP3/4	8TP3/4 Pickup 3/4T-	1.00	236.11	HR	8.181				1,932		1,932
D	Driller	1.00	236.11	MH	23.480	8,755					8,755
DB	Driller / Blaster	1.00	236.11	MH	23.480	8,755					8,755
DBF	Driller / Blaster Fore	1.00	236.11	MH	25.828	9,508					9,508
DH	Driller's Helper	1.00	236.11	MH	19.958	7,583					7,583
$359,478.58	0.0555 MH/M3		944.44	MH	[1.449]	34,601		315,657	9,221		359,479
72.0003 Units/Hr *	720.0034 Un/Shift		18.0001	Unit/M		2.04		18.57	0.54		21.15
2515A	Presplitting Rock Blasting				Quan: 2,226.00 M	Hrs/Shft: 10.00		Cal 060 WC MB0000			
**Unreviewed											
Mar 2011											
'-Assume load factor 3.8 kg/m =11.4 kg/ 3-m hole.											
-Assume one electric cap per hole=60 caps total (@ $18/cap)											
-Assume loading and preparation rate of 0.1 hrs per hole											
-Time to load a blast of 60 holes is 6 hours											
BLASTP	Pre-Split Blasting		44.52	CH	Prod: 50.0000 UH		Lab Pcs: 4.00		Eqp Pcs: 6.00		
3X18	Explosive for Spl@10		8,458.80	KG	9.150		82,816				82,816
3X20	Blasting Caps@107%		445.20	EA	8.500		4,049				4,049
8PEDH4	Discharge Hose 4"	2.00	89.04	HR	0.272				24		24
8PES4	Pump Electric 4"(Sub	2.00	89.04	HR	5.541				493		493
8TFB10	Truck Flatbed 10MT(	1.00	44.52	HR	30.873				1,374		1,374
8TP3/4	8TP3/4 Pickup 3/4T-	1.00	44.52	HR	8.181				364		364
D	Driller	1.00	44.52	MH	23.480	1,651					1,651
DB	Driller / Blaster	1.00	44.52	MH	23.480	1,651					1,651
DBF	Driller / Blaster Fore	1.00	44.52	MH	25.828	1,793					1,793
DH	Driller's Helper	1.00	44.52	MH	19.958	1,430					1,430
$95,645.53	0.0800 MH/M		178.08	MH	[2.087]	6,524		86,865	2,256		95,646
50.0000 Units/Hr *	500.0000 Un/Shift		12.5000	Unit/M		2.93		39.02	1.01		42.97

DIRECT COST REPORT

Activity / Resource	Desc	Quantity Pcs	Quantity Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 60010	CLIENT# = 40220	Land Item	SCHEDULE: 126 273 100							
Description = Rock Excavation - Structures for Primary			Unit = M3	Takeoff Quan: 17,000.000				Engr Quan: 17,000.000		
2531	Load and Haul		Quan: 25,500.00 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
Mar 2011										
All rock is hauled to BR-6 for processing and then to be hauled to rockfill working platform										
[redacted] May 8, 2008: rock excavation quantity added by 2% to account for overbreak										
L&HR	Load & Haul Rock		102.00 CH	Prod: 250.0000 UH			Lab Pcs: 3.40		Eqp Pcs: 3.40	
8L988	988 Cat Loader	1.00	102.00 HR	199.312			20,330			20,330
8T773D	773F Cat Off Hwy. Tr	2.00	204.00 HR	206.190			42,063			42,063
8TP3/4	8TP3/4 Pickup 3/4T-	0.40	40.80 HR	18.108			739			739
OEF	Operating Eng. Forem	0.40	40.80 MH	27.984	1,769					1,769
OL2	Operator Loader 3.8-7	1.00	102.00 MH	20.370	3,364					3,364
T1	Teamster Haul Truck	2.00	204.00 MH	22.022	7,160					7,160
$75,424.14	0.0136 MH/M3		346.80 MH	[0.34]	12,293		63,131			75,424
250.0000 Units/Hr *	2,500.0000 Un/Shift		73.5294 Unit/M		0.48		2.48			2.96
2510A	Presplitting Drilling		Quan: 2,226.00 M	Hrs/Shft: 10.00	Cal 060 WC MB0000					
**Unreviewed										
Mar 2011										
'-Drill on 1 m centre to centre 5m deep 75 mm dia.										
-Each hole produces 5X1=5 m2 of rock										
-Load factor 3.8 kg/m =19 kg/hole.										
-Per spillway length 30 m x 2 sides=60mx1m= 60 holes, total										
-Drilling rate 20m'/hr , with two rigs 40m'/hr										
-Total drilling time 60 holesx5=300m/40=8 hrs total drilling time										
REDL	Presplit&Line Drilling		67.45 CH	Prod: 33.0000 UH			Lab Pcs: 5.00		Eqp Pcs: 9.00	
3X40	Drill Bits@107%		8,904.00 LS	0.130			1,239			1,239
3X50	Drill Steel@107%		8,904.00 LS	0.410			3,906			3,906
8CS750	750cfm Air Compress	2.00	134.91 HR	74.387				10,036		10,036
8DAT	Air Track	2.00	134.91 HR	58.520				7,895		7,895
8PEDH4	Discharge Hose 4"	2.00	134.91 HR	0.331				45		45
8PES4	Pump Electric 4"(Sub	2.00	134.91 HR	5.541				748		748
8TP3/4	8TP3/4 Pickup 3/4T-	1.00	67.45 HR	18.108				1,221		1,221
D	Driller	2.00	134.91 MH	21.810	4,696					4,696
DBF	Driller / Blaster Fore	1.00	67.45 MH	23.991	2,548					2,548
DH	Driller's Helper	2.00	134.91 MH	19.460	4,242					4,242
$36,574.78	0.1515 MH/M		337.27 MH	[3.632]	11,486		5,145	19,944		36,575
33.0022 Units/Hr *	330.0222 Un/Shift		6.6001 Unit/M		5.16		2.31	8.96		16.43
=====> Item Totals:	60010	- Rock Excavation - Structures for Primary								
$719,251.51	0.2043 MH/M3		3,473.26 MH	[5.194]	124,458		417,489	177,304		719,252
42.309	17000 M3				7.32		24.56	10.43		42.31

DIRECT COST REPORT

Activity / Resource	Desc	Quantity Pcs	Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total

BID ITEM = 200000 CLIENT# = 40620 Land Item SCHEDULE: 1 100
Description = Cement for Concrete Unit = Takeoff Quan: 0.000 Engr Quan: 0.000

There are no activities in this biditem.

BID ITEM = 210000 Land Item SCHEDULE: 1 100
Description = Concrete Unit = Takeoff Quan: 0.000 Engr Quan: 0.000

Images/Docs Attached

There are no activities in this biditem.

BID ITEM = 210010 Land Item SCHEDULE: 1 100
Description = Concrete-Primary Spillway Unit = M3 Takeoff Quan: 15,292.000 Engr Quan: 15,292.000

Images/Docs Attached

4420 Found. Prep. for Concrete Quan: 2,150.00 M2 Hrs/Shft: 10.00 Cal 060 WC MB0000

**Unreviewed

In 2007 Update:
1). Assume 50% area need slush grouting.
2). 2 labour helpers added in the crew FPC to account for possible scaling and washing rock surfaces; refer to modified Crew FPC.
3). Production rate aslo adjusted due to the same reason:
for embankment foundation: from 40UH to 10UH; for concrete structure foundation: from 33UH to 20UH
To be reviewed in the future if there is a better way to quantify rock surfacing works. - Sep. 12, 2007 [redacted]

FPC2	Found. Prep. for Concrete		107.50	CH	Prod: 19.9997 UH		Lab Pcs: 7.00		Eqp Pcs: 3.00	
2C6GS	Grout Slurry	1,075.00	M2		18.490	19,877				19,877
3ZS20	Small Tools & Suppli		107.50	LS	11.000		1,183			1,183
8CS750	750cfm Air Compress	1.00	107.50	HR	64.063			6,887		6,887
8PES4	Pump Electric 4"(Sub	1.00	107.50	HR	5.541			596		596
8TP3/4	8TP3/4 Pickup 3/4T-	1.00	107.50	HR	8.181			880		880
LF	Labor Foreman	1.00	107.50	MH	23.540	4,039				4,039
LG	Labor General	2.00	215.00	MH	22.290	7,699				7,699
LH	Labor Helper	4.00	430.01	MH	18.496	12,851				12,851
$54,010.20	0.3500 MH/M2		752.51	MH	[8.29]	24,589	19,877	1,183	8,362	54,010
20.0000 Units/Hr *	200.0000 Un/Shift		2.8571	Unit/M		11.44	9.25	0.55	3.89	25.12

44290 Concrete Patching Quan: 1,700.00 M2 Hrs/Shft: 10.00 Cal 060 WC MB0000

**Unreviewed

assumed 30m2 per crew hour

CP	Concrete Patching		56.66	CH	Prod: 30.0000 UH		Lab Pcs: 6.00		Eqp Pcs: 3.00	
3ZS20	Small Tools & Suppli	56.67	LS		11.000		623			623

DIRECT COST REPORT

Activity / Resource	Desc	Quantity Pcs	Quantity Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 210010			Land Item	SCHEDULE: 1 100						
Description = Concrete-Primary Spillway				Unit = M3	Takeoff Quan: 15,292.000			Engr Quan: 15,292.000		
8RTML	RT Man Lift	3.00	170.00 HR	7.627				1,297		1,297
CMF	Cement Mason Forem	1.00	56.67 MH	29.040	2,569					2,569
CMJ	Cement Mason Journe	5.00	283.33 MH	27.790	12,344					12,344
$16,832.30	0.2000 MH/M2		340.00 MH	[6.533]	14,912		623	1,297		16,832
30.0035 Units/Hr *	300.0353 Un/Shift		5.0000 Unit/M		8.77		0.37	0.76		9.90
4430	Concrete Supply			Quan: 15,750.76	M3	Hrs/Shft: 10.00	Cal 060 WC MB0000			
										**Unreviewed
4COBP	Concrete 35 mpa	1.00	15,750.76 M3	339.080				5,340,768		5,340,768
44301	Place Concrete - Con. Pump			Quan: 13,388.15	M3	Hrs/Shft: 10.00	Cal 060 WC MB0000			
										**Unreviewed
assume 85% by pump, 7.5% by 200T Crane, 7.5% by 65T crane										
assumed 60m3/hr is ideal, allowed for 83% efficiency factor = ~50m3/hr										
CONP1	Concrete Placing - Pump		267.76 CH	Prod: 50.0000 UH			Lab Pcs: 16.00		Eqp Pcs: 6.00	
3ZS20	Small Tools & Suppli		267.76 LS	11.000			2,945			2,945
8CEP138	Conc. Pump 148ft(w/	1.00	267.76 HR	48.737				13,050		13,050
8CEV2.5	Concrete Vibrator 2.5	3.00	803.29 HR	1.642				1,319		1,319
8TFB20	Truck Flatbed 20MT	1.00	267.76 HR	59.337				15,888		15,888
8TP3/4	8TP3/4 Pickup 3/4T-	1.00	267.76 HR	8.181				2,191		2,191
CA	Carpenter Appr. 3	1.00	267.76 MH	22.936	10,326					10,326
CJ	Carpenter Journeyma	1.00	267.76 MH	28.670	12,490					12,490
CMF	Cement Mason Forem	1.00	267.76 MH	29.040	12,137					12,137
COT	Concrete Tester	1.00	267.76 MH	27.790	11,665					11,665
COW	Concrete Worker	5.00	1,338.82 MH	22.340	47,564					47,564
LG	Labor General	4.00	1,071.05 MH	22.290	38,353					38,353
RFJ	Re-Bar Fitter Journey	2.00	535.53 MH	27.790	26,955					26,955
T3	Teamster Tandem/Wa	1.00	267.76 MH	21.900	9,345					9,345
$204,228.66	0.3199 MH/M3		4,284.20 MH	[9.006]	168,835		2,945	32,448		204,229
50.0006 Units/Hr *	500.0056 Un/Shift		3.1250 Unit/M		12.61		0.22	2.42		15.25
44303	Place Concrete-220T Cr.+Buc.			Quan: 1,181.31	M3	Hrs/Shft: 10.00	Cal 060 WC MB0000			
										**Unreviewed
assume 85% by pump, 7.5% by 200T Crane, 7.5% by 65T crane - [redacted] Oct 22, 2008										
CONP2	Concrete Placing-Crane 208T		47.25 CH	Prod: 25.0011 UH			Lab Pcs: 17.50		Eqp Pcs: 8.25	
3ZS20	Small Tools & Suppli		47.25 LS	11.000			520			520
8CEB2	Concrete Bucket 2m3	2.50	118.13 HR	4.060				480		480
8CEV2.5	Concrete Vibrator 2.5	3.00	141.75 HR	1.642				233		233
8CR208	208T Crawler Crane	1.25	59.06 HR	182.002				10,749		10,749
8TP3/4	8TP3/4 Pickup 3/4T-	1.50	70.88 HR	8.181				580		580
CA	Carpenter Appr. 3	1.00	47.25 MH	22.936	1,822					1,822
CJ	Carpenter Journeyma	1.00	47.25 MH	28.670	2,204					2,204
CMF	Cement Mason Forem	1.00	47.25 MH	29.040	2,142					2,142
COT	Concrete Tester	1.00	47.25 MH	27.790	2,059					2,059
COW	Concrete Worker	5.00	236.25 MH	22.340	8,393					8,393
LG	Labor General	4.00	189.00 MH	22.290	6,768					6,768

Activity / Resource	Desc	Quantity Pcs	Quantity Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 210010			Land Item	SCHEDULE: 1 100						
Description = Concrete-Primary Spillway			Unit = M3	Takeoff Quan: 15,292.000				Engr Quan: 15,292.000		
MO	Mechanic Oiler	1.25	59.06 MH	25.700	2,377					2,377
OC2	Operator Mob. Crane	1.25	59.06 MH	36.480	3,801					3,801
RFJ	Re-Bar Fitter Journey	2.00	94.50 MH	27.790	4,756					4,756
$46,882.80	0.6999 MH/M3		826.87 MH	[20.751]	34,322		520	12,041		46,883
25.0013 Units/Hr *	250.0127 Un/Shift		1.4287 Unit/M		29.05		0.44	10.19		39.69
44304	Place Concrete-65T Cr.+Buck.		Quan: 1,181.31 M3	Hrs/Shft: 10.00	Cal 060 WC MB0000					
										**Unreviewed
assume 85% by pump, 7.5% by 200T Crane, 7.5% by 65T crane - [redacted] Oct 22, 2008										
CONP3	Concrete Placing-65TCrane		59.06 CH	Prod: 20.0001 UH		Lab Pcs: 16.25		Eqp Pcs: 8.25		
3ZS20	Small Tools & Suppli		59.07 LS	11.000		650				650
8CEB2	Concrete Bucket 2m3	2.50	147.66 HR	4.060				600		600
8CEV2.5	Concrete Vibrator 2.5	3.00	177.20 HR	1.642				291		291
8CRRT65	65T Rough Terrain Cr	1.25	73.83 HR	144.056				10,636		10,636
8TP3/4	8TP3/4 Pickup 3/4T-	1.50	88.60 HR	8.181				725		725
CA	Carpenter Appr. 3	1.00	59.07 MH	22.936	2,278					2,278
CJ	Carpenter Journeyma	1.00	59.07 MH	28.670	2,755					2,755
CMF	Cement Mason Forem	1.00	59.07 MH	29.040	2,678					2,678
COT	Concrete Tester	1.00	59.07 MH	27.790	2,573					2,573
COW	Concrete Worker	5.00	295.33 MH	22.340	10,492					10,492
LG	Labor General	4.00	236.26 MH	22.290	8,460					8,460
OC4	Operator Mob. Crane	1.25	73.83 MH	33.180	4,383					4,383
RFJ	Re-Bar Fitter Journey	2.00	118.13 MH	27.790	5,946					5,946
$52,466.76	0.8125 MH/M3		959.83 MH	[23.876]	39,566		650	12,251		52,467
20.0019 Units/Hr *	200.0186 Un/Shift		1.2307 Unit/M		33.49		0.55	10.37		44.41
44500	Finish Concrete		Quan: 7,000.00 M2	Hrs/Shft: 10.00	Cal 060 WC MB0000					
										**Unreviewed
Assumed 60m2 per hour [redacted]										
CONF	Concrete Finishing		116.66 CH	Prod: 60.0000 UH		Lab Pcs: 9.00		Eqp Pcs: 0.00		
2CT25	Concrete Finishin@10		116.67 LS	18.171		2,268				2,268
3ZS20	Small Tools & Suppli		116.67 LS	11.000			1,283			1,283
CMA	Cement Mason Appr.	1.00	116.67 MH	21.284	3,978					3,978
CMF	Cement Mason Forem	1.00	116.67 MH	26.290	4,836					4,836
CMJ	Cement Mason Journe	5.00	583.33 MH	25.040	23,153					23,153
LG	Labor General	1.00	116.67 MH	20.840	3,939					3,939
LH	Labor Helper	1.00	116.67 MH	17.460	3,316					3,316
$42,774.23	0.1500 MH/M2		1,050.01 MH	[4.104]	39,222	2,268	1,283			42,774
60.0034 Units/Hr *	600.0343 Un/Shift		6.6666 Unit/M		5.60	0.32	0.18			6.11
44505	Concrete - Green Cutting		Quan: 2,625.00 M2	Hrs/Shft: 10.00	Cal 060 WC MB0000					
										**Unreviewed
Production rate 40m2/CH.										
CONGC	Concrete Green Cutting		65.62 CH	Prod: 39.9996 UH		Lab Pcs: 4.00		Eqp Pcs: 2.00		
3ZS20	Small Tools & Suppli		65.63 LS	11.000		722				722
8CS900	900cfm Air Compress	1.00	65.63 HR	81.370				5,340		5,340

DIRECT COST REPORT

Activity / Resource	Desc	Quantity Pcs	Quantity Unit	Unit Cost	Labor	Perm Materi	Constr Matl/Ex	Equip Ment	Sub-Contrac	Total
BID ITEM = 210010				Land Item	SCHEDULE: 1 100					
Description = Concrete-Primary Spillway				Unit = M3	Takeoff Quan: 15,292.000			Engr Quan: 15,292.000		
8PES4	Pump Electric 4"(Sub	1.00	65.63 HR	5.541				364		364
COW	Concrete Worker	2.00	131.25 MH	19.460	4,149					4,149
LF	Labor Foreman	1.00	65.63 MH	22.090	2,332					2,332
LH	Labor Helper	1.00	65.63 MH	17.460	1,865					1,865
$14,772.55	0.1000 MH/M2		262.51 MH	[2.248]	8,347		722	5,704		14,773
40.0030 Units/Hr *	400.0305 Un/Shift		9.9996 Unit/M		3.18		0.28	2.17		5.63
44700	Cure Concrete- Complete			Quan: 4,775.00 M2	Hrs/Shft: 10.00	Cal 060 WC MB0000				
										**Unreviewed
Assumed production rate of 0.03CH/m3 of concrete.										
CONC	Concrete Curing		119.37 CH	Prod: 40.0000 UH		Lab Pcs: 2.00		Eqp Pcs: 0.00		
2BURLP	Burlap for concre@10		4,775.00 M2	1.600		8,175				8,175
2CT05	Curing Compound@1		4,775.00 L	0.776		3,965				3,965
LG	Labor General	1.00	119.38 MH	22.290	4,275					4,275
LH	Labor Helper	1.00	119.38 MH	18.496	3,568					3,568
$19,982.56	0.0500 MH/M2		238.76 MH	[1.19]	7,842	12,140				19,983
40.0017 Units/Hr *	400.0168 Un/Shift		19.9992 Unit/M		1.64	2.54				4.18
=====> Item Totals: 210010 - Concrete-Primary Spillway										
$5,792,717.76	0.5698 MH/M3		8,714.69 MH	[15.86]	337,635	34,285	7,926	72,103	5,340,768	5,792,718
378.807	15292 M3				22.08	2.24	0.52	4.72	349.25	378.81
BID ITEM = 210025				Land Item	SCHEDULE: 1 100					
Description = Concrete-Prim Spwy East Transition				Unit = M3	Takeoff Quan: 293.000			Engr Quan: 293.000		
4420	Found. Prep. for Concrete			Quan: 52.00 M2	Hrs/Shft: 10.00	Cal 060 WC MB0000				
										**Unreviewed
FPC2	Found. Prep. for Concrete		2.60 CH	Prod: 19.9969 UH		Lab Pcs: 7.00		Eqp Pcs: 3.00		
2C6GS	Grout Slurry		26.00 M2	18.490		481				481
3ZS20	Small Tools & Suppli		2.60 LS	11.000			29			29
8CS750	750cfm Air Compress	1.00	2.60 HR	64.063				167		167
8PES4	Pump Electric 4"(Sub	1.00	2.60 HR	5.541				14		14
8TP3/4	8TP3/4 Pickup 3/4T-	1.00	2.60 HR	8.181				21		21
LF	Labor Foreman	1.00	2.60 MH	23.540	98					98
LG	Labor General	2.00	5.20 MH	22.290	186					186
LH	Labor Helper	4.00	10.40 MH	18.496	311					311
$1,306.24	0.3500 MH/M2		18.20 MH	[8.29]	595	481	29	202		1,306
20.0000 Units/Hr *	200.0000 Un/Shift		2.8571 Unit/M		11.44	9.25	0.55	3.89		25.12
44290	Concrete Patching			Quan: 293.00 M2	Hrs/Shft: 10.00	Cal 060 WC MB0000				
										**Unreviewed
not required										
CP	Concrete Patching		9.76 CH	Prod: 30.0000 UH		Lab Pcs: 6.00		Eqp Pcs: 3.00		

Bid Item #	Bid Item Description	RFP Quantity	Units	Contract Quantity	Units
5	Rock Ecavation in TR Channel	315600	m3	315600	m3

Activity #	Activity Description	Quantity	Units	Man-hr/Unit	Unit/hr
5.1	Rock Excavation Drilling	80500	m	0.075	16.66
5.2	Blasting	321912	m3	0.0553	240
5.3	Load & Haul 2km	334788.48	m3	0.0377	150

Labour Hrs	Equip Hrs	Labour $	Equip $	PM$	CM $	SUB $	Unit Price	Total
							$19.94	$6,293,861
6037.5	4,115.8	$424,902	$645,159	$0	$272,422	$0	$16.68	$1,342,483
17801.7	747.1	$183,077	$88,691	$0	$1,997,608	$0	$7.05	$2,269,376
12621.5	13,854.0	$482,682	$2,199,320	$0	$0	$0	$8.01	$2,682,002

SAMPLE ONLY IRREVOCABLE LETTER OF CREDIT

BY ORDER OF our client _____ ("_____"), we, _____ ("Bank") hereby open our irrevocable standby letter of credit No. _____ in your favour for a maximum aggregate amount not to exceed $_____ Canadian dollars, effective immediately and, save and except for any extension of the term by reason of an event of force majeure as hereinafter provided, expiring at our _____ office with our close of business on _____, 20__, relative to the agreement between yourselves _____ and _____ for _____ dated _____ ("Contract").

Drawings under this letter of credit shall be made by your sight draft on us and accompanied by a written demand for payment purportedly signed by your authorized officer, delivered to the Bank at the _____office and any demand must bear on its face our credit number _____.

Partial drawings are permitted.

Drawings presented by you under this letter of Credit shall be honoured on presentation by payment at sight without inquiry by the Bank as to your rights to make such demand and without recognizing any claims of _____ against you.

This letter of credit shall expire at the bank of _____, Winnipeg, Manitoba, upon our receipt of your signed written notice that _____ has complied with the terms and conditions of the Contract or _____, 20__ whichever shall first occur. If this letter of credit expires during an interruption of business as described in article 17 of the UCP 600, as defined hereinafter, we hereby specifically agree to effect payment if the credit is drawn against us within thirty (30) days after the resumption of our business.

This letter of credit is subject to the Uniform Customs and Practice for Documentary Credits, (2007 Revision), International Chamber of Commerce - Publication No. 600.

Address all demand, documentation and correspondence regarding this letter of credit to the attention of _____ at the above-mentioned address, mentioning specifically our credit no. _____.

Monthly Construction Site Workforce Forecast

S/N	Labour	Year											
		J	F	M	A	M	J	J	A	S	O	N	D
	CONSTRUCTION SUPPORT AND SERVICE TRADES												
1	Technical (Surveyors and Drafting)												
2	Clerical (Clerks and Typists)												
3	Catering and Janitorial												
4	Security												
5	First Aid												
6	Employee Retention Support												
	Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	CONTRACTOR SUPERVISORY												
7	**Contractor Supervisory**												
	MANITOBA HYDRO SITE STAFF												
8	**Manitoba Hydro Site Staff**												
	NON-DESIGNATED TRADES (CONSTRUCTION, TRANSPORTATION AND INDUSTRIAL)												
9	Trade Helpers and Construction Labourers												
10	Driller / Blaster												
11	Grouters												
12	Heavy Equipment Operator (excluding Crane Operators)												
13	Teamster												
14	Serviceman (including Oilers, Warehouseman)												
	Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	DESIGNATED TRADES5 (CONSTRUCTION, TRANSPORTATION AND INDUSTRIAL)												
15	Crane Operator												
16	Industrial Welder												
17	Mechanic												
18	Carpenter												
19	Millwright (Industrial Mechanic)												
20	Painter												
21	Glazier												
22	Cement Mason												
23	Sheet Metal Worker												
24	Roofer												
25	Insulator												
26	Boilermaker												
27	Iron Worker (excluding Reinforcing Workers)												
28	Reinforcing Worker												
29	Electrician												
30	Elevator Worker												
31	Utilityman / Groundman												
32	Lineman												
33	Plumber												
34	Pipefitter												
35	Storekeeper & OD II												
	Subtotal	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
	Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**

FORM OF PROPOSAL
BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATED

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
01 10 05		**Indirects**				
a		Indirect Costs		EC		
b		Contingency		EC		
01 51 00		**Temporary Utilities**				
a		Temporary Power				
	i	800A @ 347/600Vac, in the Service Bay Erection Area		EC		
	ii	400A @ 347/600Vac, in the Intake Hoist Housing		EC		
	iii	800A @ 347/600Vac, near the Spillway Bridge Deck		EC		
	iv	300A @ 347/600Vac for the Powerhouse Crane bus		EC		
	v	100A @ 347/600Vac for the Draft Tube Crane bus		EC		
b		Temporary Heating				
	i	Year 4		EC		
	ii	Year 5		EC		
	iii	Year 6		EC		
	iv	Year 7		EC		
01 52 00		**Construction Facilities**				
a		Mobilization of equipment				
b		Other Mobilization and Site Preparation				
	i	The construction, including the supply of materials, for the Contractor's temporary roads, parking areas and storage areas		EC		-
	ii	The initial installation, including the supply of materials, of temporary communications, lighting, power, water, sanitary and sewage services at the Contractors' office and shops work area.		EC		-
	iii	Supply and installation or construction of temporary site buildings required by the Contractor		EC		-
c		Demobilization of Equipment		EC		
d		Final Clean-up		EC		
01 54 11		**Powerhouse Cranes**				
a		Crane Operators				
	i	straight-time (1.0x) labour hours associated with the operation of the Powerhouse crane(s).	19,400	hr		
	ii	time-and-one-half (1.5x) labour hours associated with the operation of the Powerhouse crane(s)	4,850	hr		
	iii	double-time (2.0x) labour hours associated with the operation of the Powerhouse crane(s)	13,825	hr		
03 11 00		**Concrete Formwork**				
a		Flat forms				
	i	Flat forms Intake	45,301	m^2		-
	ii	Flat forms Powerhouse	24,005	m^2		-
	iii	Flat forms Tailrace	47,309	m^2		-
	iv	Flat forms Service Bay	8,748	m^2		-
	v	Flat forms Spillway	14,983	m^2		-
	vi	Flat forms Transitions & Walls	10,180	m^2		-
b		Curved forms				
	i	Curved forms Intake	3,350	m^2		-
	ii	Curved forms Powerhouse (including SSC walls)	14,545	m^2		-
	iii	Curved forms Tailrace	150	m^2		-
	iv	Curved forms Spillway	800	m^2		-
c		Soffit forms				
	i	Soffit forms Intake	320	m^2		-
	ii	Soffit forms Powerhouse	5,039	m^2		-
	iii	Soffit forms Tailrace	4,382	m^2		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	iv	Soffit forms Service Bay	6,705	m^2		-
	v	Soffit forms Spillway	222	m^2		-
	vi	Intake water passage roof forms	1,260	m^2		-
	vii	Powerhouse Semi-Spiral Case water passage roof forms	2,660	m^2		-
d		Other forms				
	i	Powerhouse Draft Tube water passage forms	7,385	m^2		-
	ii	Spillway rollways	2,390	m^2		-
	iii	Cantilevered Service Bay formwork	60	m^2		-
03 15 13		**Waterstops**				
a		Type A (WSA)				
	i	Type A waterstop Powerhouse Complex (including Service Bay, Transitions and Walls)	10,650	m		-
	ii	Type A waterstop Spillway Complex (including Transitions & Walls)	3,200	m		-
b		Type B (WSB)				
	i	Type B waterstop Powerhouse Complex (including Service Bay, Transitions and Walls)	9,500	m		-
	ii	Type B waterstop Spillway Complex (including Transitions & Walls)	5,700	m		-
c		Type C (WSC) - Hydrotite				
	i	Type C waterstop Powerhouse Complex (including Service Bay, Transitions and Walls)	835	m		-
	ii	Type C waterstop Spillway Complex (including Transitions & Walls)	525	m		-
d		Injection Hose Waterstop				
	i	Injection Hose waterstop Powerhouse Complex (including Service Bay, Transitions and Walls)	135	m		-
	ii	Injection Hose waterstop Spillway Complex(including Transitions & Walls)	35	m		-
e		Grout Injection				
	i	Grout injection for Injection Hose waterstop Powerhouse Complex	1	litres		-
	ii	Grout injection for Injection Hose waterstop Spillway Complex	1	litres		-
03 15 19		**Embedded Anchors**				
a		Anchor bolts with pipe sleeves for Powerhouse Complex	63,000	kg		-
b		Anchors embedded in primary concrete for gate guides supplied by contractor	210,000	kg		-
c		Roadway guardrail anchors (c/w bolts and washers)	5,788	kg		-
d		Channel inserts in concrete (unistrut)	3,500	kg		-
e		Bull rings & ladder rungs	700	kg		-
f		High strength anchors for Spillway precast panels	2,000	kg		-
g		Anchors embedded in primary concrete for gate parts (install only)	38,165	kg		-
h		Embedded Anchors for mechanical & electrical equipment (install only)	400	kg		-
i		Embedded Anchors for turbine & generator equipment (install only)	7	each		-
j		Embedded Anchors for Spillway Hoist Housing Towers (install only)	32	each		-
03 21 00		**Reinforcing Steel**				
a		Spillway Structure	2,829,546	kg		-
b		Spillway Transition Structures	159,525	kg		-
c		Walls A to D (Spillway)	80,860	kg		-
d		Intake Structure	5,811,260	kg		-
e		Powerhouse Structure	8,086,905	kg		-
f		Tailrace Structure	4,892,100	kg		-
g		Service Bay Structure	1,244,461	kg		-
h		Powerhouse Transition Structures	295,130	kg		-
i		Wall E & F (Powerhouse)	49,000	kg		-
j		Splices for No. 35 M bars			**Cash Allowance**	**30,000.00**

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
k		Splices for No. 45 M bars			**Cash Allowance**	**80,000.00**
l		Splices for No. 55 M bars			**Cash Allowance**	**140,000.00**
m		Welded Wire Fabric			**Cash Allowance**	**50,000.00**
~~n~~		~~Anchor Dowels - Passive Anchors (incl Drill and Grouting)~~	~~1~~	~~each~~		~~-~~
03 30 00		**Cast-In-Place Concrete**				
a		Spillway Structure				
	i	Spillway base slabs	13,377	m^3		-
	ii	Spillway piers	24,455	m^3		-
	iii	Spillway rollways	6,368	m^3		-
	iv	Spillway North Transition	6,100	m^3		-
	v	Spillway South Transition	4,535	m^3		-
	vi	Spillway Walls A to D	2,130	m^3		-
	vii	Spillway structural sections	325	m^3		-
b		Service Bay				
	i	Service Bay gravity section	18,129	m^3		-
	ii	Service Bay structural sections	16,307	m^3		-
c		Powerhouse				
	i	Intake base slab from rock to invert of water passages	9,200	m^3		-
	ii	Intake piers from invert to roof of water passages	25,946	m^3		-
	iii	Intake from roof of intake water passages to gate housing	37,064	m^3		-
	iv	Powerhouse draft tubes	35,214	m^3		-
	v	Floors and walls of Powerhouse semi-spiral cases	43,195	m^3		-
	vi	Powerhouse Unit 7 end wall above semi-spiral case wall	167	m^3		-
	vii	Roofs of semi-spiral cases	12,208	m^3		-
	viii	Powerhouse structural section	3,854	m^3		-
	ix	Tailrace base slab	11,297	m^3		-
	x	Tailrace piers and draft tube soffit	28,456	m^3		-
	xi	Tailrace structural sections	8,126	m^3		-
	xii	Powerhouse north transition	7,150	m^3		-
	xiii	Powerhouse south transition	14,500	m^3		-
	xiv	Powerhouse walls E and F	2,060	m^3		-
d		Other Concrete				
	i	Secondary Concrete works	1,698	m^3		-
	ii	Concrete for metal decking	200	m^3		-
	iii	Dental Concrete for dykes and dams	**15,000**	m^3		-
	iv	Concrete at Batch Plant	10	m^3		-
03 35 00		**Concrete Finishing and Repair**				
a		Type F3 concrete finishing and repair	250	m^2		-
b		Type F4 concrete finishing and repair	27,200	m^2		-
c		Type U3 concrete finishing and repair	19,650	m^2		-
d		Type U4 concrete finishing and repair	6,100	m^2		-
03 35 05		**Floor Hardener and Concrete Surface Sealer**				
a		Floor hardener	7,700	m^2		-
b		Surface sealer	10,500	m^2		-
03 40 00		**Precast Concrete**				
a		Intake water passage roof	498	m^3		-
b		Draft tube extension roof panels	189	m^3		-
c		Tailrace D/S wall support beams	199	m^3		-
d		Spillway rollway blockout precast panels	910	m^3		-
e		Traffic Barriers			**Cash Allowance**	**10,000.00**
f		Curbs			**Cash Allowance**	**3,000.00**
g		Catch Basins			**Cash Allowance**	**40,000.00**
h		**Drainage and Dewatering Sump floor slab**	**60**	**m^3**		

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
03 41 33		**Precast, Prestressed Concrete Beams and Girders**				
a		Spillway Bridge Girders	1,145	m^3		-
b		Tailrace Electrical Gallery floor	2,021	m^3		-
c		Spillway Load Centre floor	165	m^3		-
d		Oil Water Separator forms	98	m^3		-
03 45 13		**Precast Wall Panels**				
a		Insulated Precast Wall Panels	4,050	m^2		-
b		Non-insulated Precast Panels (For bottom 1m of steel cladding)	200	m^2		-
03 53 00		**Concrete Floor Toppings**				
a		50 mm thick	7,500	m^2		-
b		100 mm thick	3,500	m^2		-
03 60 00		**Equipment Grouting (Skin/Contact Grout)**				
a		Grouting for Draft-tube Liner, Stay Rings, Steel Bulkhead Doors	10,000	litres		-
04 22 00		**Concrete Unit Masonry**				
a		100 mm concrete unit masonry walls	100	m^2		-
b		150 mm concrete unit masonry walls	150	m^2		-
c		200 mm concrete unit masonry walls	2,875	m^2		-
d		200 mm concrete unit masonry walls - fire rated	665	m^2		-
05 12 23		**Structural Steel**	-			
		Structural Steel				
a		Light Weight < 24.9 Kg/m	115,952	kg		-
b		Medium Weight > 25 kg/m and < 124.9 kg/m	388,306	kg		-
c		Heavy Weight > 125 kg/m	377,076	kg		-
d		Shop Fabricated Beams and Columns (WWF)	803,450	kg		-
e		Crane Runway Beam complete with Crane Rails and Accessories	514	m		-
f		Crane end stops	400	kg		-
g		Fire Proofing of Structural Steel (spray on)	850	m^2		-
h		Galvanizing of Steel	28,500	kg		-
05 31 23		**Steel Decking**				
a		Metal Decking for roofing	8,750	m^2		-
b		Metal Decking for concrete floor (Q-Decking)	1,300	m^2		-
05 50 00		**Miscellaneous Metal**				
a		Hatchway, manhole, gate slot frame and trench frames and covers (galvanized)	12,000	kg		-
b		Hatchway, manhole and trench frames and covers (painted)	3,000	kg		-
c		Structural steel bulkhead doors and frames (painted)	25,200	kg		-
d		Stairs and landings with handrails, ladders with and without cages, platforms complete with accessories (galvanized)	81,000	kg		-
e		Fixed and removable handrails for platforms, equipment hatches and openings (galvanized)	59,000	kg		-
f		Draft tube pier nose armour (painted)	28,000	kg		-
g		Spillway pier nose armour (painted)	9,600	kg		-
h		Miscellaneous structural steel framing not included in superstructure steel package (galvanized)	10,000	kg		-
i		Miscellaneous structural steel framing not included in superstructure steel package (painted)	10,000	kg		-
j		Galvanized guard rails and posts	100,000	kg		-
k		Galvanized wall rails	1,000	kg		-
l		Galvanized corner protection angles	1,000	kg		-
m		Bollards, door guard posts	1,000	kg		-
n		Domed hatches with liner for Draft Tube and dewatering sump accesses	2,000	kg		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
o		Galvanized contraction joint angles for joint sealers	6,000	kg		-
p		Galvanized pipe sleeves for electrical and mechanical works	1,000	kg		-
q		Pipe sleeves for pressure relief drains and grout curtain	3,500	m		-
r		Metal abrasive nosings for concrete stairs	700	m		-
s		Corrugated pipe sleeves for stay ring anchors	168	each		-
07 11 13		**Bituminous Damp proofing - Not Currently Included**			**Cash Allowance**	**200,000.00**
07 21 13		**Board Insulation - Not Currently Included**			**Cash Allowance**	**25,000.00**
07 21 29		**Sprayed Insulation - Not Currently Included**			**Cash Allowance**	**25,000.00**
07 27 00		**Air Barriers - Not Currently Included**			**Cash Allowance**	**25,000.00**
07 62 00		**Metal Flashing and Trim - Not Currently Included**			**Cash Allowance**	**500,000.00**
07 64 00		**Metal Wall Cladding - Not Currently Included**			**Cash Allowance**	**5,000,000.00**
07 52 00		**Modified Bituminous Membrane Roofing - Not Currently Included**			**Cash Allowance**	**3,500,000.00**
07 91 26		**Joint Fillers**				
a		Type 1 joint fillers	140	m^2		-
b		Type 2 joint fillers	20	m^2		-
c		Type 3 joint fillers	810	m		-
d		Type 4 joint fillers	80	m^3		-
07 92 00		**Joint Sealants**				
a		Type A joint sealants	425	m		-
b		Type B joint sealants	20	m		-
c		Type C joint sealants	235	litres		-
d		Type D joint sealants	135	litres		-
08 11 00		**Metal Doors and Frames - Not Currently Included**			**Cash Allowance**	**500,000.00**
08 36 19		**Service Bay Door**				
a		Service Bay Door		EC		-
08 50 00		**Windows - Not Currently Included**			**Cash Allowance**	**20,000.00**
08 70 05		**Cabinet and Miscellaneous Hardware - Not Currently Included**			**Cash Allowance**	**20,000.00**
08 71 00		**Door Hardware - Not Currently Included**			**Cash Allowance**	**10,000.00**
08 80 50		**Glazing - Not Currently Included**			**Cash Allowance**	**10,000.00**
09 21 16		**Gypsum Board Assemblies - Not Currently Included**			**Cash Allowance**	**10,000.00**
09 22 16		**Non-Structural Metal Framing - Not Currently Included**			**Cash Allowance**	**10,000.00**
09 22 26		**Metal Suspension Systems - Not Currently Included**			**Cash Allowance**	**10,000.00**
09 51 13		**Acoustical Panel Ceilings - Not Currently Included**			**Cash Allowance**	**10,000.00**
09 65 19		**Resilient Tile Flooring - Not Currently Included**			**Cash Allowance**	**50,000.00**
09 90 00		**Painting and Coating**				
a		Concrete block walls	6,800	m^2		-
b		Concrete surfaces including walls, ceilings and floors	19,575	m^2		-
c		Interior steel surfaces , such as door frames	1,350	m^2		-
d		Exterior steel surfaces, such as transmission line take-off structures	30	m^2		-
e		Interior drywall or wood	800	m^2		-
10 21 13		**Metal Toilet Compartments - Not Currently Included**			**Cash Allowance**	**10,000.00**
10 21 16		**Shower and Dressing Compartments - Not Currently Included**			**Cash Allowance**	**10,000.00**
10 28 10		**Toilet and Bath Accessories - Not Currently Included**			**Cash Allowance**	**10,000.00**
10 51 13		**Metal Lockers - Not Currently Included**			**Cash Allowance**	**10,000.00**
10 56 16		**Fabricated Wood Storage Shelving - Not Currently Included**			**Cash Allowance**	**10,000.00**
14 20 00		**Elevators**				
a		Equipment				

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	i	Control Building Elevator	1	each		-
	ii	Upstream Service Bay Elevator	1	each		-
	iii	South Transition Elevator	1	each		-
b		Provision of all close-out activities such as training and demonstration services.		EC		-
c		Provision of initial maintenance services, as specified		EC		-
21 12 00		**Powerhouse Fire Protection Standpipe System**				
a		Equipment				
	i	Fire pump / electric motor driven	1	each		-
	ii	Fire pump / diesel driven	1	each		-
	iii	Diesel fire pump fuel oil storage tank	1	each		-
	iv	Jockey pump	2	each		-
	v	Fire hose cabinet	20	each		-
	vi	Standard fire hose reel	52	each		-
	vii	Fire header hydropneumatic tank	1	each		-
	viii	Wall hydrant	8	each		-
	ix	Pumper connection	1	each		-
b		Exposed Piping				
	i	Pipe 400	2	m		-
	ii	Pipe 350	528	m		-
	iii	Pipe 300	64	m		-
	iv	Pipe 250	3	m		-
	v	Pipe 150	318	m		-
	vi	Pipe 100	363	m		-
	vii	Pipe 80	8	m		-
	viii	Pipe 65	17	m		-
	ix	Pipe 50	200	m		-
	x	Pipe 32	10	m		-
c		Exposed Fittings				
	i	Trimmed elbow 350	2	each		-
	ii	Sockolet 400 -400 -80	1	each		-
	iii	Sockolet 350 -350 -100	1	each		-
	iv	Sockolet 350 -350 -32	1	each		-
	v	Tee 350 -350 -350	5	each		-
	vi	Tee 350 -350 -200	1	each		-
	vii	Tee 300 -300 -300	2	each		-
	viii	Tee 300 -300 -250	1	each		-
	ix	Tee 150 -150 -150	6	each		-
	x	Tee 150 -150 -100	14	each		-
	xi	Tee 100 -100 -100	28	each		-
	xii	Tee 65 -65 -65	7	each		-
	xiii	Weldolet 350 -350 -150	3	each		-
	xiv	Weldolet 350 -350 -100	25	each		-
	xv	Thredolet 350 -350 -40	1	each		-
	xvi	Concentric reducer 400 -300	2	each		-
	xvii	Concentric reducer 350 -300	2	each		-
	xviii	Concentric reducer 350 -250	2	each		-
	xix	Concentric reducer 100 -65	21	each		-
	xx	Concentric reducer 80 -40	3	each		-
	xxi	Concentric swage 40 -32	3	each		-
	xxii	Elbow, 90 deg, lr 350 -350	15	each		-
	xxiii	Elbow, 90 deg, lr 300 -300	13	each		-
	xxiv	Elbow, 90 deg, lr 200 -200	1	each		-
	xxv	Elbow, 90 deg, lr 250 -250	1	each		-
	xxvi	Elbow, 90 deg, lr 150 -150	11	each		-
	xxvii	Elbow, 90 deg, lr 100 -100	86	each		-
	xxviii	Elbow, 90 deg, lr 80 -80	1	each		-
	xxix	Elbow, 90 deg, lr 65 -65	14	each		-
	xxx	Elbow, 45 deg, lr 350 -350	2	each		-
	xxxi	Elbow, 45 deg, lr 300 -300	1	each		-
	xxxii	Elbow, 45 deg, lr 150 -150	3	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	xxxiii	Elbow, 45 deg, lr 100 -100	25	each		-
	xxxiv	Elbow, 90 deg, sr 400 -400	1	each		-
	xxxv	Elbow, 90 deg, sr 80 -80	2	each		-
	xxxvi	Elbow, 90 deg sr 32 -32	6	each		-
	xxxvii	Flange, weld neck 400 -400	4	each		-
	xxxviii	Flange, weld neck 350 -350	33	each		-
	xxxix	Flange, weld neck 300 -300	8	each		-
	xl	Flange, weld neck 250 -250	6	each		-
	xli	Flange, weld neck 200 -200	1	each		-
	xlii	Flange, weld neck 150 -150	4	each		-
	xliii	Flange, weld neck 100 -100	112	each		-
	xliv	Flange, blind 350 -350	1	each		-
	xlv	Flange, blind 300 -300	2	each		-
	xlvi	Flange, blind 150 -150	4	each		-
	xlvii	Flange, socketweld 32 -32	5	each		-
d		Valves				
	i	Butterfly valve 350	8	each		-
	ii	Butterfly valve 300	3	each		-
	iii	Butterfly valve 250	2	each		-
	iv	Butterfly valve 150	5	each		-
	v	Butterfly valve 100	56	each		-
	vi	Butterfly valve 65	9	each		-
	~~vii~~	~~Ball valve 100~~ **NOT USED**	~~18~~	~~each~~		~~-~~
	viii	Ball valve 32	4	each		-
	ix	Ball valve 25	2	each		-
	x	Ball valve 20	11	each		-
	xi	Ball valve 15	26	each		-
	xii	Gate valve 400	2	each		-
	xiii	Gate valve 65	14	each		-
	xiv	Gate valve (hose valve on test header) 65	20	each		-
	xv	Check valve 350	2	each		-
	xvi	Check valve 32	2	each		-
	xvii	Globe valve 15	4	each		-
e		Instrumentation		EC		-
f		Testing, flushing, cleaning		EC		-
g		Pre-commissioning		EC		-
21 13 00		**Powerhouse Fire Suppression Sprinkler System**				
a		Dry deluge sprinkler systems				
	i	Design		EC		-
	ii	Supply and install		EC		-
b		Wet pipe sprinkler systems				
	i	Design		EC		-
	ii	Supply and install		EC		-
c		Dry pre-action sprinkler systems				
	i	Design		EC		-
	ii	Supply and install		EC		-
22 11 00		**Domestic Water System**				
a		Fixtures & Equipment				
	i	Water treatment plant	1	each		-
	ii	Water closet	12	each		-
	iii	Urinal	3	each		-
	iv	Lavatory	3	each		-
	v	Slop sink	2	each		-
	vi	Kitchen sink	7	each		-
	vii	Laboratory sink	2	each		-
	viii	Shower	6	each		-
	ix	Wash fountain	4	each		-
	x	Eye wash station	5	each		-
	xi	Hot water tank	2	each		-
	xii	Recirculation pump	1	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	xiii	Hydro-pneumatic tank	1	each		-
	xiv	Domestic water pump	2	each		-
b		Exposed Piping				
	i	Tube 65	20	m		-
	ii	Tube 50	259	m		-
	iii	Tube 40	100	m		-
	iv	Tube 32	500	m		-
	v	Tube 20	200	m		-
	vi	Tube 15	50	m		-
c		Exposed Fittings				
	i	Tee 50 -50 -50	5	each		-
	ii	Tee 40 -40 -40	5	each		-
	iii	Tee 32 -32 -32	5	each		-
	iv	Cross 50 -50 -50	1	each		-
	v	Concentric reducer 65 -40	2	each		-
	vi	Concentric reducer 50 -40	2	each		-
	vii	Concentric reducer 50 -32	3	each		-
	viii	Concentric reducer 40 -32	2	each		-
	ix	Concentric reducer 32 -15	1	each		-
	x	Elbow, 90 deg 65 -65	6	each		-
	xi	Elbow, 90 deg 50 -50	24	each		-
	xii	Elbow, 90 deg 40 -40	10	each		-
	xiii	Elbow, 90 deg 32 -32	5	each		-
	xiv	Elbow, 90 deg 15 -15	5	each		-
	xv	Coupling 50 -50	10	each		-
	xvi	Coupling 40 -40	10	each		-
	xvii	Coupling 32 -32	25	each		-
	xviii	Union 65 -65	2	each		-
	xix	Union 50 -50	10	each		-
	xx	Union 40 -40	10	each		-
	xxi	Union 32 -32	5	each		-
	xxii	Union 15 -15	5	each		-
	xxiii	Cap 32	10	each		-
	xxiv	Cap 15	10	each		-
d		Valves				
	i	Butterfly valve 65	1	each		-
	ii	Ball valve 65	2	each		-
	iii	Ball valve 50	5	each		-
	iv	Ball valve 32	3	each		-
	v	Ball valve 15	2	each		-
	vi	Check valve 50	2	each		-
	vii	Check valve 15	1	each		-
e		Components				
	i	Expansion joints	6	each		-
	ii	Trap primers	9	each		-
	iii	Shock absorbers	12	each		-
f		Insulation		EC		-
g		Instrumentation		EC		-
h		Testing, flushing, cleaning		EC		-
i		Pre-commissioning		EC		-
22 13 00		**Sanitary System**				
a		Equipment				
	i	Waste water treatment plant	1	each		-
	ii	Waste water treatment plant room sump pump	1	each		-
b		Exposed Piping				
	i	Tube 100	107	m		-
	ii	Tube 80	50	m		-
	iii	Tube 50	183	m		-
c		Exposed Fittings				
	i	Lateral 100 -100 -100	4	each		-
	ii	Double lateral 100 -100 -100	2	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	iii	Elbow, 45 deg 100 -100	8	each		-
	iv	Elbow, 90 deg 100 -100	15	each		-
	v	Elbow, 90 deg 50 -50	5	each		-
	vi	Cleanout 100	37	each		-
	vii	Cleanout 80	4	each		-
	viii	Cleanout 50	42	each		-
d		Valves				
	i	Ball valve 50	2	each		-
	ii	Check valve 50	1	each		-
e		Components				
	i	Expansion joints	6	each		-
f		Instrumentation		EC		-
g		Testing, flushing, cleaning		EC		-
h		Pre-commissioning		EC		-
22 14 00		**Clear Water Drainage System**				
a		Equipment				
	i	Unit clearwater drainage sump pump	4	each		-
	ii	Elevator shaft drainage pump	3	each		-
	iii	Coalescing plates	3	each		-
	iv	Oil recovery belt skimmer	3	each		-
	v	Oil recovery tank (208 L)	3	each		-
	vi	Oil recovery pump	3	each		-
	vii	Oil recovery floating oil skimmer	1	each		-
	viii	Oil/water monitoring system	1	each		-
	ix	Sampling pump	3	each		-
b		Exposed Piping				
	i	Pipe 400	9	m		-
	ii	Pipe 250	159	m		-
	iii	Pipe 200	90	m		-
	iv	Pipe 150	271	m		-
	v	Pipe 100	100	m		-
	vi	Pipe 80	100	m		-
	vii	Pipe 50	100	m		-
c		Exposed Fittings				
	i	Trimmed elbow 250	1	each		-
	ii	Lateral 400 -400 -250	1	each		-
	iii	Lateral 250 -250 -250	7	each		-
	iv	Lateral 250 -250 -150	5	each		-
	v	Lateral 200 -200 -200	14	each		-
	vi	Lateral 150 -150 -150	10	each		-
	vii	Tee 250 -250 -250	3	each		-
	viii	Concentric reducer 350 -250	6	each		-
	ix	Concentric reducer 250 -200	18	each		-
	x	Concentric reducer 200 -150	14	each		-
	xi	Elbow, 90 deg, lr 250 -250	19	each		-
	xii	Elbow, 90 deg, lr 200 -200	7	each		-
	xiii	Elbow, 90 deg, lr 150 -150	25	each		-
	xiv	Elbow, 45 deg, lr 200 -200	21	each		-
	xv	Elbow, 45 deg, lr 250 -250	4	each		-
	xvi	Elbow, 45 deg, lr 150 -150	12	each		-
	xvii	Flange 350 -350	26	each		-
	xviii	Flange 250 -250	12	each		-
	xix	Flange 200 -200	16	each		-
	xx	Flange 150 -150	8	each		-
	xxi	Flange 100 -100	12	each		-
d		Valves				
	i	Butterfly valve 350	10	each		-
	ii	Butterfly valve 250	4	each		-
	iii	Butterfly valve 200	4	each		-
	iv	Butterfly valve 150	4	each		-
	v	Butterfly valve 100	3	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	vi	Ball valve 100	3	each		-
	vii	Ball valve 50	3	each		-
	viii	Ball valve 20	3	each		-
	ix	Ball valve 15	3	each		-
	x	Check valve 350	3	each		-
	xi	Check valve 200	4	each		-
	xii	Check valve 50	3	each		-
	xiii	Check valve 20	3	each		-
e		Embedded Piping				
	i	Pipe 400	144	m		-
	ii	Pipe 350	32	m		-
	iii	Pipe 300	109	m		-
	iv	Pipe 250	422	m		-
	v	Pipe 200	289	m		-
	vi	Pipe 150	2,580	m		-
	vii	Pipe 100	352	m		-
	viii	Pipe 80	100	m		-
	ix	Pipe 50	100	m		-
f		Embedded Fittings				
	i	Trimmed elbow 400	4	**each**		-
	ii	Trimmed elbow 250	2	**each**		-
	iii	Trimmed elbow 150	1	each		-
	iv	Lateral 400 -400 -400	1	each		-
	v	Lateral 400 -400 -350	6	each		-
	vi	Lateral 250 -250 -250	1	each		-
	vii	Lateral 250 -250 -200	1	each		-
	viii	Lateral 250 -250 -150	94	each		-
	ix	Lateral 200 -200 -150	3	each		-
	x	Lateral 150 -150 -150	95	each		-
	xi	Lateral 100 -100 -100	14	each		-
	xii	Tee 350 -350 -350	4	each		-
	xiii	Tee 350 -350 -250	2	each		-
	xiv	Tee 250 -250 -250	4	each		-
	xv	Tee 150 -150 -150	1	each		-
	xvi	Tee 150 -150 -100	3	each		-
	xvii	Tee 100 -100 -100	4	each		-
	xviii	Concentric reducer 400 -350	1	each		-
	xix	Concentric reducer 150 -100	1	each		-
	xx	Elbow, 90 deg, lr 350 -350	5	each		-
	xxi	Elbow, 90 deg, lr 300 -300	3	each		-
	xxii	Elbow, 90 deg, lr 250 -250	8	each		-
	xxiii	Elbow, 90 deg, lr 200 -200	21	each		-
	xxiv	Elbow, 90 deg, lr 150 -150	240	each		-
	xxv	Elbow, 90 deg, lr 100 -100	18	each		-
	xxvi	Elbow, 45 deg, lr 250 -250	1	each		-
	xxvii	Elbow, 45 deg, lr 200 -200	1	each		-
	xxviii	Elbow, 45 deg, lr 150 -150	141	each		-
	xxix	Elbow, 90 deg, sr 250 -250	1	each		-
g		Insulation		EC		-
h		Components				
	i	Floor drain	157	each		-
	ii	Equipment drains	20	each		-
	iii	Trench drain	102	each		-
	iv	Roof drain	33	each		-
	v	Foot valve	3	each		-
	vi	Manifold sampling valve assembly	1	each		-
i		Instrumentation		EC		-
j		Testing, flushing, cleaning		EC		-
k		Pre-commissioning		EC		-
22 15 00		**Service Air and Brake Air Systems**				
a		Equipment				

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	i	Brake and service air compressor	2	each		-
	ii	Service air receiver	2	each		-
	iii	Brake air receiver	1	each		-
	iv	Compressed air oil-water separator	1	each		-
b		Service Air - Exposed Piping				
	i	Pipe 50	1,045	m		-
	ii	Pipe 40	275	m		-
	iii	Pipe 32	50	m		-
	iv	Pipe 25	1,100	m		-
	v	Pipe 20	50	m		-
	vi	Pipe 15	30	m		-
c		Service Air - Exposed Fittings				
	i	Tee 50 -50 -50	12	each		-
	ii	Cap 50	2	each		-
	iv	Concentric reducer 80 -50	2	each		-
	v	Coupling 50 -50	2	each		-
	vi	Elbow: 90 deg sr 50	52	each		-
	vii	Elbow, 45 deg lr 50	5	each		-
	viii	Elbow, 90 deg lr 80	5	each		-
	ix	Flange 80	3	each		-
d		Service Air - Valves				
	i	Ball valve 50	52	each		-
	ii	Ball valve 40	52	each		-
	iii	Ball valve 25	23	each		-
	iv	Ball valve 20	60	each		-
	v	Check valve 50	1	each		-
	vi	Check valve 25	7	each		-
	vii	Check valve 20	7	each		-
e		Brake Air - Exposed Piping				
	i	Pipe 50	239	m		-
f		Brake Air - Exposed Fittings				
	i	Cap 50	1	each		-
	ii	Concentric Reducer 80 -50	2	each		-
	iii	Elbow, 90 deg sr 50	10	each		-
	iv	Elbow, 90 deg lr 80	1	each		-
	v	Flange 80	2	each		-
g		Brake Air - Valves				
	i	Ball valve 50	1	each		-
	ii	Ball valve 25	18	each		-
	iii	Check valve 50	1	each		-
	iv	Check valve 25	7	each		-
h		Components				
	i	Condensate drains	5	each		-
	ii	Flexible pipe connector	2	each		-
	iii	Pressure safety valve 50	1	each		-
i		Instrumentation		EC		-
j		Testing, flushing, cleaning		EC		-
k		Pre-commissioning		EC		-
23 30 00		**Heating Ventilation and Air Conditioning System**				
a		Fans				
	i	Service Bay el 141.7 transfer fan	1	each		-
	ii	Compressor cooling supply fan	3	each		-
	iii	Waste water plant exhaust fan	1	each		-
	iv	Oil room exhaust fan	1	each		-
	v	Service Bay battery room exhaust fan	1	each		-
	vi	Water treatment plant exhaust fan	1	each		-
	vii	Pump room supply fan	1	each		-
	viii	Compressor room supply fan	1	each		-
	ix	Welding room exhaust fan	1	each		-
	x	Diesel generator room exhaust fan	2	each		-
	xi	Control building exhaust fan	1	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	xii	Service Bay electrical room exhaust fan	1	each		-
	xiii	Intake passage fume exhaust fan	1	each		-
	xiv	Diesel fire pump room transfer fan	1	each		-
	xv	Erection floor exhaust fan	2	each		-
	xvi	Service Bay stairway pressurization fan	3	each		-
	xvii	Unit 7 intake stairway pressurization fan	1	each		-
	xviii	Unit electrical gallery battery room exhaust fan	2	each		-
	xix	Hoist housing fire exhaust fan	7	each		-
	xx	Electrical gallery smoke exhaust fan	7	each		-
	xxi	Electrical gallery transfer fan	7	each		-
	xxii	Draft tube gallery transfer fan	7	each		-
	xxiii	Dewatering gallery transfer fan	2	each		-
	xxiv	Unit dewatering gallery stairway exhaust fan	3	each		-
b		Welding Extraction Arm	1	each		-
c		Grilles, Registers and Diffusers				
	i	Compressor room supply grille	4	each		-
	ii	Compressor room supply grille	3	each		-
	iii	Compressor room supply grille	3	each		-
	iv	Water treatment room room supply grille	1	each		-
	v	Powerhouse roof supply grille	18	each		-
	vi	Powerhouse & Service Bay transfer grille	100	each		-
	vii	Diesel generator room transfer grille	4	each		-
	viii	Powerhouse and Service Bay fume and smoke exhaust grille	5	each		-
	ix	Square cone diffuser	40	each		-
	x	Louvered face return	10	each		-
	xi	Louvered face supply	5	each		-
	xii	Spiral duct grille	5	each		-
	xiii	Door grille	10	each		-
d		Louvers				
	i	Service Bay u/s wall powerhouse exhaust louver	29	each		-
	ii	Service Bay supply chase	1	each		-
	iii	Service Bay exhaust chase	1	each		-
	iv	Generator room diesel generator #1	1	each		-
	v	Generator room diesel generator #2	1	each		-
	vi	Generator room diesel generator #1 room exhaust	1	each		-
	vii	Generator room diesel generator #2 room exhaust	1	each		-
e		Dampers				
	i	Balancing damper	49	each		-
	ii	Powerhouse & Service Bay fire damper	30	each		-
	iii	Powerhouse & Service Bay fire damper	33	each		-
	iv	Service Bay roof fan return air damper	9	each		-
	v	Service Bay electrical gallery return air damper	1	each		-
	vi	Powerhouse intake passage fume exhaust	21	each		-
	vii	Service Bay u/s wall exhaust damper	9	each		-
	viii	Service Bay relief damper	18	each		-
	ix	Hoist housing water passage damper	1	each		-
	x	Electrical service gallery, Service Bay exhaust damper	11	each		-
	xi	Powerhouse roof outdoor air damper	9	each		-
	xii	Exhaust chase exhaust damper	1	each		-
	xiii	Supply chase exhaust damper	1	each		-
	xiv	Supply chase mixing damper	1	each		-
	xv	Diesel generator rooms outdoor air damper	3	each		
f		Rooftop Air Supply Units				
	i	Service Bay supply unit	2	each		-
	ii	Powerhouse supply unit	7	each		-
g		Control building cooling unit	1	each		-
h		Engineering room split a/c unit	1	each		-
i		Communication room air conditioning unit	1	each		-
j		HVAC control system		EC		-
k		Exposed Ducting				
	i	Duct <450	2,713	kg		-
	ii	Duct 460-1000	12,812	kg		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	iii	Duct >1000	10,767	kg		-
l		HVAC ducting insulation		EC		-
m		Instrumentation		EC		-
n		Balancing		EC		-
o		Pre-commissioning		EC		-
25 11 00		**Unit Control and Monitoring System**				
a		UCMS Network Equipment Supply and Installation				
	i	Service Bay Fibre Termination Panel 1 SB1-FTP	1	each		-
	ii	Service Bay Fibre Termination Panel 2 SB2-FTP	1	each		-
	iii	Powerhouse Fibre Termination Panel 1 PH1-FTP	1	each		-
	iv	Powerhouse Fibre Termination Panel 2 PH2-FTP	1	each		-
	v	Intake Fibre Termination Panel	1	each		-
	vi	Spillway Fibre Termination Panel SP1--FTP	1	each		-
	vii	Minor Fibre termination panels in Powerhouse and Spillway adjacent to equipment	20	each		-
b		Line Protection System Fibre Termination Panels, supply and install				
	i	Line Fibre Termination Panel 1	1	each		-
	ii	Line Fibre Termination Panel 2	1	each		-
	iii	Line Fibre Termination Panel 3	1	each		-
	iv	Line Fibre Termination Panel 4	1	each		-
c		Control Room operator desks and interfacing to viewers and the facility systems.				
	i	Operator desks for operators in the Control Room		EC		-
	ii	Raceways and Wire ducts to interface viewers and the other infrastructure		EC		-
d		Unit Control and Monitoring System PLC installation				
	i	Station PLC	1	each		-
	ii	Unit 1 PLC	1	each		-
	iii	Unit 2 PLC	1	each		-
	iv	Unit 3 PLC	1	each		-
	v	Unit 4 PLC	1	each		-
	vi	Unit 5 PLC	1	each		-
	vii	Unit 6 PLC	1	each		-
	viii	Unit 7 PLC	1	each		-
	ix	Auxiliary PLC 1	1	each		-
	x	Auxiliary PLC 2	1	each		-
	xi	Spillway PLC	1	each		-
	xii	Remote I/O Panels	7	each		-
	xiii	Server A Cubicle	1	each		-
	xiv	Server B Cubicle	1	each		-
	xv	Viewer 1-Control Room	1	each		-
	xvi	Viewer 2-Control Room	1	each		-
	xvii	Viewer 3-Control Room	1	each		-
26 05 21		**Wire and Cable System**				
a		15 kV Cable and Termination kits				
	i	1C, 350 MCM Cable	216	m		-
	ii	1C, 250 MCM Cable	20,874	m		-
	iii	3C, 250 MCM Cable	564	m		-
b		1000V Cable Power Cables				
	i	3C, #12 AWG Cable	6,064	m		-
	ii	3C, #10 AWG Cable	792	m		-
	iii	3C, #8 AWG Cable	594	m		-
	iv	3C, #6 AWG Cable	1,704	m		-
	v	3C, #4 AWG Cable	1,650	m		-
	vi	3C, #2 AWG Cable	1,914	m		-
	vii	3C, #1 AWG Cable	318	m		-
	viii	3C, 1/0 AWG Cable	870	m		-
	ix	3C, 2/0 AWG Cable	2,670	m		-
	x	3C, 4/0 AWG Cable	300	m		-
	xi	3C, 250 kcmil Cable	174	m		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	xii	3C, 350 kcmil Cable	894	m		-
	xiii	3C, 500 kcmil Cable	1,806	m		-
	xiv	3C, 750 kcmil Cable	402	m		-
c		Control Cable, 600V Shielded Cables				
	i	4C, #14 Cable	5,784	m		-
	ii	2C, #14 Cable	3,129	m		-
	iii	10C, #14 Cable	8,315	m		-
	iv	2C, #12 Cable	1,574	m		-
	v	4C, #12 Cable	6,476	m		-
	vi	15C, #12 Cable	1,008	m		-
d		125 Vdc Cables, (600V Shielded)				
	i	2C, #10 Cable	10,710	m		-
	ii	2C, #6 Cable	1,570	m		-
	iii	2C, 1/0 AWG Cable	300	m		-
	iv	2C, 2/0 AWG Cable	1,155	m		-
	v	2C, 4/0 AWG Cable	820	m		-
	vi	1C, 750 MCM Exane 125 Cable	130	m		-
	vii	1C, 750 MCM Cable	231	m		-
e		Instrument cables				
	i	1PR, #16 Cable	6,562	m		-
	ii	2PR, #16 Cable	3,766	m		-
	iii	4PR, #16 Cable	4,170	m		-
	iv	6PR, #16 Cable	2,937	m		-
	v	8PR, #16 Cable	1,500	m		-
	vi	4TR, #16 Cable	378	m		-
	vii	6TR, #16 Cable	420	m		-
	viii	1C, #8 Insulated Ground Wire	600	m		-
f		Fire Alarm Signalling Cable		EC		-
26 05 27		**Embedded Grounding**				
a		Stranded, 500 MCM bare Copper Conductor	8,318	m		-
b		Stranded, 4/0 AWG bare Copper Conductor	10,000	m		-
c		Horizontal Exothermic Tee Connection 500MCM Run and 500 MCM Tap	2,940	each		-
d		Horizontal Exothermic Tee Connection 500MCM Run and 4/0 Tap	3,010	each		-
e		Horizontal Exothermic Tee Connection 4/0 AWG Run and 4/0 Tap	105	each		-
f		Horizontal Exothermic Cross Connection 500MCM to 500 MCM	245	each		-
26 05 28		**Surface Grounding**				
a		In Powerhouse and Spillway				
	i	2'x1/2" Copper bar including mounting hardware	1,000	m		-
	ii	Stranded, 500 MCM bare copper conductor	1,000	m		-
	iii	Stranded, 4/0 AWG bare copper conductor on cable trays	5,500	m		-
b		Outside the Powerhouse and Spillway				
	i	Stranded, 4/0 AWG bare copper conductor	3,000	m		-
	ii	Fence grounding hardware and pigtails	200	m		-
	iii	Miscellaneous Structures	20	each		-
c		Communication Room				
	i	Grounding Bar for single point bonding	1	each		-
	ii	Screen Mesh for communication room	1	each		-
d		Grounding Connections of overhead lines sky wires	4	each		-
e		Grounding Connections of HV disconnect and grounding switches	8	each		-
f		Grounding connections of GSU Transformer	7	each		-
g		Grounding connections of line protection panels	4	each		-
26 05 29		**Cable and Wire Support System**				
a		Cable Trays - Horizontal				
	i	900 mm wide	689	m		-
	ii	600 mm wide	2,523	m		-
	iii	300 mm wide	1,400	m		-
	iv	150 mm wide	100	m		-
b		Cable Trays - Vertical				

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	i	900 mm wide	100	m		-
	ii	600 mm wide	100	m		-
	iii	300 mm wide	350	m		-
	iv	150 mm wide	75	m		-
c		Conduits and Support System Exposed				
	i	4" Rigid metal conduit	500	m		-
	ii	3" Rigid metal conduit	1,000	m		-
	iii	2" Rigid metal conduit	1,500	m		-
	iv	1" Rigid metal conduit	2,000	m		-
d		Embedded Conduits				
	i	4" Rigid metal conduit	1,000	m		-
	ii	3" Rigid metal conduit	100	m		-
	iii	2" Rigid metal conduit	1,500	m		-
	iv	1" Rigid metal conduit	100	m		-
e		Cable Trays Support System				
	i	900 mm wide - 3 stack	130	each		-
	ii	600 mm wide - 3 stack	10	each		-
	iii	300 mm wide - 3 stack	50	each		-
	iv	900 mm wide - 2 stack	80	each		-
	v	600 mm wide - 2 stack	80	each		-
	vi	300 mm wide - 2 stack	8	each		-
	vii	900 mm wide - single stack	5	each		-
	viii	600 mm wide - single stack	115	each		-
	ix	300 mm wide - single stack	200	each		-
	x	150 mm wide - single stack	32	each		-
26 05 43		**Installation of Cable in Trenches and Ducts**				
a		Trench 610 mm for direct cable burial for traffic Area			**Cash Allowance**	**100,000.00**
b		Trench 610 mm for direct cable burial for non-traffic Area			**Cash Allowance**	**100,000.00**
c		Trench 610 mm for				-
	i	Cable in duct for traffic area			**Cash Allowance**	**100,000.00**
	ii	Cable in duct for non-traffic area			**Cash Allowance**	**100,000.00**
26 11 02		**600 V Load Centre Switchgear**				
a		Powerhouse Load Centres				
	i	Powerhouse Load Centre 1 LC-PH1	1	each		-
	ii	Powerhouse Load Centre 2 LC-PH2	1	each		-
	iii	Powerhouse Load Centre 3 LC-PH3	1	each		-
	iv	Powerhouse Load Centre 4 LC-PH4	1	each		-
b		Service Bay Load Centres				
	i	Service Bay Load Centre 1 LC-SB1	1	each		-
	ii	Service Bay Load Centre 2 LC-SB2	1	each		-
c		Spillway Load Centres				
	i	Spillway Load Centre 1 LC-SP1	1	each		-
	ii	Spillway Load Centre 2 LC-SP2	1	each		-
26 12 25		**Installation of Medium Voltage (MV) Equipment**				
a		Current Limiting Reactors CLR1, CLR3, CLR5 & CLR7	4	each		-
b		Station Service 13.8 kV breakers 52SST1, 52SST3, 52SST5 & 52SST7	4	each		-
c		13.8-12.47 kV Station Service Transformers SST1, SST2, SST3 &SST4	4	each		-
d		Station Service 12.47 kV Switchgear assemblies				
	i	SST1 Switchgear Assembly SS1	1	each		-
	ii	SST2 Switchgear Assembly SS2	1	each		-
	iii	SST3 Switchgear Assembly SS3	1	each		-
	iv	SST4 Switchgear Assembly SS4	1	each		-
e		12.7-0.6 kV Station Service transformers and NGR assemblies				
	i	Powerhouse Transformers PH-T1, PH-T2, PH-T3, PH-T4	4	each		-
	ii	Service Bay Transformers SB-T1, SB-T2	2	each		-
	iii	Spillway Transformers SP-T1, SP-T2	2	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
26 12 27		**Installation of Motor Control Centres (MCC)**				
a		Unit Motor Control Centres				
	i	Unit 1 Motor Control Centre MCC-PH1	1	each		-
	ii	Unit 2 Motor Control Centre MCC-PH2	1	each		-
	iii	Unit 3 Motor Control Centre MCC-PH3	1	each		-
	iv	Unit 4 Motor Control Centre MCC-PH4	1	each		-
	v	Unit 5 Motor Control Centre MCC-PH5	1	each		-
	vi	Unit 6 Motor Control Centre MCC-PH6	1	each		-
	vii	Unit 7 Motor Control Centre MCC-PH7	1	each		-
b		Intake Motor Control Centres				
	i	Intake Motor Control Centre MCC-IT1	1	each		-
	ii	Intake Motor Control Centre MCC-IT2	1	each		-
c		Service Bay Motor Control Centres				
	i	Service Bay Motor Control Centre MCC-SB1	1	each		-
	ii	Service Bay Motor Control Centre MCC-SB2	1	each		-
	iii	Service Bay Motor Control Centre MCC-SB3	1	each		-
d		Powerhouse Emergency Motor Control Centres				
	i	Powerhouse Emergency Motor Control Centre EMCC-PH1	1	each		-
	ii	Powerhouse Emergency Motor Control Centre EMCC-PH2	1	each		-
	iii	Powerhouse Emergency Motor Control Centre EMCC-PH3	1	each		-
	iv	Powerhouse Emergency Motor Control Centre EMCC-PH4	1	each		-
e		Service Bay Emergency Motor Control Centre EMCC-SB1	1	each		-
26 13 19		**GCB, Isolated Phase Bus (IPB) & Excitation System Installation**				
a		IPB Assembly and Connections				
	i	IPB Assembly, and GSU Transformer T1, GCB1, VT1 and CLR1 Connections		EC		-
	ii	IPB Assembly, and GSU Transformer T2, GCB2, and VT2 Connections		EC		-
	iii	IPB Assembly, and GSU Transformer T3, GCB3, VT3 and CLR3 Connections		EC		-
	iv	IPB Assembly, and GSU Transformer T4, GCB4, and VT4 Connections		EC		-
	v	IPB Assembly, and GSU Transformer T5, GCB5, VT5 and CLR5 Connections		EC		-
	vi	IPB Assembly, and GSU Transformer T6, GCB6, and VT6 Connections		EC		-
	vii	IPB Assembly, and GSU Transformer T7, GCB7, VT7 and CLR7 Connections		EC		-
b		Generator Circuit Breakers	7	each		-
c		Exciter systems, Potential Power Transformer and static excitation system	7	each		-
d		13.8 kV System VT Cubicles, VT1-VT7	7	each		-
26 22 13		**Low Voltage Distribution System**				
a		Supply and installation of Distribution Panels				
	i	Distribution Panel DP-PH1	1	each		-
	ii	Distribution Panel DP-PH2	1	each		-
	iii	Distribution Panel DP-PH3	1	each		-
	iv	Distribution Panel DP-PH4	1	each		-
	v	Distribution Panel DP-PH5	1	each		-
	vi	Distribution Panel DP-PH6	1	each		-
	vii	Distribution Panel DP-PH7	1	each		-
	viii	Distribution Panel DP-IT1	1	each		-
	ix	Distribution Panel DP-IT2	1	each		-
	x	Distribution Panel DP-SB1	1	each		-
	xi	Distribution Panel DP-SB2	1	each		-
	xii	Distribution Panel DP-SP1	1	each		-
	xiii	Distribution Panel DP-SP2	1	each		-
	xiv	Distribution Panel DP-SP3	1	each		-
b		600-600/347 V Isolation Transformers for 347 Emergency Lighting	2	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
c		347 V Lighting Distribution Panels	2	each		-
d		600-120/208 V Isolation Transformers	20	each		-
e		120/208 V Lighting Distribution Panels	17	each		-
f		600-208/120 V Step down transformer for emergency Supply	2	each		-
g		120/208 V Essential Distribution Panels	2	each		-
h		600 V Essential Distribution Panels				
	i	Emergency DP EDP-IT1	1	each		-
	ii	Emergency DP EDP-IT2	1	each		-
	iii	Emergency DP EDP-IT3	1	each		-
	iv	Emergency DP EDP-SP1	1	each		-
	v	Emergency DP EDP-SP2	1	each		-
	vi	Emergency DP EDP-SP3	1	each		-
i		Safety Disconnect Switches				
	i	200 A Safety disconnect switch	4	each		-
	ii	100 A Safety disconnect switch	10	each		-
	iii	60 A safety disconnect switch	40	each		-
	iv	30 A Safety disconnect switch	60	each		-
j		Welding and Power Receptacles				
	i	120 Vac NEMA 5-15 R Duplex receptacle for indoor application	160	each		-
	ii	CSA Approved 120 Vac GFCI with 5 mA sensitivity with Box for indoor	40	each		-
	iii	CSA Approved GFCI with 5 mA sensitivity with Box for outdoor	30	each		-
	iv	14-30R, 30A 125/250 Vac Receptacle with Box	20	each		-
	v	600 Vac, 60 A Receptacles	36	each		-
	vi	600 Vac, 200 A Receptacles	8	each		-
k		Distribution system design		EC		-
26 29 10		**Motor Starters and Control Stations**				
a		Drainage Water System				
	i	Control Station in Dewatering Gallery	1	each		-
	ii	Control Station in Electrical Gallery	1	each		-
b		Clear Water System				
	i	Control Station in Dewatering Gallery	1	each		-
	ii	Control Station in Electrical Gallery	1	each		-
c		Motor Starters				
	i	NEMA Size 1 Starter	2	each		-
	ii	NEMA Size 2 Starter	2	each		-
	iii	NEMA Size 3 Starter	2	each		-
	iv	NEMA Size 4 Starter	2	each		-
	v	NEMA Size 5 Starter	1	each		-
26 32 13		**Standby Diesel Generators**				
a		Equipment				
	i	Powerhouse standby diesel generator	2	each		-
	ii	Spillway emergency standby diesel generator	1	each		-
	iii	Diesel generator fuel oil storage tank	3	each		-
b		Cooling air system		EC		-
c		Exhaust system		EC		-
d		Fuel Oil - Exposed Piping				
	i	Pipe 80	25	m		-
	ii	Pipe 50	75	m		-
	iii	Pipe 20	90	m		-
e		Fuel Oil - Exposed Fittings				
	i	Elbow, 90 deg, lr 80	2	each		-
	ii	Elbow, 90 deg, lr 50	12	each		-
	iii	Elbow, 90 deg, lr 20	20	each		-
	iv	Flange, weld neck 80 -80	1	each		-
f		Fuel Oil - Valves				
	i	Ball valve 20	7	each		-
	ii	Ball valve w/ spring return (firesafe valve) 20	3	each		-
g		Instrumentation		EC		-
h		Testing, flushing, cleaning		EC		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
i		Pre-commissioning		EC		-
26 33 00		**Battery Systems UPS and Inverters**				
a		Supply and Installation of 125 Vdc Battery Systems				
	i	Battery Banks	2	each		-
	ii	Battery Chargers	4	each		-
	iii	Fused disconnect switches	2	each		-
	iv	DC Switchboards	2	each		-
	v	Tie switch	1	each		-
	vi	DC Panel Boards	14	each		-
b		Supply and Installation of 125 Vdc to 120 Vac Inverters	2	each		-
c		UPS for Emergency Lighting Supply				
	i	Sealed Battery	1	each		-
	ii	UPS assembly	1	each		-
d		48 Vdc Communication Battery System				
	i	48 Vdc Battery Banks	2	each		-
	ii	Fused Disconnect Switches	2	each		-
	iii	Tie Switch	1	each		-
e		24 Vdc Spillway Battery System				
	i	Battery Banks	2	each		-
	ii	Battery chargers	2	each		-
	iii	Battery metering panels	2	each		-
	iv	Fused Disconnect Switches	2	each		-
	v	Panelboards	2	each		-
	vi	Tie switch	1	each		-
26 36 23		**Automatic Transfer Switch Installation**				
a		Powerhouse Transfer Switches				
	i	Auto Transfer Switch ATS1	1	each		-
	ii	Auto Transfer Switch ATS2	1	each		-
	iii	Auto Transfer Switch ATS3	1	each		-
	iv	Auto Transfer Switch ATS4	1	each		-
b		Spillway Transfer Switch ATS5	1	each		-
c		Black Start Generator Switchgear Assemblies				
	i	Switchgear Assembly BSDG1	1	each		-
	ii	Switchgear Assembly BSDG2	1	each		-
26 50 00		**Facility Lighting and Controls**				
a		Lighting System Design		EC		-
	i	120 Vac Lighting		EC		-
	ii	347 Vac Lighting		EC		-
b		Exterior Lighting		EC		-
c		Emergency Lighting		EC		-
d		Exit signs		EC		-
27 00 00		**Communication System**				
a		Communication System Design		EC		-
b		Supply and installation of telephone and data network				
	i	Wiring Closet	5	each		-
	ii	Wiring Cubicle	7	each		-
	iii	Telephone/Data receptacles	150	each		-
c		Paging System		EC		-
d		Patch panels and junction boxes		EC		-
e		Communication Cables				
	i	CAT6 Cable	12,000	m		-
	ii	Copper backbone cable for telephones	2,000	m		-
	iii	72SM, Fibre Cable	240	m		-
	iv	24SM, Fibre Cable	1,500	m		-
	v	48SM, Fibre Cable	400	m		-
	vi	24SM, Fibre Cable	200	m		-
	vii	12SM, Fibre Cable	40	m		-
	viii	6SM, Fibre Cable	50	m		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	ix	48MM, Fibre Cable	30	m		-
	x	24MM, Fibre Cable	1,593	m		-
	xi	12MM, Fibre Cable	462	m		-
	xii	6MM, Fibre Cable	4,002	m		-
f		Wireless data network access point	30	each		-
g		Communications Room Cable Tray	50	m		-
h		Powerhouse and Spillway Area Communication Cable Trays	1,500	m		-
i		Fibre Guide Infrastructure in Communications room				
	i	4" wide fibre guide	50	each		-
	ii	2" wide fibre guide	50	each		-
28 13 00		**Access Control and Intrusion Detection System**				
a		Design of Access and Intrusion Alarm System		EC		-
b		Supply and installation of the system		EC		-
28 23 00		**Video Surveillance**				
a		Design of surveillance system		EC		-
b		Supply and installation of the system		EC		-
28 31 00		**Fire Detection and Alarm Systems**				
a		Design of Fire Alarm and Detection Systems		EC		-
b		Supply and installation of the system		EC		-
28 33 00		**Spillway Warning System**				
a		Design of Spillway Warning System		EC		-
b		Supply and installation of the system		EC		-
31 11 00		**Clearing, Grubbing and Stripping**				
a		Clearing the sites of the permanent project structures	1,800,000	m^2		-
b		Grubbing the sites of the permanent project structures	130,000	m^2		-
c		Stripping the sites of the permanent project structures	130,000	m^2		-
d		Clearing the sites of the miscellaneous project structures			**Cash Allowance**	**100,000.00**
e		Grubbing the sites of the miscellaneous project structures			**Cash Allowance**	**100,000.00**
f		Stripping the sites of the miscellaneous project structures			**Cash Allowance**	**100,000.00**
31 14 13		**Stockpiling of Materials for Post Construction Operation and Maintenance**				
a		Produce coarse concrete aggregate (40mm) for future use by the Engineer	4,500	Tonnes		-
b		Produce coarse concrete aggregate (20mm) for future use by the Engineer	4,500	Tonnes		-
c		Produce fine concrete aggregate for future use by the Engineer	1,800	Tonnes		-
d		Produce Class 4 filter material for future use by the Engineer	10,000	Tonnes		-
e		Produce Class 5 riprap bedding for future use by the Engineer	4,200	Tonnes		-
f		Produce Class 7 rockfill material for future use by the Engineer	8,250	Tonnes		-
g		Produce Class 8 riprap material for future use by the Engineer	3,750	Tonnes		-
h		Produce road topping material for future use by the Engineer	30,800	Tonnes		-
31 23 13		**Foundation Preparations**				
a		Prepare Rock Foundations for Placement of Impervious Fill				
	i	for North Dam	7,700	m^2		-
	ii	for Central Dam	54,200	m^2		-
	iii	for South Dam	12,300	m^2		-
	iv	for North Dyke	1,000	m^2		-
	v	for South Dyke	1,000	m^2		-
	vi	for Transmission Tower Spur	50	m^2		-
	vii	for miscellaneous structures			**Cash Allowance**	**50,000.00**
b		Prepare Rock Foundations for Placement of Granular Fill				

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	i	for North Dam	1,900	m^2		-
	ii	for Central Dam	3,000	m^2		-
	iii	for South Dam	10,300	m^2		-
	iv	for North Dyke	500	m^2		-
	v	for South Dyke	500	m^2		-
	vi	for Transmission Tower Spur	50	m^2		-
	vii	for miscellaneous structures			**Cash Allowance**	**50,000.00**
c		Prepare Rock Foundations Under Riprap Bedding, Rockfill, and Riprap				
	i	for North Dam	5,900	m^2		-
	ii	for Central Dam	27,200	m^2		-
	iii	for South Dam	1,100	m^2		-
	iv	for North Dyke	100	m^2		-
	v	for South Dyke	100	m^2		-
	vi	for Transmission Tower Spur	450	m^2		-
	vii	for miscellaneous structures			**Cash Allowance**	**50,000.00**
d		Prepare Earth Foundations Under Impervious Fill Areas				
	i	for North Dam	950	m^2		-
	ii	for Central Dam	9,200	m^2		-
	iii	for South Dam	5,500	m^2		-
	iv	for North Dyke	29,200	m^2		-
	v	for South Dyke	50,600	m^2		-
	vi	for Transmission Tower Spur	50	m^2		-
	vii	for miscellaneous structures			**Cash Allowance**	**50,000.00**
e		Prepare Earth Foundations Under Granular Fill				
	i	for North Dam	315	m^2		-
	ii	for Central Dam	1,300	m^2		-
	iii	for South Dam	1,100	m^2		-
	iv	for North Dyke	184,000	m^2		-
	v	for South Dyke	318,800	m^2		-
	vi	for Transmission Tower Spur	50	m^2		-
	vii	for miscellaneous structures			**Cash Allowance**	**50,000.00**
f		Prepare Earth Foundations Under Riprap Bedding, Rock Fill, and Riprap				
	i	for North Dam	250	m^2		-
	ii	for Central Dam	7,500	m^2		-
	iii	for South Dam	400	m^2		-
	iv	for North Dyke	33,000	m^2		-
	v	for South Dyke	57,000	m^2		-
	vi	for Transmission Tower Spur	50	m^2		-
	vii	for miscellaneous structures			**Cash Allowance**	**50,000.00**
g		Prepare Earth Foundations Under Granular Dyke				
	i	for North Dyke	18,100	m^2		-
	ii	for South Dyke	1,000	m^2		-
h		Prepare Earth Foundations for the Placement of Geotextile				
	i	for North Dam			**Cash Allowance**	**500.00**
	ii	for Central Dam			**Cash Allowance**	**5,000.00**
	iii	for South Dam			**Cash Allowance**	**1,000.00**
	iv	for North Dyke			**Cash Allowance**	**65,000.00**
	v	for South Dyke			**Cash Allowance**	**115,000.00**
	vi	for Transmission Tower Spur			**Cash Allowance**	**100.00**
	vii	for miscellaneous structures			**Cash Allowance**	**2,000.00**

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
i		Not Used				
j		Sand Drains				
	i	300 diameter sand drains -for North Dyke	5,030	m		-
	ii	300 diameter sand drains -for South Dyke	300	m		-
	iii	Class 2a in for sand drains -for North Dyke	356	m^3		-
	iv	Class 2a in for sand drains -for South Dyke	25	m^3		-
k		Exploratory Holes to Confirm Thickness of Clay				
	i	Drilling exploratory holes -for North Dyke	7,899	m		-
	ii	Drilling exploratory holes -for South Dyke	13,680	m		-
	iii	Bentonite in Grout Mix -for North Dyke	27,600	kg		-
	iv	Bentonite in Grout Mix -for South Dyke	49,200	kg		-
	v	Cement in Grout Mix -for North Dyke	27,600	kg		-
	vi	Cement in Grout Mix -for South Dyke	49,200	kg		-
	vii	Sand in Grout Mix -for North Dyke	49,680	kg		-
	viii	Sand in Grout Mix -for South Dyke	88,560	kg		-
l		Bedrock Excavation				
	i	for North Dam	200	m^3		-
	ii	for Central Dam	300	m^3		-
	iii	for South Dam	200	m^3		-
31 23 16		**Unclassified Excavations**				
a		Excavate Unclassified Materials for Concrete Structures and their Associated Channels and Permanent Ditches Including Transportation to EMPA				
	i	for all concrete structures in Powerhouse area	1,077,900	m^3		-
	ii	for Tailrace Channel Improvement	131,600	m^3		-
	iii	for all concrete structures in Spillway area	17,200	m^3		-
b		Excavate Unclassified Materials for Main Dams and Dyke and Their Associated Permanent Ditches Including Transportation to EMPA				
	i	for North Dam	100,700	m^3		-
	ii	for Parking Lot and Access Ramp	19,350	m^3		-
	iii	for South Dam (Main Section)	33,600	m^3		-
	iv	for South Dam (South Abutment)	5,100	m^3		-
	v	for South Dam Tie-In	33,100	m^3		-
	vi	for Central Dam	595,150	m^3		-
	vii	for South Access Road Ramp	8,900	m^3		-
	viii	for North Access Road Ramp	13,400	m^3		-
	ix	for Transmission Tower Spur	200	m^3		-
	x	for miscellaneous structures			**Cash Allowance**	**20,000.00**
c		Excavate Unclassified Materials for Dykes during the Winter				
	i	for North Dyke	592,840	m^3		-
	ii	for South Dyke	626,650	m^3		-
31 23 17		**Rock Excavations**				
a		Excavate Rock Materials Including Blasting, Drilling, and Ripping of Boulders Including Transportation for Further Use or Disposal				
	i	for Powerhouse Intake Approach Channel	283,700	m^3		-
	ii	for Spillway Approach Channel	128,840	m^3		-
	iii	for Powerhouse Intake Area	433,500	m^3		-
	iv	for Spillway Discharge Channel	177,460	m^3		-
	v	for Service Bay, Powerhouse	260,000	m^3		-
	vi	for Spillway concrete structures	52,950	m^3		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	vii	for Tailrace Channel	315,600	m^3		-
	viii	for Tailrace Channel improvement	192,500	m^3		-
	ix	for Tailrace Channel under Powerhouse Cofferdam	95,700	m^3		-
	x	for miscellaneous structures			**Cash Allowance**	**50,000.00**
b		Pre-split and Line Drilling Prior to Blasting for Rock Excavation				
	i	for Pre-split drilling at Powerhouse and Service Bay Structures, Intake and Tailrace Channels	44,400	m		-
	ii	for Pre-split drilling at Spillway Structure, Approach and Discharge Channels	17,700	m		-
	iii	for Line Drilling of Powerhouse	7,300	m		-
	iv	for Line Drilling of Spillway	100	m		-
31 23 18		**Spillway Rock Excavation in the Wet**				
a		Excavate Rock Materials Including installing Rock Groin/Working Platform, Blasting, Drilling, and Removal/Transportation for Further Use or Disposal				
	i	Installation and removal of Rock Groin/Working Platform	62,800	tonnes		-
	ii	for Spillway Approach Channel	5,300	m^3		-
31 23 23		**Impervious Fill (Class 1)**				
a		Supply, Transport, and Place Class 1 Impervious Fill				
	i	for North Dam	65,200	m^3		-
	ii	for South Dam	239,800	m^3		-
	iii	for South Dam - Saddle Dams	29,900	m^3		-
	iv	for Central Dam	682,600	m^3		-
	v	for North Dyke	292,250	m^3		-
	vi	for South Dyke	321,000	m^3		-
	vii	for South Access Road Ramp	6,000	m^3		-
	viii	for North Access Road Ramp	6,000	m^3		-
31 23 24		**Granular Fill**				
a		Supply, Transport, and Place Class 2a Fill				
	i	for North Dam	5,800	m^3		-
	ii	for Parking Lot and Access Ramp	4,000	m^3		-
	iii	for South Dam	23,100	m^3		-
	iv	for South Dam - Saddle Dams	31,100	m^3		-
	v	for Central Dam	65,600	m^3		-
	vi	for North Dyke	308,450	m^3		-
	vii	for South Dyke	234,150	m^3		-
	viii	for South Access Road Ramp	2,000	m^3		-
	ix	for North Access Road Ramp	2,000	m^3		-
	x	for Transmission Tower Spur	4,900	m^3		-
	xi	for Winter placement for North Dyke	650,000	m^3		-
	xii	for Winter placement for South Dyke	700,000	m^3		-
b		Supply, Transport, and Place Class 2b Fill				
	i	for North Dam	200	m^3		-
	ii	for South Dam	200	m^3		-
	iii	for South Dam - Saddle Dams	50	m^3		-
	iv	for Central Dam	500	m^3		-
	v	for North Dyke	170,930	m^3		-
	vi	for South Dyke	270,350	m^3		-
	vii	for South Access Road Ramp	2,000	m^3		-
	viii	for North Access Road Ramp	2,000	m^3		-
	ix	for Transmission Tower Spur	200	m^3		-
c		Supply, Transport and Place Class 3 Fill				
	i	for North Dam	7,000	m^3		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	ii	for South Dam	36,700	m^3		-
	iii	for Central Dam	97,700	m^3		-
	iv	for North Dyke	102,510	m^3		-
	v	for South Dyke	128,350	m^3		-
	vi	for South Access Road Ramp	2,000	m^3		-
	vii	for North Access Road Ramp	2,000	m^3		-
d		Supply, Transport and Place Class 4 Fill				
	i	for North Dam	12,600	m^3		-
	ii	for South Dam	53,800	m^3		-
	iii	for Central Dam	152,300	m^3		-
	iv	for North Dyke	138,400	m^3		-
	v	for South Dyke	187,250	m^3		-
	vi	for Transmission Tower Spur	6,700	m^3		-
31 23 25		**Road Topping**				
a		Supply, Transport and Place Road Topping Materials				
	i	for North Dam	300	m^3		-
	ii	for Parking Lot and Access Ramp	3,700	m^3		-
	iii	for South Dam	1,600	m^3		-
	iv	for South Dam - Saddle Dams	1,000	m^3		-
	v	for Central Dam	3,600	m^3		-
	vi	for North Dyke	27,050	m^3		-
	vii	for South Dyke	28,780	m^3		-
	viii	for South Access Road Ramp	800	m^3		-
	ix	for North Access Road Ramp	700	m^3		-
	x	for Transmission Tower Spur	3,000	m^3		-
31 23 26		**Riprap Bedding**				
a		Supply, Transport and Place Class 5 Fill				
	i	for North Dam	5,200	m^3		-
	ii	for Parking Lot and Access Ramp	500	m^3		-
	iii	for South Dam	19,200	m^3		-
	iv	for Central Dam	56,700	m^3		-
	v	for North Dyke	37,050	m^3		-
	vi	for South Dyke	61,400	m^3		-
	vii	for South Access Road Ramp	500	m^3		-
	viii	for Transmission Tower Spur	200	m^3		-
31 23 27		**Rockfill**				
a		Supply, Transport and Place Class 6 Fill				
	i	for North Dam	59,800	m^3		-
	ii	for Parking Lot and Access Ramp	91,300	m^3		-
	iii	for South Dam	111,200	m^3		-
	iv	for South Dam - Saddle Dams	135,600	m^3		-
	v	for Central Dam	413,500	m^3		-
	vi	for North Dyke	160,550	m^3		-
	vii	for South Dyke	158,900	m^3		-
	viii	for South Access Road Ramp	56,300	m^3		-
	ix	for North Access Road Ramp	166,500	m^3		-
	x	for Transmission Tower Spur	114,400	m^3		-
31 23 34		**Perimeter Ditches along Dyke**				
a	i	Ditching - deep -for North Dyke			**Cash Allowance**	**2,500,000.00**
	ii	Ditching - deep -for South Dyke			**Cash Allowance**	**2,500,000.00**
	iii	Ditching - shallow -for North Dyke			**Cash Allowance**	**600,000.00**
	iv	Ditching - shallow -for South Dyke			**Cash Allowance**	**750,000.00**

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
b	i	Sediment Ponds -for North Dyke			**Cash Allowance**	**150,000.00**
	ii	Sediment Ponds -for South Dyke			**Cash Allowance**	**200,000.00**
c	i	Rockfill Ditch Checks -for North Dyke			**Cash Allowance**	**200,000.00**
	ii	Rockfill Ditch Checks -for South Dyke			**Cash Allowance**	**200,000.00**
d	i	Ditch Turn-outs -for North Dyke			**Cash Allowance**	**60,000.00**
	ii	Ditch Turn-outs -for South Dyke			**Cash Allowance**	**80,000.00**
31 26 00		**Excavated Material Placement Areas (EMPA) - Not Currently Included - to be developed with Manitoba Hydro**			**Cash Allowance**	**500,000.00**
31 33 13		**Rock Support and Protection; Rock Bolts and Anchors**				
a	i	Supply and install 25-mm diameter mechanical rock bolts -for Powerhouse	6,600	m		-
	ii	Supply and install 25-mm diameter mechanical rock bolts -for Spillway	1,500	m		-
b	i	Supply and Install 25-mm diameter resin rock bolts -for Powerhouse	1,000	m		-
	ii	Supply and Install 25-mm diameter resin rock bolts -for Spillway	300	m		-
c	i	Supply and Install 25-mm rock dowels -for Powerhouse	100	m		-
	ii	Supply and Install 25-mm rock dowels -for Spillway	140	m		-
d	i	Supply and Install Rock Netting -for Powerhouse	9,400	m^2		-
	ii	Supply and Install Rock Netting -for Spillway	2,000	m^2		-
e		Supply and install domed rock bolt bearing plates	400	each		-
f		Supply and install 6 m long rock drain holes	200	each		-
g		Supply and apply corrosion protection compound to exposed ends of rock bolts	600	each		-
h		Supply and install rockfall netting (mesh) plates, including jam nuts	200	each		-
31 34 00		**Geogrid Soil Reinforcement - Not Currently Included**			**Cash Allowance**	**250,000.00**
31 35 19		**Geotextiles**				
		Embankment Construction -for Transmission Tower Spur (Class 4)				
a		Supply and install geotextile filter fabric			**Cash Allowance**	**500,000.00**
31 36 13		**Gabions - Not Currently Included**			**Cash Allowance**	**50,000.00**
		Embankment Construction (Class 7 & 8)				
31 37 00		**Riprap**				
a		Supply, Transport and Place Class 7 Riprap				
	i	for North Dam	200	m^3		-
	ii	for Parking Lot and Access Ramp	100	m^3		-
	iii	for South Dam	200	m^3		-
	iv	for Central Dam	500	m^3		-
	v	for North Dyke	7,500	m^3		-
	vi	for South Dyke	200	m^3		-
	vii	for Transmission Tower Spur	6,100	m^3		-
b		Supply, Transport and Place Class 8 Riprap				
	i	for North Dam	6,100	m^3		-
	ii	for Parking Lot and Access Ramp	500	m^3		-
	iii	for South Dam	19,700	m^3		-
	iv	for Central Dam	54,400	m^3		-
	v	for North Dyke	62,550	m^3		-
	vi	for South Dyke	114,050	m^3		-
	vii	for Transmission Tower Spur	12,900	m^3		-
31 52 00		**Cofferdams, Rock Groins, Causeways**				
a		Stripping				
	i	for Stage I Island Cofferdam	4,000	m^2		-
	ii	for abutment contact of cofferdams	30,500	m^2		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
b		Supply, Transport and Place Impervious Fill (Class A)				
	i	for Quarry Cofferdam	7,775	Tonnes		-
	ii	for Central Dam Stage I Cofferdam	68,780	Tonnes		-
	iii	for North Channel Stage I Cofferdam	66,608	Tonnes		-
	iv	for Powerhouse Stage I Cofferdam	73,509	Tonnes		-
	v	for Spillway Stage I Cofferdam	**398,900**	Tonnes		-
	vi	for Stage I Island Cofferdam	12,916	Tonnes		-
	vii	for Stage II Island Cofferdam	22,040	Tonnes		-
	viii	for Stage II Diversion Tie-in cofferdams inside Spillway Cofferdam	2,000	Tonnes		-
	ix	for South Dam Stage II Upstream Cofferdam	119,320	Tonnes		-
	x	for South Dam Stage II Downstream Cofferdam	61,750	Tonnes		-
	xi	for Tailrace Channel Summer Level Cofferdam	121,030	Tonnes		-
c		Supply, Transport and Place Transition Material (Class B)				
	i	for North Channel Stage I Cofferdam	19,815	Tonnes		-
	ii	for Powerhouse Stage I Cofferdam	4,165	Tonnes		-
	iii	for Spillway Stage I Cofferdam	**109,430**	Tonnes		-
	iv	for Stage I Island Cofferdam	3,269	Tonnes		-
	v	for Central Dam Stage I Cofferdam	32,472	Tonnes		-
	vi	for Stage II Island Cofferdam	11,660	Tonnes		-
	vii	for Stage II Diversion Tie-in cofferdams inside Spillway Cofferdam	1,000	Tonnes		-
	viii	for South Dam Stage II Upstream Cofferdam	54,120	Tonnes		-
	ix	for South Dam Stage II Downstream Cofferdam	22,000	Tonnes		-
	x	for Tailrace Channel Summer Level Cofferdam	45,980	Tonnes		-
d		Supply, Transport and Place Rockfill (Class C)				
	i	C1/C2 for Causeway to N-5	15,278	Tonnes		-
	ii	C1/C2 for Causeway to G-3	28,395	Tonnes		-
	iii	C1/C2 for Quarry Cofferdam	10,129	Tonnes		-
	iv	C1/C2 for North Channel Rock Groin	71,793	Tonnes		-
	v	C3/C4 for North Channel Rock Groin	2,000	Tonnes		-
	vi	C1/C2 for North Channel Stage I Cofferdam	39,000	Tonnes		-
	vii	C3/C4 for North Channel Stage I Cofferdam	1,350	Tonnes		-
	viii	C1/C2 for Powerhouse Stage I Cofferdam	104,900	Tonnes		-
	ix	C1/C2 for Spillway Stage I Cofferdam	448,850	Tonnes		-
	x	C3/C4 for Spillway Stage I Cofferdam	96,300	Tonnes		-
	xi	C1/C2 for Central Dam Stage I Cofferdam	67,135	Tonnes		-
	xii	C1/C2 for Stage II Diversion Tie-in cofferdams inside Spillway Cofferdam	83,450	Tonnes		-
	xiii	C3/C4 for Stage II Diversion Tie-in cofferdams inside Spillway Cofferdam	69,525	Tonnes		
	xiv	C1/C2 for South Dam Stage II Upstream Cofferdam	22,950	Tonnes		-
	xv	C3/C4 for South Dam Stage II Upstream Cofferdam	118,200	Tonnes		-
	xvi	C1/C2 for South Dam Stage II Downstream Cofferdam	58,140	Tonnes		-
	xvii	C1/C2 for Tailrace Channel Summer Level Cofferdam	221,000	Tonnes		-
	xviii	C3/C4 for Tailrace Channel Summer Level Cofferdam	62,550	Tonnes		-
	xix	C2 for Quarry Cofferdam	1,470	Tonnes		-
	xx	C2 for North Channel Stage I Cofferdam	6,265	Tonnes		-
	xxi	C3/C4 for North Channel Stage I Cofferdam	1,000	Tonnes		-
	xxii	C2 for Powerhouse Stage I Cofferdam	28,200	Tonnes		-
	xxiii	C2 for Spillway Stage I Cofferdam	35,950	Tonnes		-
	xxiv	C3/C4 for Spillway Stage I Cofferdam	36,920	Tonnes		-
	xxv	C2 for Stage I Island Cofferdam	1,000	Tonnes		-
	xxvi	C2 for Central Dam Stage I Cofferdam	18,100	Tonnes		-
	xxvii	C2 for Stage II Island Cofferdam	16,150	Tonnes		-
	xxviii	C2 for Stage II Diversion Tie-in cofferdams inside Spillway Cofferdam	5,000	Tonnes		-
	xxix	C3/C4 for Stage II Diversion Tie-in cofferdams inside Spillway Cofferdam	5,000	Tonnes		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	xxx	C2 for South Dam Stage II Upstream Cofferdam	14,770	Tonnes		-
	xxxi	C2 for South Dam Stage II Downstream Cofferdam	7,400	Tonnes		-
	xxxii	C2 for Tailrace Channel Summer Level Cofferdam	19,720	Tonnes		-
	xxxiii	C3/C4 for Tailrace Channel Summer Level Cofferdam	5,400	Tonnes		
f		Supply, Transport and Place Road Topping Class RT				
	i	for Causeway to N-5	6,096	m^3		-
	ii	for Causeway to G-3	4,364	m^3		-
	iii	for North Channel Stage I Cofferdam	620	m^3		-
	iv	for Powerhouse Stage I Cofferdam	715	m^3		-
	v	for Spillway Stage I Cofferdam	**6,000**	m^3		-
	vi	for Stage I Island Cofferdam	465	m^3		-
	vii	for Central Dam Stage I Cofferdam	1,425	m^3		-
	viii	for Stage II Island Cofferdam	1,100	m^3		-
	ix	for South Dam Stage II Downstream Cofferdam	900	m^3		-
	x	for Tailrace Channel Summer Level Cofferdam	1,700	m^3		-
g		Initial Dewatering				
	i	for Quarry Cofferdam	100,000	m^3		-
	ii	for North Channel Stage I Cofferdam	80,000	m^3		-
	iii	for Powerhouse Stage I Cofferdam	322,000	m^3		-
	iv	for Spillway Stage I Cofferdam	358,000	m^3		-
	v	for Stage I Island Cofferdam	1,000	m^3		-
	vi	for Central Dam Stage I Cofferdam	1,242,000	m^3		-
	vii	for Stage II Island Cofferdam	1,007,000	m^3		-
	viii	for South Dam Stage II Downstream Cofferdam	260,000	m^3		-
	ix	for Tailrace Channel Summer Level Cofferdam	1,242,000	m^3		-
h		Maintenance of Crest Elevation and Continued Pumping				
	i	for Causeway to N-5	84	months		-
	ii	for Causeway to G-3	84	months		-
	iii	for Quarry Cofferdam	60	months		-
	iv	for North Channel Rock Groin	59	months		-
	v	for North Channel Stage I Cofferdam	58	months		-
	vi	for Powerhouse Stage I Cofferdam	57	months		-
	vii	for Spillway Stage I Cofferdam	22	months		-
	viii	for Stage I Island Cofferdam	58	months		-
	ix	for Central Dam Stage I Cofferdam	45	months		-
	x	for Stage II Island Cofferdam	23	months		-
	xi	for South Dam Stage II Upstream Cofferdam	12	months		-
	xii	for South Dam Stage II Downstream Cofferdam	12	months		-
	xiii	for Tailrace Channel Summer Level Cofferdam	6	months		-
i		Removal of Cofferdam and Causeway "in the wet"				
	i	-for Causeway to N-5	2,200	m^3		-
	ii	-for Causeway to G-3	4,100	m^3		-
	iii	-for Powerhouse Stage I Cofferdam	61,200	m^3		-
	iv	-for Spillway Stage I Cofferdam	111,000	m^3		-
	v	-for Stage I Island Cofferdam	7,500	m^3		-
	vi	-for Central Dam Stage I Cofferdam	300	m^3		-
	vii	-for South Dam Stage II Downstream Cofferdam	1,000	m^3		-
	viii	-for Tailrace Channel Summer Level Cofferdam	222,260	m^3		-
j		Removal of Cofferdam and Causeway "in the dry"				
	i	-for Causeway to N-5	12,400	m^3		-
	ii	-for Causeway to G-3	16,200	m^3		-
	iii	-for Powerhouse Stage I Cofferdam	61,200	m^3		-
	iv	-for Spillway Stage I Cofferdam	111,000	m^3		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	v	-for Stage I Island Cofferdam	1,900	m^3		-
	~~vi~~	~~-for Stage II Island Cofferdam~~	~~50~~	~~m^3~~		-
	vi	-for Stage II Diversion Tie-in cofferdams inside Spillway Cofferdam	2,000	m^3		-
	vii	-for South Dam Stage II Downstream Cofferdam	200	m^3		-
	viii	-for Tailrace Channel Summer Level Cofferdam	55,600	m^3		-
	ix	-for Quarry Cofferdam	9,800	m^3		-
k		Removal of Cofferdam and Causeway "in the dry" w/Stable ice cover formation				
	i	-for North Channel Rock Groin	42,300	m^3		-
	ii	-for North Channel Stage I Cofferdam	71,100	m^3		-
	iii	-for Stage II Island Cofferdam	15,000	m^3		-
l		Removal of Culverts -for Causeway to N-5	130	m		-
m		Armouring of Cofferdam Remnants by placement of				
	i	Transition Material (Class B) -for Spillway Stage I Cofferdam	1,000	Tonnes		-
	ii	Class C1 -for Spillway Stage I Cofferdam	250	Tonnes		-
	iii	Class C2 -for Spillway Stage I Cofferdam	250	Tonnes		-
	iv	Class C3 -for Spillway Stage I Cofferdam	250	Tonnes		-
	v	Class C4 -for Spillway Stage I Cofferdam	250	Tonnes		-
n		Shoreline Erosion Protection				
	i	Riprap erosion protection -for South Dam Stage II Upstream Cofferdam	7,920	Tonnes		-
	ii	Class C1 Riprap -for Causeway to G-3	100	Tonnes		-
	iii	Class C2 Riprap -for Causeway to N-5	100	Tonnes		-
31 68 00		**Post Tensioning Bars**				
a		Spillway Post Tensioned Anchors - 36mm dia	500	m		-
31 81 00		**Foundation Grouting**				
a		Rotary and percussion drilling of grout holes through plain and reinforced concrete, rock, and hardened grout; including drill setups				
	i	for Powerhouse	2,700	m		-
	ii	for Spillway	1,250	m		-
	iii	for North Dam	650	m		-
	iv	for South Dam	3,600	m		-
	v	for Central Dam	10,150	m		-
b		NQ3 core drilling of holes through plain and reinforced concrete, rock, and hardened grout; including drill setups				
	i	for Powerhouse	50	m		-
	ii	for Spillway	30	m		-
	iii	for North Dam	20	m		-
	iv	for South Dam	30	m		-
	v	for Central Dam	50	m		-
c		Place packer assemblies and make connections for water pressure testing and for grouting, including the initial setting of the packer(s) and resetting of the packer(s) at subsequent depths				
	i	for Powerhouse	690	each		-
	ii	for Spillway	330	each		-
	iii	for North Dam	200	each		-
	iv	for South Dam	1,000	each		-
	v	for Central Dam	2,800	each		-
d		Wash and pressure test holes				
	i	for Powerhouse	13	hrs		-
	ii	for Spillway	7	hrs		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	iii	for North Dam	4	hrs		-
	iv	for South Dam	24	hrs		-
	v	for Central Dam	67	hrs		-
e		Supply, transport, store, mix and inject cement grout materials				
	i	for Powerhouse	65,900	kg		-
	ii	for Spillway	30,800	kg		-
	iii	for North Dam	15,300	kg		-
	iv	for South Dam	85,500	kg		-
	v	for Central Dam	240,500	kg		-
f		Supply, transport, store, mix and inject sand incorporated into grout				
	i	for Powerhouse	330	kg		-
	ii	for Spillway	150	kg		-
	iii	for North Dam	80	kg		-
	iv	for South Dam	430	kg		-
	v	for Central Dam	1,200	kg		-
g		Supply, transport, store, mix and inject bentonite incorporated into grout				
	i	for Powerhouse	1,630	kg		-
	ii	for Spillway	760	kg		-
	iii	for North Dam	375	kg		-
	iv	for South Dam	2,130	kg		-
	v	for Central Dam	6,000	kg		-
31 82 00		**Foundation Drain Holes**				
a		Drilling 75 mm drain holes				
	i	for Powerhouse	5,060	m		-
	ii	for Spillway	400	m		-
~~b~~		~~Installing Collars for drain holes~~				
	~~i~~	~~for Powerhouse~~	~~843~~	~~m~~		~~-~~
	~~ii~~	~~for Spillway~~	~~66~~	~~m~~		~~-~~
c		Drill 48 mm drain holes				
	i	for Powerhouse	660	m		-
	ii	for Powerhouse Service Bay	160	m		-
	iii	for Spillway	400	m		-
32 31 13		**Chain Link Fences and Gates**				
		Supply, transport, handle, fabricate, backfill holes for posts, drill set-ups, drilling supplies				
a		7-ft high Chain Link Fence and Gates		m	**Cash Allowance**	**1,500,000.00**
b		Parking Lot Fence		m	**Cash Allowance**	**500,000.00**
c		Security Gates		each	**Cash Allowance**	**500,000.00**
33 42 00		**Corrugated Steel Culverts**				
		Supply, transport, handle, store, assemble, install corrugated steel pipe culverts including connecting bands, end sections and all other parts required including excavation for culverts, and supplying and placing of bedding cover and backfill materials				
a		Corrugated Steel Pipe Culverts				
	i	1.5 m diameter culverts -for Causeway to N-5	45	m		-
	ii	1.0 m diameter culverts -for Causeway to N-5	85	m		-
	iii	Up to and including 1.0-m diameter	200	m		-
	iv	Larger than 1.0-m diameter	200	m		-
33 72 00		**Unit Protection System**				
a		Protection Panels				
	i	Unit #1 Protection Panel	1	each		-
	ii	Unit #2 Protection Panel	1	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	iii	Unit #3 Protection Panel	1	each		-
	iv	Unit #4 Protection Panel	1	each		-
	v	Unit #5 Protection Panel	1	each		-
	vi	Unit #6 Protection Panel	1	each		-
	vii	Unit #7 Protection Panel	1	each		-
34 71 33		**Guard Rails and Posts**				
a		**Guard Rail and Posts**				
	i	**Guard Rail**	**6,000**	**m**		
35 20 13		**Bulkhead Gates, Stoplogs and Trashracks**				
a		Bulkhead Gates				
	i	Intake bulkhead gate		EC		-
	ii	Draft tube bulkhead gate		EC		-
b		Spillway stoplogs		EC		-
c		Intake trashracks	147	each		-
35 20 17		**Embedded Guides**				
a		Intake Bulkhead Gate Guides, Lintel and Sill Beams				
	i	Embedded guides	1,302	m		-
	ii	Sill beams	123	m		-
	iii	Side seating beams	36	m		-
	iv	Lintel beams	119	m		-
b		Intake Trashrack Guides and Seating Beams				
	i	Embedded guides	1,317	m		-
	ii	Side seating beams	27	m		-
c		Draft Tube Gate Guides, Lintel and Sill Beams				
	i	Embedded guides	729	m		-
	ii	Sill beams	141	m		-
	iii	Side seating beams	31	m		-
	iv	Lintel beams	139	m		-
d		Spillway Stoplogs Guides and Sill Beams				
	i	Embedded guides	534	m		-
	ii	Sill beams	92	m		-
	iii	Side seating beams	16	m		-
40 05 00		**Pipe Hangers and Supports**				
a		Pipe hangers and supports		EC		-
b		Firestops		EC		-
40 23 19		**Service Water, Cooling Water & Shaft Seal Water**				
a		Equipment				
	i	Service water strainer	7	each		-
	ii	Station service water pump	7	each		-
b		Service Water - Exposed Piping				
	i	Pipe 500	175	m		-
	ii	Pipe 400	53	m		-
	iii	Pipe 300	25	m		-
	iv	Pipe 250	97	m		-
	v	Pipe 200	100	m		-
	vi	Pipe 50	788	m		-
	vii	Pipe 25	20	m		-
c		Service Water - Exposed Fittings				
	i	Tee 500 -500 -400	1	each		-
	ii	Tee 500 -500 -250	7	each		-
	iii	Tee 400 -400 -400	1	each		-
	iv	Tee 300 -300 -300	7	each		-
	v	Tee 250 -250 -200	7	each		-
	vi	Tee 200 -200 -200	7	each		-
	vii	Tee 50 -50 -50	31	each		-
	viii	Sockolet 400 -400 -80	1	each		-
	ix	Sockolet 400 -400 -25	1	each		-
	x	Sockolet 250 -250 -25	7	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	xi	Weldolet 500 -500 -50	1	each		-
	xii	Weldolet 400 -400 -50	1	each		-
	xiii	Cap 50	2	each		-
	xiv	Concentric reducer 500 -400	1	each		-
	xv	Concentric reducer 80 -50	4	each		-
	xvi	Coupling 50 -50	2	each		-
	xvii	Elbow, 90 deg, sr 50 -50	57	each		-
	xviii	Elbow, 90 deg, sr 25 -25	14	each		-
	xix	Elbow, 90 deg lr 400 -400	6	each		-
	xx	Elbow, 90 deg lr 250 -250	21	each		-
	xxi	Elbow, 90 deg lr 200 -200	7	each		-
	xxii	Elbow, 45 deg, lr 400 -400	2	each		-
	xxiii	Elbow, 45 deg, lr 250 -250	7	each		-
	xxiv	Flange, weldneck 400 -400	1	each		-
	xxv	Flange, weldneck 300 -300	56	each		-
	xxvi	Flange, weldneck 250 -250	35	each		-
	xxvii	Flange, weldneck 200 -200	86	each		-
	xxviii	Flange, blind 500 -500	2	each		-
	xxix	Flange, blind 400 -400	1	each		-
	xxx	Flange, blind 300 -300	7	each		-
	xxxi	Trimmed elbow 250 -250	14	each		-
d		Service Water - Valves				
	i	Ball valve 200	21	each		-
	ii	Ball valve 25	56	each		-
	iii	Check valve 250	7	each		-
	iv	Butterfly valve 300	14	each		-
	v	Butterfly valve 250	7	each		-
	vi	Butterfly valve 200	21	each		-
e		Shaft Seal Water - Exposed Piping				
	i	Tube, hard 32	147	m		-
f		Shaft Seal Water - Exposed Fittings				
	i	Weldolet 200 -200 -50	7	each		-
	ii	Concentric swage 50 -32	7	each		-
	iii	Elbow, 90 deg 32 -32	42	each		-
g		Shaft Seal Water - Valves				
	i	Ball valve 32	14	each		-
	ii	Check valve 32	7	each		-
h		Service Water - Embedded Piping				
	i	Pipe 50	5	m		-
	ii	Pipe 300	128	m		-
i		Service Water - Embedded Fittings				
	i	Elbow, 90 deg, lr 300 -300	7	each		-
j		Insulation		EC		-
k		Instrumentation		EC		-
l		Testing, flushing, cleaning		EC		-
m		Pre-commissioning		EC		-
40 23 21		**Dewatering System**				
a		Equipment				
	i	Dewatering sump pump	4	each		-
b		Exposed Piping				
	i	Pipe 350	112	m		-
	ii	Pipe 25	150	m		-
c		Exposed Fittings				
	i	Tee 350 -350 -350	9	each		-
	ii	Concentric reducer 400 -350	2	each		-
	iii	Concentric reducer 350 -200	4	each		-
	iv	Elbow, 90 deg, lr 350 -350	21	each		-
	v	Elbow, 45 deg, lr 500 -500	1	each		-
	vi	Elbow, 45 deg, lr 350 -350	2	each		-
	vii	Elbow, 90 deg, sr 350 -350	6	each		-
	viii	Flange, weld neck 500 -500	14	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
	ix	Flange, weld neck 400 -400	4	each		-
	x	Flange, weld neck 350 -350	78	each		-
	xi	Flange, weld neck 200 -200	4	each		-
	xii	Flange, blind 350 -350	2	each		-
d		Valves				
	i	Butterfly valve 500	7	each		-
	ii	Butterfly valve 400	2	each		-
	iii	Butterfly valve 350	33	each		-
	iv	Check valve 350	6	each		-
e		Embedded Piping				
	i	Pipe 500	254	m		-
	ii	Pipe 400	39	m		-
	iii	Pipe 350	178	m		-
	iv	Pipe 300	105	m		-
	v	Pipe 25	20	m		-
f		Embedded Fittings				
	i	Tee 350 -350 -350	9	each		-
	ii	Tee 400 -400 -400	4	each		-
	iii	Concentric reducer 400 -350	4	each		-
	iv	Elbow, 90 deg, lr 500 -500	7	each		-
	v	Elbow, 90 deg, lr 400 -400	2	each		-
	vi	Elbow, 90 deg, lr 350 -350	6	each		-
	vii	Elbow, 90 deg, lr 300 -300	9	each		-
	viii	Elbow, 90 deg, lr 250 -250	8	each		-
	ix	Elbow, 90 deg, lr 200 -200	21	each		-
	x	Elbow, 90 deg, lr 100 -100	18	each		-
	xi	Elbow, 45 deg, lr 500 -500	3	each		-
	xii	Elbow, 45 deg, lr 400 -400	4	each		-
	xiii	Elbow, 90 deg, sr 400 -400	4	each		-
	xiv	Elbow, 90 deg, sr 350 -350	8	each		-
	xv	Elbow, 90 deg, sr 300 -300	9	each		-
	xvi	Trimmed elbow 500 -500	3	each		-
g		Instrumentation		EC		-
h		Testing, flushing, cleaning		EC		-
i		Pre-commissioning		EC		-
40 90 00		**Piezometers & Station Instrumentation System**				
a		Exposed Piping				
	i	Tube, hard 50	200	m		-
	ii	Tube, soft 25	100	m		-
	iii	Tube, soft 20	20	m		-
b		Exposed Fittings				
	i	Tee 50 -50 -50	28	each		-
	ii	Elbow, 90 deg 50 -50	28	each		-
	iii	Elbow, 90 deg 25 -25	84	each		-
c		Valves				
	i	Ball valve 50	6	each		-
	ii	Ball valve 25	21	each		-
	iii	Ball valve 20	177	each		-
	iv	Gate valve 25	3	each		-
	v	Gate valve 20	2	each		-
	vi	Globe valve 20	2	each		-
d		Embedded Piping				
	i	Tube, hard 50	90	m		-
	ii	Tube, soft 25	525	m		-
	iii	Tube, soft 20	400	m		-
e		Embedded Fittings				
	i	Elbow, 90 deg 25 -25	140	each		-
	ii	Elbow, 90 deg 20 -20	462	each		-
f		Components				
	i	Three-valve manifold 25	21	each		-
	ii	Three-valve manifold 20	7	each		-

Item No.		DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT
g		Instrumentation		EC		-
h		Testing, flushing, cleaning		EC		-
i		Pre-commissioning		EC		-
41 22 00		**Small Cranes**				
a		Machine shop bridge crane	1	each		-
b		Machine shop floor crane	1	each		-
c		Oil/water separator bridge crane	1	each		-
d		Waste water treatment plant monorail crane	1	each		-
e		Intake hoist housing monorail crane	1	each		-
41 22 13		**Crane Rails**				
a		Draft tube gate crane rails complete with plates, anchors and grout	420	m		-
43 20 00		**Oil Storage & Handling System**				
a		Equipment				
	i	Oil storage tank	4	each		-
	ii	Waste oil pump	1	each		-
	iii	Used oil pump	1	each		-
	iv	New/clean oil pump	1	each		-
	v	Clean oil pump (portable)	1	each		-
	vi	Dirty oil pump (portable)	1	each		-
	vii	Used oil pump (mobile)	1	each		-
	viii	Mobile oil purifier	1	each		-
	ix	Oil filter unit	2	each		-
b		Lubricating and Governor Oil Piping - Exposed Piping				
	i	Pipe 80	704	m		-
c		Lubricating and Governor Oil Piping - Exposed Fittings				
	i	Tee 80 -80 -80	15	each		-
	ii	Elbow, 90 deg, lr 80 -80	114	each		-
	iii	Elbow, 45 deg, lr 80 -80	2	each		-
	iv	Flange, weld neck 80 -80	217	each		-
d		Lubricating and Governor Oil Piping - Valves				
	i	Butterfly valve 80	86	each		-
	ii	Ball valve 80	6	each		-
	iii	Check valve 80	2	each		-
e		Waste Oil - Exposed Piping				
	i	Pipe, plain end 80	377	m		-
	ii	Pipe, bevelled end 50	2	m		-
f		Waste Oil - Exposed Fittings				
	i	Tee 80 -80 -80	7	each		-
	ii	Concentric reducer 80 -50	1	each		-
	iii	Elbow, 90 deg, lr 50 -50	1	each		-
	iv	Elbow, 45 deg, lr 80 -80	42	each		-
	v	Elbow, 45 deg, lr 50 -50	1	each		-
	vi	Sockolet 50 -50	2	each		-
	vii	Flange, weld neck 80 -80	42	each		-
g		Waste Oil - Valves				
	i	Ball valve 80	1	each		-
	ii	Ball valve 25	3	each		-
	iii	Butterfly valve 80	17	each		-
	iv	Check valve 80	1	each		-
	v	Check valve 25	3	each		-
h		Instrumentation		EC		-
i		Testing, flushing, cleaning		EC		-
j		Pre-commissioning		EC		-
		TOTAL INITIAL TARGET PRICE			**$**	**22,626,600.00**

Item No.	DESCRIPTION	ESTIMATED QUANTITY	UNIT	UNIT PRICE	AMOUNT

REQUEST FOR PROPOSAL 016203

PART 2 - CONTRACT DOCUMENTS
VOLUME 1 OF 3

INCLUDING ADDENDA 1 TO 10

KEEYASK GENERATING STATION

GENERAL CIVIL WORKS

DECEMBER 5, 2013 **ADDENDA 1-10**

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KEEYASK GENERATING STATION
GENERAL CIVIL WORKS
CONTRACT 016203

PART 2
VOLUME 1 – CONTRACT DOCUMENTS

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Articles of Agreement [**(14 pages)**]

General Specification with Table of Contents **[(**Error! Bookmark not defined. **pages)]**

Terms and Conditions of Payment with Table of Contents **[(28 pages)]**

ECIS Obligations Terms and Conditions of Agreement [**(27 pages)**]

KEEYASK GENERATING STATION PROJECT

GENERAL CIVIL WORKS

ARTICLES OF AGREEMENT

This Agreement made on the _____ day of _____, 2014
by and between:

MANITOBA HYDRO
(hereinafter the "Purchaser")

and

_____
(hereinafter the "Contractor")

Whereas:

A. The Purchaser is proposing to undertake the Keeyask Generating Station Project which if built, will contribute approximately 695 megawatts to the Purchaser's integrated power system;

B. On May 29, 2009, the Purchaser and Cree Nation Partners (consisting of Tataskweyak Cree Nation and War Lake First Nation), York Factory First Nation and Fox Lake Cree Nation signed the Joint Keeyask Development Agreement (the "JKDA") regarding potential development of the Keeyask Project, including the Keeyask Generating Station Project. The JKDA sets out the terms and conditions upon which the Keeyask Hydropower Limited Partnership, of which the above parties are limited partners, shall own and proceed with the development of the Keeyask Project;

C. The Purchaser is contracted by the Keeyask Hydropower Limited Partnership to act as project manager to complete the planning, design and engineering and to construct and commission the proposed Keeyask Generating Station Project, including construction of the general civil works. The Purchaser has final decision-making authority with respect to all matters arising out of the contract award of the general civil works contract and oversight of all work resulting therefrom;

D. The Purchaser desires a capable and well-experienced heavy civil construction contractor with considerable relevant prior experience and proven success completing work of similar scale and complexity in remote northern locations to participate and perform work and services in both Phase I and Phase II of the Keeyask Generating Station Project;

E. The Purchaser, based on and in reliance upon representations and submittals from the Contractor, has selected the Contractor as its preferred proponent in a competitive procurement process to perform the Work, including the ECIS Obligations and all of the general civil works for the Keeyask Generating Station Project as set out in and required by the Contract;

F. In Phase I, the Contractor will act as one of three primary participants in the Purchaser's Early Contractor Involvement Team to perform the ECIS Obligations, including review the design for constructability and completeness of detail and provide input and recommendations to other participants in the Purchaser's Early Contractor Involvement Team, and to prepare key deliverables for construction of the general civil works for the Keeyask Generating Station Project;

G. In Phase II, the Contractor will perform all Work to construct the general civil works for the Keeyask Generating Station Project;

H. The Contractor has offered to execute and complete the required ECIS Obligations and to perform all Work for the Phase II construction of the general civil works for the Keeyask Generating Station Project in consideration for the compensation and on the terms and conditions provided in the Contract; and

I. The Parties have agreed to incorporate certain early contractor involvement objectives and principles, sharing of risks, cost reimbursable, target based pricing elements and open book accounting principles that will apply to Phase I and Phase II as applicable, all of which have been incorporated into the Contract prior to its execution.

The Purchaser and the Contractor agree as follows:

1 THE WORK

The Contractor shall:

(a) commence the ECIS Obligations by March 31, 2014;

(b) perform the ECIS Obligations required by the Contract;

(c) if a Notice to Proceed is issued by the Purchaser to the Contractor as provided in Section 4 NOTICE TO PROCEED WITH PHASE II below, commence the Phase II Work on June 27, 2014 or as otherwise directed by the Purchaser in the Notice to Proceed ("Commencement Date"); and perform the Work required by the Contract for Phase II for the Keeyask Generating Station Project located on the Lower Nelson River, 170 Kilometers Northeast of Thompson, in Northern Manitoba;

(d) subject to adjustment as provided for in the Contract, attain final completion of the Phase II Work on or before [**NTD: Date to be inserted based on Contractor's submitted construction schedule)**] ("Completion Date"); and

(f) do and fulfill everything indicated by the Contract.

2 AMENDMENTS

The Contract may be amended in writing only as provided in the Contract.

3 CONTRACT AND PRIORITY OF DOCUMENTS

Each of the documents which are referred to below and are attached as appendices hereto form a part of the Contract, and by this reference are incorporated herein with the same effect as if at length set forth herein, and unless there is something in the subject or context inconsistent therewith, the words and expressions contained in these Articles of Agreement shall have the same meaning as corresponding words and expressions in the said documents. All the terms, and conditions, provisions and requirements of the Contract and all documents referred to below shall apply to and have effect in connection with the Contract provided, however, that in the event of any conflict or inconsistency between these Articles of Agreement and the documents referenced below, the order of priority of same for the purposes of the interpretation and application of the Contract shall be as follows:

(a) Amending Agreements between the Parties (if any) in reverse numerical sequence commencing with the most recent Amending Agreement;

(b) these Articles of Agreement;

(c) Change Orders (if any) in reverse numerical sequence commencing with the most recent Change Order, provided however that no Change Order shall amend the Articles of Agreement, the General Specification or the Terms and Conditions of Payment;

(d) the Purchaser's Purchase Order Number [**to be completed**] dated [**insert**] for the Work;

(e) Volume 1 - Terms and Conditions of Payment;

(f) Volume 1 - General Specification;

(g) the ECIS Agreement (provided that the ECIS Agreement shall have priority over any other document in respect of matters relating solely to Phase 1);

(h) Extra Work Orders;

(i) Issued for Construction Purchaser's Drawings issued after the signing of the Contract;

(j) Volume 2 Technical Specifications (all sections of which are of equal priority);

(k) Volume 3 - Appendices;

(l) the ECIS Deliverables; and

(m) the Contractor's Submission Extracts.

Provided that priority, in the event of any continuing conflict within documents ranked as aforesaid, shall be determined so that:

i) Later dated documents shall govern over earlier documents of the same type;

ii) Detailed Purchaser's Drawings shall govern over general Purchaser's Drawings;

iii) Purchaser's Drawings shall govern over the 3D Project Models described in the General Specification.

If an ambiguity or discrepancy is found in the documents, the Engineer shall issue any necessary clarification or instruction on its own or at the request of either the Purchaser or the Contractor.

4 NOTICE TO PROCEED WITH PHASE II

The following are conditions precedent to any obligation on the Purchaser to issue a Notice to Proceed such that these events must occur before the Purchaser will be in a position to authorize the Contractor to proceed with the Phase II Work:

(a) Receipt by the Purchaser and/or the Keeyask Hydropower Limited Partnership of all approvals and/or licences required under any federal or provincial legislation to proceed with the construction and operation of the Keeyask Generating Station Project, including construction of the Work;

(b) Receipt by the Purchaser of any required Order-In-Council;

(c) Manitoba Hydro Board of Directors approval to proceed with the Keeyask Generating Station Project;

(d) That no deficiency notice shall have been delivered to the Purchaser and/or the Keeyask Hydropower Limited Partnership in respect of the licence for the Keeyask Generating Station Project which has not been resolved;

(e) That there is no order or injunction entered in any action or proceeding in any court of competent jurisdiction, or by any Authority over the enforcement of the applicable Laws, delaying, making illegal or prohibiting the development of the Keeyask Generating Station Project;

(f) That the Purchaser and/or the Keeyask Hydropower Limited Partnership shall own, or be entitled to own, or have a lease or other authorization to enter the lands upon which the Keeyask Generating Station Project, including the Work, is to be constructed and will be performed; and

(g) That the Purchaser at its discretion shall be satisfied with the Contractor's performance of its ECIS Obligations, including with the Contract Schedule for the Work received from the Contractor as part of the ECIS Obligations.

The above conditions precedent are for the benefit of the Purchaser, the satisfaction or waiver of which by the Purchaser in its discretion shall be evidenced by the issuance of a written document in the form of a Notice to Proceed by the Purchaser to the Contractor. The Notice to Proceed shall be the Contractor's authorization to commence and proceed with the Phase II Work in accordance with the Contract.

In the event that the issuance of the Notice to Proceed is delayed from June 27, 2014 to a date on or before June 27, 2015, the Initial Target Price will be adjusted in accordance with the Contractor's delay costs set out in the Contractor's Submission Extracts. If the Notice to Proceed is issued on June 27, 2015, then the Contract Schedule shall be adjusted by one year. If the Notice to Proceed is issued between June 27, 2014 and June 27, 2015, then the Contract Schedule shall be adjusted in accordance with Section 33 CLAIMS, DISPUTES AND ARBITRATION of the General Specification; provided, however, that no such adjustment will be greater than one calendar year.

Without the written agreement of the Contractor, the Purchaser may not specify a date later than June 27, 2015.

In the event that the Purchaser is unwilling or unable to issue the Notice to Proceed, and the Purchaser so notifies the Contractor in writing, the Purchaser shall pay the Contractor for the Phase 1 Work in accordance with the ECIS Agreement. Such payment shall be conditional upon the Contractor's delivery and the transfer of ownership to the Purchaser of all design documents, materials, equipment and supplies forming part of the Work, for which the Contractor is entitled to be paid. For clarity, other than as aforesaid, the Purchaser shall have no obligation or liability for any claims, costs, losses, expenses, consequential or indirect damages (including, loss of profit, loss of opportunity, and loss of revenue) howsoever incurred or sustained by the Contractor and arising out of the non-issuance of the Notice to Proceed.

5 PRICE AND PAYMENT OF THE WORK

The general basis of payment for the Work will be on a cost reimbursable basis with provisions for an Initial Target Price and Final Target Price in accordance with and subject to the terms of the Contract.

Subject to provisions regarding the sharing of savings and cost overruns in relation to the Final Target Price for the Work as set out in Section 9.5 TOTAL CONTRACT PRICE of the Terms and Conditions of Payment and subject to substantiation of Actual Costs by the Contractor as certified by the Engineer in accordance with the Contract, the Purchaser shall, as the Work progresses, pay the Contractor in Canadian funds in accordance with the Terms and Conditions of Payment set out in the Contract.

For purposes of payment, the Work shall be measured as set out in the Contract documents.

In the event of loss or damage occurring where payment becomes due under relevant insurance policies, payments shall be made to the Contractor and/or the Purchaser in accordance with Section 31 INSURANCE of the General Specification.

6 CONTRACT SCHEDULE

The Contractor shall fully, in accordance with the Contract, complete the Work in accordance with the Contract Schedule, including the Contract Dates set out therein, except as may be adjusted in accordance with the provisions of the Contract. The initial Contract Schedule shall be the schedule as developed by the Contractor and expressly accepted as the Contract Schedule for Phase II by the Purchaser in the course of the Contractor's performance of its ECIS Obligations under Phase I.

7 CONTRACTOR'S OBLIGATIONS AND CONTRACTOR'S REPRESENTATIVE [as required]

[**insert joint venture/consortium member name**], [**insert joint venture/consortium member name**] and [**insert joint venture/consortium member name**] hereby covenant and agree that each is jointly and severally liable with the other to perform all Work, including the ECIS Obligations and all of Contractor's covenants, obligations, liabilities and responsibilities under the Contract and further agree that the Purchaser may look to any or all of [**insert joint venture/consortium member names**] for the performance or fulfillment of all or any of the Contractor's obligations under the Contract or for the performance or fulfillment of all or any part of the Work, including the ECIS Obligations, regardless of the division of the Work that may be specified between [**insert joint venture/consortium member names**] as part of their contractual arrangement. [**insert joint venture/consortium member names**] hereby specify to the Purchaser that [**insert Contractor's Representative's position title**], [**insert Contractor's Representative's name**], shall act as the Contractor's Representative to give and receive communications on behalf of the Contractor during the performance of the Work and such designation shall be effective until revoked or amended in writing by all of [**insert joint venture/consortium member names**] and received by the Purchaser. It is further acknowledged and agreed by the parties that [**insert joint venture/consortium member names**] are not partners for the purposes of the Laws of the province of Manitoba or Canadian federal Laws that may be applicable.

The Contractor represents and warrants that the information contained in the Submission is true and correct in all material respects as of the date of the signing of these Articles of Agreement.

With respect to the information contained in the Submission at Appendix [*] – Legal Structure, the Contractor shall not change its legal structure, member contributions, organizational structure, terms of its joint venture or consortium agreement, or any other details set out in such Appendix [*], without the prior written consent of the Purchaser,

which consent may be withheld in the Purchaser's discretion or given on such terms and conditions as Purchaser at its discretion considers in the interest of the Purchaser. Notwithstanding the above, in the event the Contractor does make any such changes without the Purchaser's consent, which shall be deemed to be a fundamental breach of a material term of the Contract, the Contractor shall forthwith advise the Purchaser in writing of any such changes including with respect to:

(a) changes or amendments to the terms of its joint venture/consortium agreement;

(b) changes or amendments to each joint venture party or consortium member's contributions of any nature to the joint venture/consortium arrangement;

(c) the withdrawal or termination of a joint venture or consortium member from the joint venture or consortium; or,

(d) changes in the financial status of a joint venture or consortium member that may impact the ability of such joint venture or consortium member to successfully perform the Work and the Contract in accordance with its terms.

No change, or amendment to a joint venture/consortium agreement, or to a member's contribution to any joint venture/consortium arrangement, or withdrawal or termination of a joint venture or consortium member, shall reduce or release any member's joint and several liability to the Purchaser for the fulfilment by the Contractor of all of the Contractor's obligations and liabilities under the Contract.

8 APPOINTMENT OF ENGINEER AND PURCHASER'S REPRESENTATIVE

Purchaser hereby appoints [**insert name of person who will be the Engineer, position and title**], who is an employee of the Purchaser, as the Engineer under the Contract and such designation shall be effective until revoked or amended in writing by Purchaser.

Purchaser hereby appoints [**insert name of Purchaser's Representative, position and title**], as the Purchaser's Representative to give and receive communications on behalf of the Purchaser during the performance of the Work and such designation shall be effective until revoked or amended in writing by Purchaser.

9 RECEIPT OF AND ADDRESSES FOR NOTICES IN WRITING

Notices in writing shall be sent by courier or by hand, before 4:00 p.m. (and any such Notices received after 4:00 p.m. shall be deemed to be received the following business day) to the recipient at the address below, or at such amended addresses as may be provided in writing (provided that the Contractor shall not change its address for Notice without the prior written consent of the Purchaser).

The Purchaser to the attention of:

Manitoba Hydro
360 Portage Avenue (18)
P.O. Box 815
Winnipeg, Manitoba R3T 2P4
Attention: [**to be advised**]

The Contractor to the attention of:

[**to be completed**] [NTD: To be Contractor's Site Address]
Attention: [**to be completed**]

The Engineer:

[**to be advised**]
Attention: [**to be advised**]

10 LANGUAGE OF THE AGREEMENT

The Contract is drawn in the English language at the request of the parties hereto and shall be administered in English.

11 PUBLIC ANNOUNCEMENTS AND MEDIA

The Contractor shall not make use of its association with the Purchaser relating in any way, directly or indirectly to the Contract or the Work, for publicity or promotion or any public announcement without the express written consent of the Purchaser.

The Contractor must refer to the Purchaser any enquiries from the media concerning the Work, the Keeyask Project, the Contract, or Purchaser's operations, business and activities. The Contractor must not, and must ensure that its Subcontractors do not, advertise or issue any information, publication, document or article (including photographs or film) for publication or media releases or other publicity relating to the Keeyask Project, the Work, the Contract, or Purchaser's operations, business and activities, without the prior approval of the Purchaser (not to be unreasonably withheld but subject to such changes as the Purchaser acting reasonably may require). Such approval will be given by the Purchaser in writing.

12 WAIVER

No waiver of any provision of the Contract, or of a breach thereof, shall be effective unless it is writing and signed by the Purchaser's Representative or the Contractor's Representative, as applicable, expressly waiving the provision or the breach thereof. A waiver of any right under the Contract on the part of either Party shall not be deemed to be a waiver of any other right, and a waiver of any right in any one instance shall not be deemed to be a waiver of that right in any other instance.

13 SEVERABILITY

If any provision of the Contract is for any reason illegal, invalid or unenforceable at law, that provision shall be deemed to be severed from the Contract and the remaining provisions of the Contract shall continue in full force and effect and continue to be binding upon the Parties as though the severed provision had never been included in the Contract. The Parties agree that they will endeavour to replace any such void or unenforceable provision with a new provision which achieves substantially the same practical or economical effect and which is valid and enforceable.

14 FURTHER ACTS AND ASSURANCES

Each of the Parties shall, from time to time, do all such acts and things and execute from time to time all such further documents and assurances as may be necessary to carry out and give effect to the terms of the Contract.

15 ASSIGNMENT

The Contractor shall not, without the prior written consent of the Purchaser in writing, which consent may be withheld by the Purchaser for any reason in its discretion, assign the Contract or any of its rights or obligations thereunder, to any other person or entity; and provided further that any such assignment for which consent has been granted shall not relieve the Contractor of any obligation under or in respect of the Contract and/or the Work save and except to the extent same has been fully performed or fulfilled by the assignee.

The Purchaser shall have the right at any time to assign the Contract, in whole or in part and any and all rights thereunder, to the Keeyask Hydropower Limited Partnership without the prior consent and without prior notice to the Contractor for which purpose the Contractor hereby expressly consents to same. The Purchaser shall advise the Contractor in writing within ten (10) days of the occurrence of such assignment, as to the particulars thereof. Such assignment shall not relieve Manitoba Hydro of its obligations to make payments to the Contractor under the Contract should Keeyask Hydropower Limited Partnership default in the making of any payments required to be made by the Purchaser to the Contractor in accordance with the terms of the Contract.

16 CHANGE IN CONTROL

No change in control of the Contractor, or any person owning, directly or indirectly, beneficially or otherwise, any of the shares or units or any other ownership interest in the Contractor or any such person shall be permitted without the prior written consent of the Purchaser, which may withhold its consent in its discretion.

This Section 16 shall not apply to any change in control of persons whose equity securities or ownership units or any other ownership interests are listed on a recognized stock exchange.

The Contractor shall provide timely notice to the Purchaser of any proposed change of control pursuant to this Section 16, and such notification shall include a statement identifying all such owners, or persons with an ownership interest in the Contractor, as the case may be, and their respective holdings of such ownership interest in the Contractor, prior to and following any such change in control.

[NTD: Provision to be discussed upon selection of the Preferred Proponent]

17 LIABILITY

The Purchaser shall indemnify and save harmless the Contractor and its directors, officers and employees (the "Indemnified Party") from and against any and all losses, costs, damages or expenses which the Indemnified Party may suffer or be put to as a result of any action, claim, suit or proceeding which may be brought or made against the Indemnified Party by the Keeyask Hydropower Limited Partnership, 5900345 Manitoba Ltd., the Cree Nation Partners Limited Partnership, the York Factory First Nation Limited Partnership or FLCN Keeyask Investments Inc. in excess of the aggregate total liability set out in Section 30.4 TOTAL LIABILITY of the General Specification.

18 SUCCESSION

The Contract shall enure to the benefit of and be binding upon the Parties hereto, their legal representatives, successors, and permitted assigns.

19 FIDIC LICENCE

The Contractor acknowledges that certain aspects of the Contract are based upon the International Federation of Consulting Engineers (FIDIC) Conditions of Contract for Design-Build Projects, 1st Edition, 1999 (the "FIDIC Conditions") for which the Purchaser has received a licence to use and amend the FIDIC Conditions. The Contractor agrees:

(a) it will not use the electronic version of the Contract for any purpose other than this specific project;

(b) it will not circulate the electronic version of the Contract outside of the working group for this specific project (other than in .PDF format if permitted by the Contract); and

(c) it will take reasonable steps to protect FIDIC's rights to the original text of the FIDIC Conditions, in particular, by suitably preventing any electronic files, whether as provided by FIDIC or as amended by the Purchaser from being used for any other purposes whatsoever than those set out in (a) above.

20 ENTIRE AGREEMENT

The Contract constitutes the entire agreement between the Purchaser and the Contractor with respect to the subject matter thereto and excludes any and all implied terms (whether implied by law, by custom of the trade, usage or otherwise), and supersedes all prior agreements, representations, discussions, proposals (including those parts of the Submission that do not form part of the Contractor's Submission Extracts), understandings, negotiations or other communications, oral or otherwise, between the Parties with respect to such subject matter.

21 COUNTERPARTS

The Contract, by these Articles of Agreement, may be signed in any number of counterparts, each of which shall be deemed to be an original and all of which when read together shall be deemed to constitute one and the same instrument. Counterparts may be signed either in original or facsimile format and the Parties adopt any facsimile signatures received by electronic transmission as original signatures of the Parties; provided however, that either Party providing its signature in such manner shall promptly forward to the other Party an original signed copy of the Contract which was first sent by electronic transmission. Any original, fax copy, copy printed from a "PDF" file, or photocopy of this Agreement bearing one or more signatures of a Party shall be admissible against that Party in any legal or arbitral proceeding as evidence of the due and proper execution and delivery of this Agreement by that Party.

22 INDEPENDENT REVIEW

Both Parties have had the opportunity to review and comment upon the Contract and obtain independent legal advice with regard to the contents, meaning and legal effect of the Contract.

23 AUTHORITY TO EXECUTE CONTRACT

The Contractor represents and warrants:

(a) it has the requisite power, authority and capacity to execute and deliver the Contract;

(b) the Contract has been duly and validly executed on its behalf by its duly authorized representatives; and

(c) the Contract constitutes a legal, valid and binding agreement enforceable against it in accordance with its terms.

24 CONSORTIUM AND JOINT VENTURE

If the Contractor is a joint venture or consortium, the Contractor, and each of [*insert full legal names of members] (each of which is referred to herein as a "Contractor Member"), jointly and severally represent and warrant that:

(a) the Contractor is a [*joint venture/consortium] of [*_____], [*_____] and [*_____];

(b) the Contract has been duly executed by an authorized representative of the Contractor and by an authorized representative of each Contractor Member;

(c) if the Contract is for any reason invalid or unenforceable against any one or more Contractor Members for any reason, the Contract shall be valid and binding on the Contractor and all other Contractor Members who have executed this Agreement;

(d) each and every Contractor Member is a resident of Canada for purposes of the Income Tax Act (Canada);

(e) the Contractor will organize itself, arrange its internal affairs and perform the Work under the Contract in such a manner that the Purchaser will not be required by section 105 of the Income Tax Regulations (Canada) or any other legislation, as same may be amended, replaced or substituted hereafter, to make any withholdings and remittances from payments otherwise due to the Contractor; and

(f) no part of any payment by the Purchaser to the Contractor that, pursuant to directions from the Contractor to the Purchaser is deposited by the Purchaser directly into a bank account of a Contractor Member, shall be paid to that Contractor Member except in compliance with section 105 of the Income Tax Regulations (Canada).

Subject to the Contractor's right to claim cost and/or schedule relief in accordance with Section 33 CLAIMS, DISPUTES AND ARBITRATION of the General Specification, if any representation or warranty under this Section 24 is false, or if the Contractor breaches any of the agreements in this Section 24, or if the Purchaser is required by Customs and Revenue Agency (Canada) to make withholdings and remittances to Customs and Revenue Agency, the Contractor shall indemnify and save the Purchaser harmless from and against any and all liabilities that the Purchaser may have resulting therefrom, including indemnifying the Purchaser for any failure of the Purchaser to make the withholdings and remittances described in section 105 of the Income Tax Regulations (Canada) as same may be amended, replaced or substituted hereafter.

25 SURVIVAL

The provisions of the Contract which by their nature are continuing shall survive termination of the Contract.

[SIGNATURE PAGE IMMEDIATELY FOLLOWS]

IN WITNESS WHEREOF the Parties hereto have executed and delivered the Contract by their duly authorized representatives and effective as of the day and year first above written.

MANITOBA HYDRO

_____
Signature

_____
Name and title of person signing

[**INSERT LEGAL NAME OF CONTRACTOR**]

_____
Signature

_____
Name and title of person signing

_____
Signature

_____
Name and title of person signing

_____
Signature

_____
Name and title of person signing

[***NTD: Add additional execution blocks as follows for each Contract Member if Contractor is a joint venture or consortium**].

Executed and delivered by

[*_____],

a member of [*_____],

by its duly authorized representative or agent:

_____

Signature

_____

Name and title of person signing

_____

Signature

_____

Name and title of person signing

_____

Signature

_____

Name and title of person signing

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GENERAL SPECIFICATION

KEEYASK GENERATING STATION
GENERAL CIVIL WORKS
CONTRACT 016203

GENERAL SPECIFICATION

1 DEFINITIONS AND INTERPRETATION

1.1 Definitions

For purposes of the Contract, the following words and expressions shall have the meanings stated.

3D Project Models	Means the three dimensional digital models of the detailed design for the Keeyask Generating Station Project as set out in Appendix B - 3D PROJECT MODELS and as may be updated from time to time during the performance of the Work.
"Actual Cost Overruns"	Means the amount by which the Actual Costs of performance of the Phase II Work exceeds the Final Target Price.
"Actual Costs"	Shall have the meaning set out in Section 11 ACTUAL COSTS of the Terms and Conditions of Payment.
"Adjusted Target Price"	Means the Initial Target Price, as adjusted upward or downward in accordance with the Contract during the performance of the Work and upon each such approved adjustment, the most current revised dollar amount will be the "Adjusted Target Price" for the purposes of the Contract.
"Articles of Agreement"	Means the execution portion of the agreement titled as such between the Parties for the performance and payment of the Work, including the ECIS Obligations, which incorporates by reference all documents which will form part of the Contract.
"Authority"	Means any and all foreign, domestic, national, federal, provincial, territorial, state, regional, municipal or local governmental authority, quasi-governmental authority, court, government or self-regulatory organization, commission, board, tribunal, organization, or any regulatory, administrative or other agency, or any political or other subdivision, department, or branch of any of the foregoing, having jurisdiction in any way over any aspect of the performance of the Contract or the provision of the Work, including without limitation any applicable Laws.
"Best-for-Project"	Means the standard against which to measure recommendations and decisions that will produce a major hydroelectric project in a remote location that is safe, durable and reliable with minimal unplanned outages throughout its entire operating life and which recommendations and decisions take into account the potential consequences of breaches or failures of water retaining structures while addressing the need to optimize schedule and cost of construction, all through construction sequencing, construction methods, alternative construction materials, material innovation / improvement, and any other means and methods as identified to reduce costs, improve schedule, maintain safety and mitigate

	risks made by the ECI Team, and which is reflective of these and other principles and objectives for the Keeyask Generating Station Project set out in the ECI Team Agreement.
"Break Fee"	Means the fee, if any, to be paid to the Contractor in the event that the Contract is terminated pursuant to Section 29.3 TERMINATION FOR CONVENIENCE of the General Specification as such fee is set out in the Contractor's Submission Extracts.
"BNA"	Means the Keeyask Project labour agreement titled the Burntwood/Nelson Agreement.
"Camp Room Surplus Allowance"	Means a number of additional camp rooms equal to up to 15% of the number of rooms included in the Contractor's Excerpts under the section heading CONTRACTOR'S CAMP REQUIREMENTS.
"Canadian Office"	Means [●] [**NTD: To insert address of Contractor's head office in Canada**]
"Cash Allowance Items"	Shall have the meaning set out in Section 5.2(d) SUFFICIENCY OF THE INITIAL TARGET PRICE of the Terms and Conditions of Payment.
"Change"	Means an addition, substitution, deletion, variation, modification, cancellation or omission of part or all of the Work required to be performed or provided under the Contract or to the Contract Schedule.
"Change Order"	Means the document or documents by which the Contractor is authorized to proceed with Changes where the Change is not related to, or is outside of, the original Contract scope of the Work as specified in such document and in accordance with the terms and conditions set out therein and in the Contract.
"Commencement Date"	Means the date set out in the Articles of Agreement or the Notice to Proceed, as applicable when the Contractor shall mobilize and the Phase II Work on Site shall begin.
"Completion Certificate"	Means a certificate in the form set out in Appendix X – COMPLETION CERTIFICATE issued by the Engineer in accordance with Sections 24.1 TAKING OVER OF PART(S) OF THE WORK or 24.3 TAKING OVER OF THE WORK of the General Specification.
"Completion Date"	Means the date set out in the Articles of Agreement by which the Work is to be completed, subject to any extension thereto properly approved thereto in accordance with the Contract, as evidenced by the issuance of a Final Completion Certificate for the Work.
"Contract"	Means the agreement entered into between the Purchaser and the Contractor for the Work to be done and material and equipment to be furnished in accordance with the Articles of Agreement, the General Specification, the Terms and Conditions of Payment, the ECIS Agreement, the Technical Specification, Appendices, including the Purchaser's Drawings, 3D Project Models and Data for Proponents, the Contractor's Submission Extracts, any appendices or attachments referred to in such documents, and any Purchase Orders issued in relation to the Work, all of which will be either referred to in or attached to and form part of said agreement and any additions and modifications made thereto made in accordance with the Contract. It shall also mean all Work Instructions, Extra Work Orders, Change Orders, specifications, Purchaser's Drawings and 3D Project Models which further detail, explain or modify the Work, even though such documents are issued after the execution of said agreement.

"Contract Dates"	Means those dates and durations identified as such in Section 3.7 CONTRACT DATES of the General Specification.
"Contract Schedule"	Means the schedule for the Work developed by the Contractor as part of its ECIS Obligations and approved by the Purchaser, setting out the Contractor's comprehensive plan for performance of the Work using a Critical Path Method (CPM) and any revisions properly approved thereto in accordance with the Contract. The Contract Schedule is the baseline control schedule which, once approved and accepted by Purchaser, will be the baseline control schedule against which progress is measured.
"Contractor"	Means the party or parties named as such in the Articles of Agreement and its or their legal personal representatives, successors and assigns.
"Contractor Parties"	Means the Contractor's Personnel, Subcontractors and their respective agents, employees, officers and directors and all others for whom the Contractor is responsible at law.
"Contractor's Confidential Information"	Means the Contractor's Intellectual Property and the Contractor's Records.
"Contractor's Documents"	Means the data, calculations, computer programs and other software, Contractor's shop drawings and other drawings as required by the Technical Specification, as-built drawings, manuals, models and other documents supplied by the Contractor under the Contract.
"Contractor's GA&O Percentage"	Means [**INSERT**]%, which shall be fixed for the duration of the Contract.
"Contractor's Intellectual Property"	Means the Contractor's intellectual property, proprietary methods, or technology, trade secrets, Contractor's Documents and the cost or pricing information of the Contractor or its Subcontractors in any form or format provided to the Purchaser in the performance of the Work or pursuant to the Contract.
"Contractor's Personnel"	Means the Contractor's Representative and all personnel, including the Key Personnel, whom the Contractor utilizes on Site, including the staff, labour and other employees of the Contractor and of each Subcontractor; and any other personnel engaged by or through the Contractor in the execution of the Work.
"Contractor's Profit Percentage"	Means [**INSERT**]%, which shall be fixed for the duration of the Contract.
"Contractor's Records"	Shall have the meaning set out in Section 23.4 CONTRACTOR'S RECORDS of the General Specification.
"Contractor's Representative"	Means the person named by the Contractor in the Articles of Agreement or appointed from time to time by the Contractor under Section 7.6 CONTRACTOR'S REPRESENTATIVE of the General Specification, who acts on behalf of the Contractor.
"Contractor's Submission"	Means the proposal submitted by the Contractor in response to Request for Proposal 016203.
"Contractor's Submission Extracts"	Means the document comprising the parts of or extracts from the Contractor's Proposal which the Parties have agreed to incorporate into the Contract in accordance with and subject to Section 3 of the Articles of Agreement and are attached hereto as Volume 5 – Contractor's Submission Extracts. If documents are expressly identified and named in the Contract to be supplied by the Contractor following the date of Contract signing, including any deliverables required to be provided by the Contractor as part of its ECIS Obligations, such documents shall form

	part of the Contractor's Submission Extracts upon being supplied to and approved by the Purchaser.
"Control Points"	Shall have the meaning set out in Section 7.17 CONTROL POINTS of the General Specification.
"Corruption"	Means any bribery, extortion, fraud, deception, collusion, cartels, abuse of power, embezzlement, trading in influence, money-laundering, or any similar activity in relation to the Project.
"Critical Path"	Means the sequence of activities that must be completed on schedule for the entire Work to be completed by the applicable Contract Date for completion of the Work set out in the Contract Schedule. An activity on the critical path cannot be started until its predecessor activity is complete; if it is delayed for a day, the entire Work will be delayed for a day.
"Data"	Shall have the meaning set out in Section 2.5 DATA FOR PROPONENTS of the General Specification.
"Delay Liquidated Damages"	Shall have the meaning set out in Section 3.10 FAILURE TO MEET TURBINE-GENERATOR READY FOR COMMISSIONING DATE of the General Specification.
"Delay Liquidated Damages Cap"	Shall have the meaning set out in Section 3.10 FAILURE TO MEET TURBINE-GENERATOR READY FOR COMMISSIONING DATE of the General Specification.
"Direct Costs"	Means the total of the craft labour, equipment and temporary or permanent materials required to complete any item set out in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE. This shall not include any costs for management, supervision or administration that is included in Item 01 10 05 a) Indirect Costs as set out in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE.
"Early Contractor Involvement Team" or "ECI Team"	Means the collaborative association involving the Purchaser, the Purchaser's Project Designer and the Contractor, and possibly others used for the Project.
"ECI"	Means an early contractor involvement process, which is part of the Purchaser's objective of using a two-phase non-traditional early contractor involvement delivery model in which a general civil contractor, using its knowledge and expertise in construction, participates as part of a three member Early Contractor Involvement Team with the Purchaser and Purchaser's Project Designer in early design refinement, risk mitigation and further development of plans, schedules and documents required for the general civil works package for the Keeyask Generating Station Project, including planning of various Project interfaces and phases.
"ECIS Agreement"	Means the part of the Contract entitled ECIS Obligations Terms and Conditions of Agreement, including Schedules A to C attached thereto, and any ESCA properly issued in relation to the ECIS Obligations as set out therein, and which ECIS Agreement applies only to Schedules A to C attached to the ECIS Obligations Terms and Conditions of Agreement.
"ECIS Deliverables"	Means all plans, schedules, reports and other documentation required by the ECIS Agreement to be prepared by the Contractor and submitted to the Purchaser, as reviewed, approved and accepted by the Purchaser and as attached hereto as Volume 4.

"ECIS Obligations"	Means all various work and services to be done, executed, provided, delivered and/or performed by the Contractor, including all personnel and materials to be furnished and/or supplied by the Contractor, necessary in the performance of all of the Contractor's obligations set out in Schedule A - Contractor's Scope of ECIS Obligations attached to the ECIS Agreement, all in accordance with and subject to the ECIS Agreement.
"Engineer"	Means the person or entity as the case may be, named in the Contract and appointed by the Purchaser to take charge of the Work in accordance with the Contract with all of the duties, responsibilities and authority set out therein. The term "Engineer" means the Engineer or the Engineer's authorized representative(s).
"Environmental Legislation"	Means all environmental protection plans, licences, permits, approvals, authorizations, Laws, policies, rules, orders, directives and guidelines in effect from time to time (including any amendments thereto or replacements thereof) applicable to or concerning the Work, or any part thereof as made by the Purchaser, or by Authorities having jurisdiction over the work and activities of the Purchaser including the Work, or any part thereof.
ESCA	Means a written document with title "Engineering Scope Change Authorization" signed by the Purchaser and issued to the Contractor pursuant to and in accordance with the ECIS Agreement and which the Contractor has by way of signature of the Contractor's authorized representative confirmed its agreement that such ESCA shall form part of the ECIS Obligations. Such ESCA includes any attachments or schedules expressly identified in the ESCA, which define the ECIS Obligations to be performed by the Contractor under such ESCA, and any further terms and conditions which the parties agree shall apply to such ESCA.
"Extra Work Order"	Means the document or documents by which the Contractor is authorized to proceed with Changes where the Change is related to or within the original Contract scope of the Work as specified in such document and in accordance with the terms and conditions set out therein and in the Contract.
"FIDIC Conditions"	Shall have the meaning set out in Section 18 FIDIC LICENCE of the Articles of Agreement.
"Final Accounting"	Shall have the meaning set out in Section 14.1 ACCOUNTING ON FINAL COMPLETION of the Terms and Conditions of Payment.
"Final Completion Certificate"	Means the last Completion Certificate issued by the Engineer in accordance with Section 24.3 TAKING OVER OF THE WORK of the General Specification.
"Final Target Price"	Means the Adjusted Target Price calculated as of the date of the Final Completion Certificate and re-calculated at the date of expiry of the last Warranty Period, as applicable.
"Float"	Means the difference between the scheduled window of time within which the Contractor anticipates performing any specific work activity less the time shown as being required to actually complete that work activity.

"Footprint"	Means the area identified in Appendix C - ENVIRONMENTAL PROTECTION PLAN and set out in the 3D Project Models which outlines the limits of the Site that are available to be disturbed for construction activities. The Footprint includes the following: - Areas Planned to be Disturbed - The Contractor may utilize this area as needed without environmental restriction or conditions - Areas Potentially Disturbed - The Contractor may utilize the area as needed however site specific areas within the limits of Areas Potentially Disturbed must follow the conditions as outlined in the Environmental Protection Plan.
"Four-Week Look-Ahead Schedule"	Shall have the meaning set out in Section 23.3.1 FOUR-WEEK LOOK-AHEAD SCHEDULE of the General Specification.
"GA&O"	Shall have the meaning set out in Section 12 GENERAL ADMINISTRATION AND OVERHEAD (GA&O) of the Terms and Conditions of Payment.
"Gross Negligence"	Means an act, omission or failure to act by a Party that constitutes a marked departure from a standard of conduct of a reasonable person in a like position, and/or a reckless disregard of or wanton indifference to the harmful and foreseeable consequences of such act, omission or failure to act.
"Indirect Damages"	Shall have the meaning set out in Section 30.5 INDIRECT DAMAGES of the General Specification.
"Ineligible Costs"	Shall have the meaning set out in Section 11.14 INELIGIBLE COSTS of the Terms and Conditions of Payment.
"Initial Target Price"	Means **[$to be completed**], as described in Section 5 INITIAL TARGET PRICE of the Terms and Conditions of Payment.
"Initial Target Price Breakdown"	Means the document of the same name set out in the Contractor's Submission Extracts in which the Contractor has set out and extended its Initial Target Price for the Work as identified therein.
"Interim Completion Certificate"	Means a certificate in the form set out in Appendix [●] – INTERIM COMPLETION CERTIFICATE issued by the Engineer under Section 24.1 TAKING OVER OF PART(S) OF THE WORK of the General Specification upon conditions being determined to be suitable for the Contractor to temporarily hand off care and control of partially completed part(s) of the Work to an Other Contractor or the Purchaser for interface work to be performed after which the Contractor resumes care and control of the part of the Work to effect its final completion.
"Issued for Construction Drawings"	Means only those drawings and other documents clearly stamped or marked "Issued for Construction" for purposes of and to be used in the construction of the Work.
"Keeyask Generating Station Project"	Means the part of the Keeyask Project consisting of temporary cofferdams, ice boom, south access road, expansion accommodations for an additional 1500 workers (Main Camp Phase 2), the permanent hydroelectric station and related works, including all dams, dykes, channels, excavation and roads, and transmission lines, all as further described in the Contract.
"Keeyask Infrastructure Project"	Means the part of the Keeyask Project consisting of the infrastructure construction work and services required for the proposed Keeyask

	Generating Station Project including a 25 kilometre two-lane, all-weather gravel road (North Access Road), the Looking Back Creek bridge, the Startup Camp near the junction of PR 280 and the North Access Road, the site preparation and the sewer and water for the Main Camp Phase 1 and Phase 2, the Main Camp Phase 1 and all camp support facilities and equipment.
"Keeyask Project" or "Project"	Means the proposed project that consists of the Keeyask Infrastructure Project and the Keeyask Generating Station Project.
"Key Personnel"	Means those individuals listed as the Construction Management Team Members in the Contractor's Submission Extracts.
"Laws"	Means all federal, provincial and local government district laws, regulations, and by-laws that apply to the performance of the Work or in relation to the Contract, including by-laws, rules, regulations, codes (including building codes), ordinances, judgments, decrees, writs, administrative interpretations, guidelines, policies, injunctions, orders or the like, of any Authority, and the interpretations thereof, applicable to the performance of the Work.
"Material Subcontract"	Shall have the meaning set out in Section 7.8 PROCESS FOR SELECTION OF SUBCONTRACTORS of the General Specification.
"Materials"	Means things of all kinds intended to form or forming part of the Work, including the supply-only materials (if any) and equipment to be supplied by the Contractor under the Contract.
"Monthly Progress Statement"	Means an application made monthly by the Contractor to the Engineer together with all documentation required to substantiate a claim for payment by the Purchaser to the Contractor for Work performed and any other amounts claimed by the Contractor in the period covered by such application for certification by the Engineer in accordance with Section 19 CERTIFICATION OF PAYMENT of the Terms and Conditions of Payment.
"Notice"	Shall have the meaning set out in Section 1.5 COMMUNICATIONS of the General Specification.
"Notice to Proceed"	Means the written authorization entitled Notice to Proceed issued by the Purchaser to the Contractor and signed by the Purchaser's Representative, authorizing and directing the Contractor to proceed with the Phase II Work commencing on the date specified in that written authorization.
"On Site Safety Supervisor"	Means the full-time dedicated representative of the Contractor at the Site with respect to all safety matters appointed pursuant to Section 8.3 DEDICATED ON SITE SAFETY SUPERVISOR of the General Specification.
"Other Contractor"	Means a contractor, consultant or supplier engaged by or through Manitoba Hydro in connection with the Keeyask Project, other than the General Civil Works Contractor and those engaged by or through the General Civil Works Contractor.
"Party" or "Parties"	Means the Purchaser or the Contractor or both, as the context requires.
"Permanent Works"	Means all equipment, systems and structures, and any and all parts of such equipment, systems and structures, to be constructed or provided by the Contractor under the Contract and which remain on Site as part of the completed Work.
"Permit Matrix"	Means the matrix of all permits, licences, approvals and authorizations required from all Authorities for the Project, which matrix is prepared by

	the Contractor as an ECIS Deliverable under the ECIS Agreement, and which includes for each permit the date by which each permit is required and the party responsible for acquiring the permit.
"Phase I"	Means the collaborative detailed design phase of the Project to be performed by the ECI Team with particular scopes of work for the Purchaser's Project Designer as set out in its design services agreement with the Purchaser and for the Contractor as set out in the ECIS Agreement.
"Phase II"	Means the construction phase of the Project to be performed by the Contractor pursuant to the Contract, with involvement of the Purchaser's Project Designer pursuant to its design services agreement with the Purchaser and other suppliers and contractors through other contracts all to be managed by the Purchaser as project manager.
"Phase II Work"	Means all Work required to be performed and provided by the Contractor under the Contract for Phase II.
"Plant"	Means all vehicles, machinery, equipment, including transportation, construction, erection and installation equipment, falsework, forms, scaffolding, cofferdams, crushers, boilers, temporary storehouses and other temporary structures, construction materials, other equipment, power tools, machinery, appliances, apparatus and other things which are brought on or constructed upon the Site by the Contractor or Contractor Parties for use in the performance of the Work, excluding all Materials and any other things intended to form or forming part of the Permanent Works.
"Powerhouse Complex"	Means the overall structure that encompasses the limits of the service bay, intake, powerhouse and tailrace and any transition structures or walls that attach to these main structures.
"Project Comprehensive Schedule"	Means the Purchaser's integrated schedule for the Project, including for the Work and all other work packages, equipment and services procured by the Purchaser as required for completion of the Project in accordance with the Purchaser's schedule requirements.
"Proposal for Extra Work"	Shall have the meaning set out in Section 27.3.1 PROPOSAL FOR EXTRA WORK of the General Specification.
"Purchase Order"	Means the document or documents issued, by the Purchaser, if any, entitled "Purchase Order".
"Purchaser"	Means Manitoba Hydro, its successors and assigns.
"Purchaser's Confidential Information"	Means any and all information disclosed directly or indirectly by the Purchaser to the Contractor in relation to the Work or pursuant to the Contract and shall include, without limitation, all information, in any form or format, not generally known or available to the public, including Request for Proposal 016203, the Contract, Purchaser's Property, Purchaser's Drawings, the 3D Project Models, maps, estimates, financial, technical and business information, proposals, methods, processes and data, testing procedures, reports, study results, evaluation results, computer software and third-party confidential information.
"Purchaser's Drawings"	Shall have the meaning set out in Section 5.4 PURCHASER'S DRAWINGS of the General Specification.
"Purchaser's Equipment"	Means the apparatus, machinery and vehicles (if any) made available by the Purchaser for use of the Contractor in the execution of the Work, as provided in the General Specification.

"Purchaser's Materials"	Means the materials (including all associated small components thereof) provided or made available by the Purchaser to be installed by the Contractor in the performance of the Work as provided for in the General Specification.
"Purchaser's Personnel"	Means the Engineer, the assistants of the Engineer referred to in Section 6.2 DELEGATION BY THE ENGINEER of the General Specification and all other staff, labour and other employees of the Engineer and of the Purchaser; and any other personnel notified to the Contractor, by the Purchaser or the Engineer, as Purchaser's Personnel.
"Purchaser's Property"	Means any and all property, whether real, personal, tangible or intangible, and regardless of medium, form or format, including any information, data, documents, equipment, materials or supplies, provided by the Purchaser to the Contractor, or acquired by the Contractor for or on behalf of the Purchaser or to which access has been given or made available by the Purchaser directly or indirectly, in the course of, or incidental to, the performance of the Work or pursuant to or in relation to the Contract.
"Purchaser's Project Designer"	Means HATCH Ltd. and its successors and assigns.
"Purchaser's Representative"	Means the person named by the Purchaser in the Articles of Agreement or appointed from time to time by the Purchaser under Section 5.6 PURCHASER'S RESPONSIBILITIES of the General Specification, who acts on behalf of the Purchaser.
"QAR" or "Quality Assurance Representative"	Means the person(s), firm(s) or corporation(s) authorized by the Engineer to inspect any part or parts of the Work to be done and/or material to be furnished pursuant to the Contract, acting directly or through its respective properly authorized assistants or agents.
"Schedule Calendar"	Means planned work hours for each calendar day, showing work-specific non-work days for the specified period of the Work, as provided in the Contract Schedule.
"Shared Savings"	Means the amount by which the Final Target Price exceeds the Actual Costs of performance of the Phase II Work.
"Site"	Means the place or places where the Permanent Works are to be installed for the Purchaser, and to which Plant and Materials are to be delivered, as further described in Section 4 SITE LOCATION AND ACCESS of the General Specification.
"Site Indirect Cost Percentage"	Means the agreed upon percentage to be used by the Purchaser and the Contractor when making adjustments to the Adjusted Target Price for additions to or deletions of the Work pursuant to an Extra Work Order or Change Order. For the purposes of the Contract, the Parties agree that the Site Indirect Cost Percentage shall be initially established at the applicable percentage (Contractor's Own Forces or Work to be performed by a Subcontractor) set out in the Contractor's Submission Extracts under the section heading SITE INDIRECTS; provided, however, that either party may seek an adjustment to such established percentages on a case by case, auditable basis, as determined by the Engineer.
"Subcontractor"	Means a person, firm or corporation having a contract with or through the Contractor (including subcontractors, vendors and suppliers of any tier) for part of the Work, including without limitation the furnishing of labour, material, supplies, equipment or apparatus therefor.
"Submission"	Means the Contractor's proposal submitted in response to the Request for

	Proposal 016203 leading up to the Contract.
"Submittal Schedule"	Shall have the meaning set out in Section 3.8 SUBMITTALS of the General Specification.
"Temporary Works"	Means all temporary works, services and facilities of every kind, including cofferdams, constructed on Site only for use in the execution and completion of the Permanent Works and the remedying of defects, thereafter to be removed.
"Time for Completion"	Means the specified time for completing the Work between the Commencement Date and the Completion Date, or where only a specific part of the Work is expressly referred to and the context requires, the time for completing a specific portion of the Work as set out in the Contract Schedule.
"Tools"	Means all small hand tools, including without limitation, picks, shovels, crow bars, sledge hammers, bolt cutters, files, fish tapes, pumps, ropes, ladders, grips and clamps which are brought upon the Site by the Contractor, the Contractor's Personnel or a Subcontractor for the performance of the Work.
"Turbine-Generator Ready for Commissioning"	Shall have the meaning set out in Section 3.10 FAILURE TO MEET TURBINE-GENERATOR READY FOR COMMISSIONING DATE of the General Specification.
"Turbine-Generator Ready for Commissioning Date"	Shall have the meaning set out in Section 3.10 FAILURE TO MEET TURBINE-GENERATOR READY FOR COMMISSIONING DATE of the General Specification.
"Unit Prices"	Means those prices or unit rates as applicable, as set out under the heading of the same name in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE.
"Warranty Period"	Shall have the meaning set out in Section 25.1 WARRANTY PERIOD of the General Specification and includes any extension thereto properly made in accordance with Section 25 WARRANTY of the General Specification.
"Working Day"	Means each day other than a Sunday, statutory holiday or statutory vacation day observed by the construction industry in Manitoba.
"Work"	Means all of the procurement, manufacturing, construction, erection, installation, environmental monitoring, testing, pre-commissioning, commissioning assistance, and all other work to be done, executed and performed and Materials, Plant, Tools, quality control, shop assembly and shop testing, mobilization and demobilization, delivery, installation at the Site, testing and pre-commissioning, training, warranty of workmanship and materials, spare parts if required, Contractor's insurance and all other services and things assigned to, undertaken by or required under the Contract to be provided by the Contractor and/or necessary for the construction of the general civil works for the Keeyask Generating Station Project, including the Temporary Works and Permanent Works, and all Contractor's Documents to be supplied by the Contractor pursuant to the Contract. The Work does not include the ECIS Obligations, which are governed by the ECIS Agreement.

1.2 Interpretation

In the Contract, except where the context requires otherwise:

(a) words indicating one gender include all genders;
(b) words indicating the singular also include the plural and words indicating the plural also include the singular;
(c) Words indicating persons or parties include corporations and other legal entities, except where the context requires otherwise;
(d) provisions including the word “agree”, “agreed” or “agreement” require the agreement to be recorded in writing;
(e) “written” or “in writing” means hand-written, type-written, printed or electronically made, and resulting in a permanent record;
(f) Notwithstanding sub-clause (e) above, written communication, including email communication, will not be a permitted means of communicating instructions or decisions, or creating contractual obligations between the Parties, unless substantiating and properly signed and/or authorized documentation in the form required by the Contract is included in or attached to such written communication;
(g) The marginal words and other headings shall not be taken into consideration in the interpretation of the provisions of the Contract;
(h) all reference to days or weeks in the Contract shall mean calendar days or calendar weeks, as applicable;
(i) defined words and phrases used in the Contract have the meanings ascribed to them in Section 1.1 DEFINITIONS of the General Specification, or as expressly defined elsewhere in the Contract;
(j) Except for those specific and limited parts of the Submission, if any, expressly incorporated by reference into the Contract as part of the Contractor’s Submission Extracts, the Submission is superseded entirely by the Contract and rendered null and void, and shall not be relied upon or used by the Contractor, the Purchaser or anyone else (including any arbitral tribunal or any court) in any way to interpret or qualify the scope of the Work, to interpret or qualify any obligations or liabilities of the Contractor, or to interpret or qualify anything else contained in the Contract;
(k) References to a Section or Paragraph of the Contract or any Appendix thereto followed by a number shall be deemed to be a reference to the whole of the Section or Paragraph of the Contract or Appendix, as applicable, bearing that number, including all subsidiary provisions containing that same number as a prefix;
(l) References containing terms such as:

    i) "by the Contractor" and "by or through the Contractor" and terms of like import are synonymous and mean by the Contractor or by anyone employed by or through the Contractor and for whom the Contractor is responsible, including the Contractor and all Contractor Parties.
    ii) "demonstrate", "demonstrating" and terms of like import when used in reference to an obligation of the Contractor mean that the Contractor shall

demonstrate sufficient to satisfy the Purchaser, acting reasonably, that the requirement to be demonstrated has been satisfied; and

iii) "includes" and "including", whether or not used with the words "without limitation" or "but not limited to", shall not be deemed limited by the specific enumeration of items but shall in all cases be deemed to be without limitation and construed and interpreted to mean "includes without limitation" and "including without limitation";

(m) References to "discretion" and similar terms used in the Contract in relation to the Purchaser mean in the sole and absolute discretion of the Purchaser acting subjectively in the best interest of the Purchaser; and

(n) Whenever the terms "will" or "shall" are used in the Contract in relation to the Contractor they shall be construed and interpreted as synonymous and to read "the Contractor shall".

1.3 Intent

The intent and spirit of the Contract is that the Work therein described or called for shall be fully completed in every detail within the timeframe and for the purpose designated therein by the Purchaser, and the Contractor shall furnish any and everything necessary for such purpose.

The Contractor shall apply to the Engineer for any explanation which the Contractor may require as to the meaning and intent of any unclear or ambiguous provision in the Contract or in any document forming part thereof.

1.4 Applicable Law

The Contract shall be subject to, interpreted, performed, and enforced in accordance with the laws of Manitoba and the applicable laws of Canada without regard to Manitoba or Federal Canadian Law governing conflicts of law, even if one or more of the parties to the Contract may be resident of, or domiciled in another province or country. Subject to Section 33 CLAIMS, DISPUTES AND ARBITRATION of the General Specification, the parties to the Contract hereby irrevocably attorn to the exclusive jurisdiction of the Court of Queen's Bench of Manitoba, Winnipeg Centre.

1.5 Communications

Unless otherwise stated in the Contract, wherever the General Specification provides for the giving or issuing of approvals, certificates, consents, determinations, notices and requests (each, a "**Notice**"), these communications shall be in writing on letterhead and signed by the appropriate signing authority, and delivered by hand (against receipt), sent by mail or courier to the address for the recipient's communications as stated in the Articles of Agreement.

However:

(a) if the recipient gives notice of another address, communications shall thereafter be delivered accordingly; and
(b) if the recipient has not stated otherwise when requesting an approval or consent, it may be sent to the address from which the request was issued.

When a Notice is issued to a Party, by the other Party or the Engineer, a copy shall be sent to the Engineer or the other Party, as the case may be.

1.6 Project Description

The Purchaser is a Crown Corporation and the Province of Manitoba's major energy utility. The majority of electricity is produced by hydroelectric generating stations having a total capacity of approximately 5000 megawatts. In order to continue to provide a highly reliable supply of power at low cost, the Purchaser continuously plans for future sources of generation. More information on the Purchaser including the corporate strategic plan and potential future projects, including the Keeyask Project, can be found on the Purchaser's website at: http://www.hydro.mb.ca/projects/keeyask.

As described in detail below, the Keeyask Project will consist of the proposed hydroelectric generating station and related works, including all Temporary Works and Permanent Works which, if built, will contribute approximately 695 megawatts to the Purchaser's integrated power system for the purpose of sale to Manitoba consumers of electrical energy and export power markets. The general site arrangement and layout for the Keeyask Generating Station is set out in the Drawing List contained in Appendix A – PURCHASER'S DRAWINGS.

On May 29, 2009, Cree Nation Partners (consisting of Tataskweyak Cree Nation and War Lake First Nation), York Factory First Nation, Fox Lake Cree Nation and the Purchaser signed the Joint Keeyask Development Agreement (the "JKDA") regarding potential development of the Keeyask Project. The JKDA sets out the terms and conditions upon which the Keeyask Hydropower Limited Partnership, of which the above parties are limited partners, shall proceed with the development of the Keeyask Project. The JKDA document is available on the Purchaser's website.

The Keeyask Project is comprised of the Keeyask Generating Station Project and the Keeyask Infrastructure Project.

The Keeyask Infrastructure Project has been reviewed and approved by the appropriate federal and provincial Authorities. It includes construction of a 25 kilometre two-lane, all-weather gravel road (North Access Road), the Looking Back Creek bridge, the Start-Up Camp near the junction of PR280 and the North Access Road, the site preparation and the sewer and water for the Main Camp Phase 1 and 2, the Main Camp Phase 1 and all the camp support facilities and equipment. Environmental Act License No. 2952 was received for the Keeyask Infrastructure Project work on March 8, 2011.

The proposed Keeyask Generating Station Project is comprised of the development and construction of the generating station itself including all Temporary Works and

Permanent Works needed for the generation and transmission of electricity as well as additional temporary and permanent infrastructure required to support construction and operation of the generating station. The Keeyask Generating Station Project has not yet received approval from applicable federal and provincial Authorities. Such approvals are anticipated to be received in approximately June, 2014. At the time of signing of the Contract, no final decision has been made by the Purchaser to proceed with the Keeyask Generating Station Project.

The Purchaser is contracted by the Keeyask Hydropower Limited Partnership to act as project manager to complete the planning, design and engineering and to construct and commission the proposed Keeyask Project including the Work. If built, the Keeyask Project will be constructed in a manner similar to other hydroelectric generation projects, pursuant to a variety of large and small contracts. The Purchaser has final decision-making authority with respect to all matters arising out of the award of the Work and the management and oversight of the Work in accordance with the Contract.

1.7 Objectives of the Parties

During the performance of the Work, the primary objectives of the Purchaser and the Contractor are:

(a) to complete the Work, in accordance with the Contract, at or below the Final Target Price;
(b) to raise, address, consider, discuss and resolve issues on a "Best-for-Project" basis, giving as much weight to the interests of each Party to the Contract as to their own self-interest;
(c) to complete the Work in accordance with and by the Contract Dates set out in the Contract Schedule; and
(d) to complete the Contract on or before the Completion Date.

1.8 Behavioural Commitments

The Parties:

(a) acknowledge that a key purpose of the Contract is to avoid disputes and they commit to notify each other in writing of perceived or real differences of opinion or conflicts of interest immediately as they arise and to strive to promptly resolve those differences or conflicts; and
(b) undertake to act reasonably and to do all things properly and reasonably within their power that are necessary to give effect to the spirit and intent of the Contract.

1.9 ECI Principles and Objectives

The Purchaser and the Contractor agree to adhere to principles of cooperation and collaboration during the performance of the Work and pursuant to the Contract. Specifically, the Contractor and Purchaser shall:

(a) collaborate, as part of the ECI Team as defined herein, in the performance of the Work and the Project; and

(b) apply the principles set out herein to the performance of the Work and the Contract.

1.10 Anti-Corruption

(a) The Contractor declares and undertakes that in relation to the Project that:

i) the Contractor has acted, and will continue to act, at all times honestly and fairly;
ii) the Contractor has not acted, and will not act, dishonestly so as to cause loss to the Purchaser or to deprive the Purchaser of its rights;
iii) the Contractor has not offered or given, and will not offer or give, directly or indirectly, any bribe or other improper benefit or advantage to any individual or organization;
iv) the Contractor has not demanded or accepted, and will not demand or accept, directly or indirectly, any bribe or improper benefit or advantage for itself or any individual or organization;
v) except as permitted under any party's gifts and hospitality policy:

(1) the Contractor has not made, and will not make, directly or indirectly, any payment except to the extent that such payment is legitimate compensation for legitimate services;
(2) the Contractor has not received, and will not receive, directly or indirectly, any payment except to the extent that such payment is legitimate compensation for legitimate services;

vi) the Contractor has not provided to any party, and will not provide to any party, any written or oral information which the Contractor knows to be false, inaccurate or misleading, or where the Contractor is wilfully blind or reckless as to whether the information is false, inaccurate or misleading; and
vii) the Contractor has not authorized or acquiesced in or turned a blind eye to, and will not authorize or acquiesce in or turn a blind eye to any Corruption.

(b) The Contractor will ensure that:

i) it and all Contractor Parties comply with the Contractor's commitments under Section 1.10 ANTI-CORRUPTION of the General Specification; and
ii) other organizations with which the Contractor contracts in connection with the Project (including any joint venture partners and any Contractor Parties) provide written commitments to that party which are equivalent to those under Section 1.10 ANTI-CORRUPTION of the General

Specification and shall take commercially reasonable steps to enforce those commitments.

(c) The Contractor represents and warrants that in relation to the Project:

i) the Contractor has not collaborated with, and will not collaborate with, any organization with which the Contractor is competing during any procurement process;
ii) in respect of any design services the Contractor provides, the Contractor will not deliberately, knowingly, with wilful blindness, or recklessly, provide or approve a design or any design variation:

(1) which is in excess of the requirements of the Project or is not otherwise approved by the Purchaser; or
(2) which will provide an improper benefit or advantage to any individual or organization.

(d) The Contractor will not, deliberately, knowingly, with wilful blindness, or recklessly, carry out, instruct, authorize, condone, or be party to:

i) the provision of work, materials, equipment or services which are not of the quality and quantity required under the Contract; or
ii) the concealment of defective work, material, equipment or services.

2 SCOPE OF THE WORK

2.1 General Overview

The description of the Work listed below is provided as a general overview and shall not to limit the Work or any obligation of the Contractor under the Contract. A detailed scope and requirements of the Work are provided in the Technical Specification and the Purchaser's Drawings. The Work and any item forming part of the Work shall also, in all respects, comply with the terms and conditions of the Contract. The Contractor shall perform the work in Phase I and Phase II of the Project as outlined below.

2.1.1 Phase I – Early Contractor Involvement Services Obligations (ECIS Obligations)

(a) ECIS Obligations and ECIS Deliverables – the Contractor shall be required to provide the services, tasks and ECIS Deliverables in accordance with the ECIS Agreement; and

(b) The Purchaser and the Contractor acknowledge that the Contractor's Submission Extracts, including the schedule and the Initial Target Price, are based on the information provided in Request for Proposal 016203 which will be further developed during the course of Phase I and performance of the ECIS Obligations, including performance of those tasks listed in Schedule A - Contractor's Scope of ECIS Obligations attached to the ECIS Agreement. Except for those items listed

in Section 5.3 FIXED TARGET PRICE ASSUMPTIONS of the Terms and Conditions of Payment, it is the intention of the Purchaser and the Contractor that the provisions of Section 27 CLARIFICATIONS AND CHANGES TO THE WORK AND ADJUSTMENTS of the General Specification will apply (including any increases or decreases to the Initial or Adjusted Target Price) as the Purchaser incorporates any changes during Phase I.

2.1.2 Phase II – Construction

The Phase II Work consists of the following main elements which are to be provided by the Contractor:

(a) Infrastructure
- i) Construction and maintenance of certain roads and infrastructure
- ii) Preparation and maintenance of the Contractor's work area
- iii) Development of Contractor's site offices
- iv) Extension of a construction power service from the Purchaser provided locations
- v) Supply and installation of materials test lab
- vi) Rock quarry and impervious material borrow, materials management program
- vii) Handling, transporting and storage of certain of the Purchaser's Materials and Purchaser's Equipment at the Site
- viii) Supplying of certain services to the Purchaser and to the Other Contractors
- ix) Construction and maintenance of the causeways to N-5 and G-3
- x) Demobilization of Contractor's site office, work areas, lab and equipment

(b) River Management
- i) Construction, maintenance and removal of Stage I and Stage II cofferdams and associated dewatering works
- ii) Stage I Cofferdams construction and maintenance for:
  - (1) Quarry Cofferdam
  - (2) North Channel Rock Groin
  - (3) Powerhouse Cofferdam
  - (4) North Channel Cofferdam
  - (5) Island Cofferdam
  - (6) Spillway Cofferdam
  - (7) Central Dam Cofferdam
  - (8) (Central Dam Rock Groin
- iii) Stage II Cofferdams Construction and Maintenance for:
  - (1) Island Cofferdam
  - (2) South Dam Upstream Cofferdam
  - (3) South Dam Downstream Cofferdam
  - (4) Powerhouse Tailrace Summer Level Cofferdam

(c) Powerhouse Complex, Spillway, Dams and Dykes Construction
- i) Excavation of overburden and rock for structures and channels

ii) Foundation preparation for earth dam and dykes and concrete structures
iii) Construction of earthfill dams and dykes
iv) Supply of cement
v) Supply and production of aggregates and rockfill products
vi) Supply and installation of reinforcement steel
vii) Concrete production and construction of concrete structures including supply and installation of the embedded materials
viii) Supply and installation of precast concrete beams and wall panels
ix) Supply and installation of miscellaneous steel such as anchors, highway guardrail, gratings, ladders, handrails, etc.
x) Supply and installation of superstructure steel
xi) Supply and installation of wall cladding, roof decking, roofing and flashing
xii) Supply and installation of station elevators
xiii) Transition structure and wall construction
xiv) Pre-commissioning and commissioning assistance for plant in service

(d) Electrical and Mechanical balance of plant, including, but not limited to:
i) Fire suppression system equipment and piping (including transformer deluge component)
ii) Station domestic water system equipment and piping
iii) Station sanitary sewage system equipment and piping
iv) Station drainage system equipment and piping (including oil/water separation capabilities)
v) Compressed air system equipment and piping
vi) HVAC system equipment and ducting (including controls)
vii) Raceways, tray, conduit, and associated cable/wiring support hardware
viii) Grounding and bonding for electrical and communication systems
ix) MV electrical distribution equipment and cabling
x) LV electrical distribution equipment and cabling
xi) Diesel generator sets and associated equipment
xii) Battery banks and associated equipment
xiii) Lighting system (including controls)
xiv) Communications system equipment and cabling (including data and voice)
xv) Paging system
xvi) Electronic safety and security system (including CCTV and alarm)
xvii) Fire detection and alarm system
xviii) Oil storage and handling systems
xix) Pressure and level instrumentation system
xx) Unit control and monitoring system
xxi) Generator and transformer protection system
xxii) Supply and installation of electrical/mechanical equipment
xxiii) Supply and installation of permanent power and communication lines and appurtenances

2.2 Purchaser's Materials and Purchaser's Equipment supplied by the Purchaser and Installed by the Contractor

The Purchaser's Materials and Purchaser's Equipment listed below are a general overview of the items to be supplied by the Purchaser and installed by the Contractor as part of the Work:

(a) Motor Control Centers
(b) Medium Voltage Station Service Equipment
(c) Generator Circuit Breakers
(d) Isolated Phase Bus
(e) Spillway Standby Power Supply
(f) Black Start Standby Power Supply
(g) 600V Switchgear and Switchboard
(h) Generator/Transformer Protective Relaying Equipment
(i) Unit Control and Monitoring System
(j) Trashracks
(k) Intake Bulkhead Gates
(l) Draft Tube Gates
(m) Spillway Stoplogs

2.3 Materials and Equipment Supplied and Installed by the Purchaser

The Purchaser has identified the materials and equipment below as being supplied and installed by the Purchaser or Other Contractors at the Site and such materials and equipment shall not form part of the Work under the Contract:

(a) Main camp, catering, camp maintenance, first aid and security services
(b) Turbine and generators
(c) Exciters
(d) Governors
(e) Intake gates, guides and hoists
(f) Spillway gates, guides and hoists
(g) Powerhouse crane
(h) Draft tube crane
(i) Spillway stop-log monorail crane
(j) Intake monorail crane
(k) Transmission lines and towers
(l) 138kV disconnects and lightning arrestors
(m) Generator step-up transformers

2.4 Start of Phase II Work

The Phase II Work shall not commence unless and until a Notice to Proceed is issued by the Purchaser to the Contractor in accordance with the Articles of Agreement. If and when such Notice to Proceed is issued, the Contractor shall proceed with the Phase II Work in accordance with the date specified in such Notice.

2.5 Data for Proponents

Appendix D - DATA FOR PROPONENTS has been prepared by the Purchaser as baseline information with respect to the physical, geotechnical, ground, subsurface, hydrological, climatic and other conditions at the Site as of the date of signing of the Contract.

The Data for Proponents is comprised of a detailed summary of physical site investigations of the Site including both data (Volumes 1, 2 and 4, hereinafter the "Data") and the Purchaser's interpretations of such data (Volume 3 – Compendium of Stage IV Design Memoranda, hereinafter "Stage IV Memos"). Any inference made in the Stage IV Memos as to the conditions existing between exploration or observation locations has been based on interpolation and, therefore, is subject to the risk of errors normally associated with such interpolations, interpretation, and calculations. The Stage IV Memos are provided for the Contractor's general information only and the Purchaser shall have no liability or responsibility for the Contractor's use or interpretation thereof. The Contractor shall be responsible for any and all interpretation of the Data. Incorrect interpretations, extrapolations or conclusions drawn by the Contractor with respect to the Data and Stage IV Memos shall not result in an adjustment to the Adjusted Target Price. The Contractor shall only be entitled to an adjustment to the Adjusted Target Price in respect of the Data to the extent permitted under Section 32 CHANGED PHYSICAL CONDITIONS of the General Specification.

3 CONTRACT SCHEDULE

3.1 General Requirements

The Contractor shall plan and schedule the Work and report progress to the Purchaser by providing all schedules using the critical path method. The Contractor shall prepare all schedules using Primavera P6 release 7.0.0 or the latest accepted version of Primavera at the time. The Contractor shall use the "retained logic" scheduling option.

The Contractor has, as part of the Submission, developed a preliminary construction schedule for the Work that matches the structure and format set out in Appendix E - WORK BREAKDOWN STRUCTURE (WBS) and such preliminary construction schedule is included in the Contractor Submission Extracts under the section heading CONSTRUCTION SCHEDULE. This preliminary construction schedule will be further developed by the Contractor as part of its ECIS Obligations for approval by the Purchaser. Once approved, this schedule will become the Contract Schedule for purposes of performance of the Work provided the Notice to Proceed is issued for Phase II to commence on June 27, 2014 as contemplated in the Articles of Agreement. Until the Contract Schedule has been approved by the Purchaser, and subject to any further direction from the Purchaser, the Contractor shall perform the Work in accordance with the preliminary construction schedule included in the Contractor's Submission Extracts under the section heading CONSTRUCTION SCHEDULE, subject to any Changes made in accordance with Section 27 CLARIFICATIONS AND CHANGES TO THE WORK

of the General Specification. The Contract Schedule shall be a complete and logical plan that can be realistically accomplished and used for executing the Work.

The Contract Schedule shall, in sufficient detail to satisfy the Engineer with regard to the planning of the Work:

(a) Include sufficient activities to assure adequate planning for the Work.
(b) Comply with phasing, work constraints and Contract Dates defined in the Contract.
(c) Include all Work, including all work to be performed by Subcontractors.
(d) Include all proposed and approved changes to the Work that impact the Contract Schedule as provided for in Section 27 CLARIFICATIONS AND CHANGES TO THE WORK of the General Specification and identify all key activities that precede and succeed approval of the change to the Work.
(e) Include a clearly defined critical path.
(f) Include a unique Activity ID for each activity (pre-approved by the Purchaser).
(g) Include a clear and unique description for each activity.
(h) Include a duration for each activity, including for the completion of the Cash Allowance Items. Activity durations must represent a reasonable timeframe to effectively complete a single defined task and be no less than 1 day in duration.
(i) Not contain negative Float.
(j) Clearly identify relationships between activities. The use of FF (finish to finish) relationships for predecessors and SS (start to start) relationships for successors in task dependent activities are not preferred relationships. If necessary, an explanation why this logic is required is to be provided under a Primavera P6 activity notebook category called “KGS-Logic”.
(k) Not have any open ended activities. In order to track multiple critical paths, the Contract Schedule can use more than one open ended successor for a milestone activity only. All other activities must have an appropriate predecessor(s) and a successor(s) necessary to execute the Work except the first and last activities.
(l) Not have any constrained activities unless approved by the Engineer. All approved constraints must include an explanation for the use of the constraint under a Primavera P6 activity notebook category called “KGS-Constraints”.
(m) No Float for the Work shall be developed through the manipulations of calendars, extending activities durations, or any other such methodology.
(n) Contain resource loading at every WBS summary at a minimum with key quantities (i.e. concrete, fill and excavation material), person-hours or equipment hours (task dependant) and associated budget.
(o) Incorporate activities that match the Contract Dates set out in Section 3.7 CONTRACT DATES of the General Specification.
(p) Include the activity coding structure provided by the Purchaser.
(q) File names for schedule submittals shall be pre-approved by the Purchaser.
(r) All Schedule Calendars, codes, resources, etc., are to be assigned at the Project level only.
(s) Utilize a unique two digit prefix representing Contractor’s name for each activity ID, code name, Schedule Calendar name, etc., pre-approved by the Purchaser.

(t) Clearly identify and define all interface activities between the Contractor and the Purchaser or Purchaser's Vendors.

(u) Identify all Purchaser, Engineer review/approval activities with a "-MH" activity code suffix. All review/approval activities must be separate and distinct activities. Review/approval response periods/durations to be as specified in the Contract.

(v) Match the Project Comprehensive Schedule WBS at all levels. Additional WBS levels required by the Contractor to effectively plan and implement the Work are to be included under the Project Comprehensive Schedule WBS levels.

(w) Include an explanation for the use of any lag assigned to an activity under a Primavera P6 activity notebook category called "KGS-Lag".

(x) At the discretion of the Contractor, include a "schedule contingency" activity(s) in any required WBS level or contiguous groups of WBS levels. This contingency will be controlled by the Contactor to account for identified schedule risk and will not be defined as Float.

(y) Format all currencies in Canadian (CAD) funds. Decimal symbol is a decimal (.). Positive currency format $1.11. Negative currency format ($1.11). Number of decimal places (2).

These requirements supplement additional schedule reporting requirements in Section 23 CONTRACTOR'S REPORTING of the General Specification.

The Engineer shall have the right to require the Contractor's timely delivery of all schedules in a form and content satisfactory to the Engineer. Notwithstanding any provisions to the contrary in the Contract, this shall be a prerequisite for certification by the Engineer to the Purchaser of payments due to the Contractor pursuant to the Contract. The Engineer shall give the Contractor 30 days prior notice of his intention to implement this condition of the Contract.

3.2 Contract Schedule & Basis of Schedule

As part of the Contractor's ECIS Obligations, the Contractor shall prepare a draft Contract Schedule for the Purchaser's approval that meets all of the dates for contract interface activities as outlined in the preliminary construction schedule included with the Contractor's Submission Extracts under the section heading CONSTRUCTION SCHEDULE. The Contract Schedule is intended to be a more detailed version of the schedule included in the Contractor's Submission Extracts and only changes to Contract Dates approved in accordance with Section 27 CLARIFICATIONS AND CHANGES TO THE WORK or Section 33.1 CONTRACTOR'S CLAIMS of the General Specification shall be permitted to be incorporated into the Contract Schedule developed by the Contractor as part of its ECIS Obligations, provided that, for greater certainty, the Purchaser and the Contractor agree that any delays in the issuance of the Notice to Proceed shall result in corresponding changes to the Contract Schedule determined pursuant to Section 27 CLARIFICATIONS AND CHANGES TO THE WORK or Section 33.1 CONTRACTOR'S CLAIMS of the General Specification. The Contract Schedule shall be submitted in .xer format and meet all the schedule requirements as set forth in this Section 3.2. The Contract Schedule shall be submitted and approved by the Purchaser prior to the start of rock excavation for the spillway. All work undertaken

before the Contract Schedule is approved must be undertaken to meet the dates outlined in the construction schedule included with the Contractor's Submission Extracts under the section heading CONSTRUCTION SCHEDULE.

Once approved, the Contractor shall maintain and display the Contract Schedule in Primavera P6 as the "project baseline" for reporting purposes as per Section 23 CONTRACTOR'S REPORTING of the General Specification.

Before the Contract Schedule is accepted the Contractor must satisfy the Engineer that the proposed Contract Schedule addresses the following items:

(a) Key Interface Dates not covered by contract date set out in Section 3.7 CONTRACT DATES of the General Specification.
(b) Contract Dates
(c) Critical Path including a narrative describing the reasons for sequencing the work in the chosen manner (timing of seasonal work, sequencing of clearing and earthworks, river management, etc.)
(d) Risks and Opportunities
(e) Assumptions
(f) Exclusions
(g) Exceptions
(h) Float
(i) Lag
(j) List and Description of all Activity Codes and Resource Codes
(k) List and Description of all Calendars

3.3 Monitoring

The Contract Schedule developed by the Contractor as part of its ECIS Obligations and approved by the Purchaser, including any revisions or amendments thereto that are made in accordance with the General Specification, shall govern the performance and delivery of the Work.

The Contractor shall be required to deliver the Work by the corresponding applicable dates set out in the approved Contract Schedule. The Contract Schedule will be used to monitor the Contractor's progress during the course of the Work. On a weekly basis, through to the submission of the final Completion Certificate, the Contractor shall submit an .xer copy of the complete Contract Schedule updated showing current progress and forecast to complete for all activities compared against the Primavera P6 "project baseline" and the previously submitted progress update (maintained and displayed in Primavera P6 as the "primary baseline") with a filter to show only activities to display a four week look ahead schedule ("Four-Week Look-Ahead Schedule"). Resource loading does not have to be updated with actual information. With this submission, the Contractor must include a narrative report summarizing the deviations from the Contract Schedule from the previous week's update as per Section 23.3 CONTRACTOR REPORTING REQUIREMENTS of the General Specification. The narrative report must also identify all activity and activity relationship deletions, changes to existing activity ID numbers and any modifications (adds, deletions, relocations) to the Contract Schedule WBS.

The Engineer will notify the Contractor and shall review with the Contractor the effect of any changes in other aspects of the Project which may affect the Contract Schedule. The Contractor shall use all reasonable efforts to accommodate changes in the Project Comprehensive Schedule without delay to the Work, subject to Section 27 CLARIFICATIONS AND CHANGES TO THE WORK of the General Specification.

The Contract Schedule shall not be modified, altered or revised except in accordance with the Contract, which modifications, alterations and revisions shall be set out in writing in accordance with Section 27 CLARIFICATIONS AND CHANGES TO THE WORK of the General Specification.

The Engineer's acceptance of any baseline, updated or revised Contract Schedule does not modify any other provision of the Contract or constitute endorsement or validation by the Engineer of the Contractor's logic, activity durations, or assumptions in creating such schedule, or any waiver of or agreement by the Engineer or the Purchaser to change the Completion Date required to be met under the Contract. The Contractor shall monitor the progress of the Work against the Contract Schedule and notify the Engineer in writing immediately upon becoming aware of any potential delays or factors that could cause a delay in achieving the Contract Dates, as well as the remedial steps the Contractor is taking or intends to take to remedy the delays caused by the Contractor or any Contractor Parties. If errors are discovered by the Contractor or the Engineer, the party discovering the error shall notify the other party and the Purchaser of such errors and the Contractor shall correct the errors, as approved by the Engineer, in its next schedule submission.

If, at any time during the course of the Work, the rate of work and/or achieved progress are, in the opinion of the Engineer, less than is required to enable the Contractor to complete the Work or any part(s) thereof by the agreed--upon scheduled time as set out in the Contract Schedule, the Engineer may order the Contractor to submit within seven (7) days, in the form required by the Engineer, its mitigation plan to recover schedule and the Contractor shall submit its mitigation plan to the Engineer within the aforesaid time period.

3.4 Contract Schedule and Float

The Contractor shall ensure its coding system is compatible with the Purchaser's Project Comprehensive Schedule reporting system.

The Contact Schedule shall clearly show when the Contractor plans to perform each activity and shall disclose the scheduled Float.

With respect to a particular activity, and unless otherwise agreed between the Parties on a Best-for-Project basis, the maximum permissible depletion of Float time shall be the maximum time period for actually performing the work activity or chain of activities set out in the Contract Schedule.

With respect to the overall Float for the Project (not limited to a specific activity), where the Engineer is satisfied that circumstances warrant on a Best-for-Project basis, the

Engineer may authorize the Contractor to deplete additional amounts of the Float time or may reduce the length of Float time remaining in the Contract Schedule for any aspect of the Work.

If, after taking into account the maximum authorized use of Float time, an activity or other chains of activities is behind on the Contract Schedule, the Contractor shall take whatever action is necessary to regain lost time.

Any Float that is identified in the Contract Schedule shall be owned by the Purchaser and used at its discretion.

3.5 Final As-Built Schedule

Within 30 days of receipt of the Final Completion Certificate, the Contractor shall deliver a final update to the Contract Schedule through the Engineer, to the Purchaser, showing the actual start and finish date for each activity identified in it.

3.6 Schedule Dates

The Purchaser will receive authorization from the Department of Fisheries and Oceans Canada (DFO) to carry out in-stream work between July 16 and August 31 of any given year. The Purchaser recognizes that in-stream work will be required outside of this period in order to achieve the Contract Schedule but the Contractor shall require the Purchaser's approval in the event the Contractor desires to do so. It is known that the period from May 15 to July 15 is a critical fish spawning window and the Contractor shall not propose any in-stream work during this period.

The Purchaser will secure approval from DFO to carry out all in-stream work according to the Contract Schedule (given that the Contract Schedule does not include in-stream work between May 15 and July 15 of any given year). The Contractor will be required to cooperate and work closely with the Purchaser and Engineer with respect to this issue. All in-stream work must be performed in accordance with the *Fisheries Act* Authorization and Appendix C - ENVIRONMENTAL PROTECTION PLAN.

3.7 Contract Dates

The Contractor shall plan, schedule, perform and complete the Work and the applicable milestones on or before the applicable Contract Dates set forth in the table below or as same may be amended/changed pursuant to the Contract.

The milestones and related Contract Dates set forth in the table below are based on the Project Comprehensive Schedule. The Contract Dates shall be incorporated in and form part of the approved Contract Schedule.

No less than 90 days prior to a scheduled Contract Date (or in the case of the Turbine-Generator Ready for Commissioning milestones, no less than 180 days prior to the applicable scheduled Turbine-Generator Ready for Commissioning Date), the Purchaser and the Contractor shall meet and work collaboratively and in good faith in an effort to

develop an agreed set of criteria which will be used to evaluate the completion of each milestone of the Work in the table below. In the event that the Purchaser and Contractor are unable to agree on the evaluation criteria for a particular milestone 30 days prior to the scheduled Contract Date (or in the case of the Turbine-Generator Ready for Commissioning milestones, 60 days prior to the applicable scheduled Turbine-Generator Ready for Commissioning Date), such criteria shall be established by the Engineer. In the event that either Party disputes the determination of the Engineer, such Party may refer the matter to be determined in accordance with Section 33 CLAIMS, DISPUTES AND ARBITRATION of the General Specification.

With the exception of the Turbine-Generator Ready for Commissioning milestones (in respect of which Section 3.10 FAILURE TO MEET TURBINE-GENERATOR READY FOR COMMISSIONING DATE of the General Specification shall apply), in the event the Contractor fails to complete a Work milestone in accordance with the applicable Contract Dates below, but only to the extent that any such failure is caused by or attributable to the acts or omissions of the Contractor or any Contractor Party, and without prejudice to any of the Purchaser's rights and remedies under Section 29 DEFAULT AND TERMINATION of the General Specification, the Contractor shall be liable to the Purchaser for any direct damages suffered by the Purchaser as a result of the substantiated delay and/or interference claims from Other Contractors up to a maximum of $250,000 per missed Contract Date.

Item	**Milestone**	**Contract Date**
1	Mobilization to Site no earlier than:	June 27, 2014
2	Draft tube form drawings complete and approved by Engineer.	**[Insert Date]**
3	All Plant required for concrete production installed, tested, accepted by the Engineer and ready for use.	**[Insert Date]**
4	All Work complete and ready to start removal of the spillway cofferdam (begin Stage 2 river management).	**[Insert Date]**
5	Service bay sufficiently advanced to permit the installation of the powerhouse crane (superstructure steel installed and anchor bolts post tensioned, crane rail installed and runway beam aligned).	**[Insert Date]**
6	Powerhouse Complex superstructure, roof and cladding complete: a) Service Bay b) Unit 1 c) Unit 2 d) Unit 3 e) Unit 4 f) Unit 5 g) Unit 6 h) Unit 7	**[Insert Dates for each of Items a) through h)]**
7	Powerhouse concrete ready to begin the installation of	**[Insert Dates**

Item	Milestone	Contract Date
	the draft tube liner and all work complete (including powerhouse roof decking) to permit the use of the Powerhouse Crane: a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4 e) Unit 5 f) Unit 6 g) Unit 7	**for each of Items a) through g)]**
8	Powerhouse concrete ready to begin the installation of the stay ring: a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4 e) Unit 5 f) Unit 6 g) Unit 7	**[Insert Dates for each of Items a) through g)]**
9	Spillway concrete complete, including all concrete finishing and all construction equipment/debris removed to allow for the installation of the guides by others.	**[Insert Dates for each of Items a) through g)]**
10	Powerhouse concrete ready to begin the installation of turbine non-embedded parts: a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4 e) Unit 5 f) Unit 6 g) Unit 7	**[Insert Date]**
11	Intake concrete complete, including all concrete finishing and all construction equipment/debris removed to allow for the installation of the guides by others.	**[Insert Date]**
12	Intake concrete, superstructure steel, cladding and roofing complete on all seven units to allow for the installation of the intake monorail.	**[Insert Date]**
13	All Work completed to permit installation of generator step-up transformers on tailrace deck.	**[Insert Date]**
14	All Work completed to permit impounding to el 158.0 m (FSL = 159.0 m – 1.0 m) including the construction	**[Insert Date]**

Item	Milestone	Contract Date
	of the North and South Dykes, Central and South Dams, transition, walls and access ramps.	
15	All Work completed to permit breaching of the cofferdams and flooding of the Intake approach channel.	**[Insert Date]**
16	All Work completed to permit breaching of the cofferdams and flooding of the tailrace cofferdam channel.	**[Insert Date]**
17	All Work complete to permit the start of final commissioning of the turbine-generator units as signified by the issuance of a Completion Certificate on a per unit basis: a) Unit 1 b) Unit 2 c) Unit 3 d) Unit 4 e) Unit 5 f) Unit 6 g) Unit 7	**[Insert Dates for each of Items a) through g)]**
18	Work completed in all respects as signified by the issuance of the Final Completion Certificate.	**[Insert Date]**

NOTES:

1. The Purchaser reserves the right to delay one or more of the above Contract Dates by issuing an Extra Work Order amending the Contract Dates above to suit the actual progress of the Project site construction. Upon amendment, the remaining Contract Dates in the Contract Schedule shall also change to maintain the intended durations between tasks.

   Any claims the Contractor may have in relation to amendments to such Contract Dates by the Purchaser shall be dealt with in accordance with Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification.

2. Any Contract Dates that fall over a Christmas break have already been adjusted to allow for a work stoppage during this time period as set out in the Contract Schedule.

[NTD: The Purchaser will be introducing a bonus pool of $50,000,000 to be earned in small regular intervals tied to leading indicators of project success such as meeting scheduled concrete placement, quality, safety and environmental performance, reporting and retaining the project management team, etc. These details will be established during ECIS. The Contractor's Fee plus any paid bonus will set the Contractor's limit of exposure for cost overruns, Direct Damages and

Delay Liquidated Damage. The bonus will be returned to the Purchaser at a 1:1 ratio for any cost overruns. This repayment is in addition to all other conditions in Section 9.5 of the Terms and Conditions of Payment.]

3.8 Submittals

As part of the ECIS Obligations, the Contractor shall develop a design submission and submittal schedule that identifies all submittals required to be submitted by the Contractor and/or the Purchaser or the Purchaser's Project Designer during the performance of the Work, and which Submittal Schedule shall be subject to prior review and approval of the Purchaser (once approved, the "Submittal Schedule"). This includes but is not limited to all inspection and testing plans, work plans, product cut sheets, shop drawings, work methods and procedures, design submission requirements and dates and other information. Each submittal will be tied to an activity or activities in the Contract Schedule. The Contractor and Purchaser shall deliver all items identified in the Submittal Schedule by the corresponding dates identified therein unless otherwise agreed in advance by the impacted party.

3.9 Adjustment to Contract Dates or Completion Date

The Contractor may perform the Work associated with Contract Dates ahead of the time fixed with the consent of the Engineer, which consent is not to be unreasonably withheld, however there shall be no variation or adjustment to extend the Contractor's time for performance of any Contract Date included in the Contract Schedule except as permitted to be made in accordance with applicable terms and conditions of the Contract.

In the event that an adjustment or change made by the Purchaser impacts the Critical Path by advancing or extending the Contract Dates, an appropriate adjustment to the Contract Dates and/or Completion Date in the Contract Schedule shall be made and documented in an Extra Work Order or Change Order.

3.10 Failure to meet Turbine-Generator Ready for Commissioning Date

The Contractor acknowledges that in the event of any failure by it to complete all Work so as to permit the start of final commissioning of any of the turbine-generator units ("Turbine-Generator Ready for Commissioning") on or before the applicable Contract Date for each unit described above in Item 17 of Section 3.7 CONTRACT DATES (the "Turbine-Generator Ready for Commissioning Date"), such failure will directly cause substantial damage to the Purchaser which damage cannot be ascertained with reasonable certainty. Accordingly, if the Contractor fails to achieve Turbine-Generator Ready for Commissioning for any unit by the applicable Turbine-Generator Ready for Commissioning Date, but only to the extent that any such failure is caused by or attributable to the acts or omissions of the Contractor or any Contractor Party, then the Contractor shall pay to the Purchaser, as a genuine pre-estimate of the Purchaser's damages and not as a penalty, an amount equal to one hundred thousand dollars ($100,000) per day per unit for failing to achieve Turbine-Generator Ready for Commissioning in respect of such turbine-generator unit by the applicable Turbine-

Generator Ready for Commissioning Date, for every day or part of a day after the Turbine-Generator Ready for Commissioning Date until the Contractor achieves Turbine-Generator Ready for Commissioning in respect of such unit (the "Delay Liquidated Damages"). The maximum liability of the Contractor to the Purchaser in respect of Delay Liquidated Damages in respect of all 7 turbine-generator units shall, in no event, exceed an amount equal to the Contractor's Profit Percentage on the Adjusted Target Price at the date of such claims plus any bonus paid to the Contractor ("Delay Liquidated Damages Cap"). Subject to the Purchaser's rights and remedies pursuant to Section 3.7 CONTRACT DATES and Section 29.2 TERMINATION BY PURCHASER and the Contractor's obligation to complete the Work, the Delay Liquidated Damages shall be the Purchaser's exclusive remedy in respect of delays by the Contractor in achieving Turbine-Generator Ready for Commissioning by the Turbine-Generator Ready for Commissioning Date.

4 SITE LOCATION AND ACCESS

4.1 Site Location

The Site of the Keeyask Project is located in northern Manitoba on the Nelson River, at the base of Gull Rapids, approximately 4 kilometres upstream of Stephens Lake, 185 kilometres northeast of Thompson, Manitoba.

The Site is accessible by road from Thompson and approximately 210 kilometres in distance. This consists of approximately 185 kilometres on Provincial Highway No. 280 and 25 kilometres (southeast) on the Purchaser's North Access Road. Thompson is 766 kilometres from Winnipeg on paved Provincial Trunk Highway No. 6.

4.2 Site Access

The Contractor shall transport all Work and all parts thereof to the Site to meet the applicable dates for such deliveries in the Contract Schedule within existing transportation limitations.

It will be the Contractor's responsibility to comply with all regulations, load restrictions and obtain and comply with all permits required for transportation**.**

5 THE PURCHASER

5.1 Right of Access to the Site

Subject to Section 7.42 CONTRACTOR'S WORKING AREAS of the General Specification, the Purchaser shall give the Contractor right of access to all parts of the Footprint, required by the Contractor for the performance of the Work, for the duration of the performance of the Work, including during the Warranty Period. The right of access may not be exclusive to the Contractor and the Purchaser reserves the right to limit or exclude the Contractor's access to certain portions of the Site from time to time provided

that if this right is exercised for reasons not the result of any default by the Contractor and if the Contractor is delayed or inevitably incurs increased costs of the Work to the extent attributable to such restriction on access then the provisions of Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification shall apply to such delays.

If, under the Contract, the Purchaser is required to give to the Contractor possession of any foundation, structure, plant or means of access, the Purchaser shall do so in the time and manner stated in the Contract. If no such time is stated in the Contract, the Purchaser shall give the Contractor right of access to the Site within such times as may be required to enable the Contractor to proceed in accordance with the Contract Schedule.

5.2 Permits, Licences or Approvals for the Project

The Purchaser will apply for and obtain only the following permits, licences and authorizations necessary for the Project to proceed as required by applicable Laws:

(a) Federal
  i) *Fisheries Act* Authorization
  ii) *Navigable Waters Protection Act* Approval
(b) Provincial
  i) Crown Lands Work Permit
  ii) *Environment Act* Licence
  iii) Quarry Lease Permits
  iv) *Water Power Act* Licence

The Contractor shall obtain all other permits required to undertake the Work, including those identified in the Permit Matrix as outlined in the ECIS Obligations.

5.3 Purchaser's Representations and Warranties

The Purchaser represents and warrants to the Contractor that:

(a) it is duly organized, validly existing and capable of entering into the Contract;
(b) except as expressly set out in the Contract, it has obtained all governmental consents, ministerial orders and other legislated permissions necessary to allow it to enter into the Contract and proceed with the Project;
(c) it has taken all due corporate action required to have authorized the execution and delivery of the Contract; and
(d) it has the financial resources available to pay the Contractor as and when payments are due in accordance with the Contract.

5.4 Purchaser's Drawings

The Purchaser has and will produce an electronic set of drawings for the Contractor's use in the performance of the Work, but not drawings for parts of the Work, if any, the design of which is expressly made the responsibility of the Contractor under the Contract and for which the Contractor is solely responsible

Issued for Proposal Purchaser's Drawings and Issued for Reference Purchaser's Drawings are set out in Appendix A - PURCHASER'S DRAWINGS and are intended for the purposes of illustrating part of the scope and the nature of the Work. Issued for Proposal Drawings and Issued for Reference Drawings shall not be used for construction unless and until specifically re-issued for that purpose after execution of the Contract and clearly stamped or otherwise marked as an Issued for Construction Drawing.

The Purchaser's Issued for Construction Drawings shall be issued to the Contractor prior to or on the dates specified in the Submittal Schedule, as approved by the Purchaser, that is to be prepared as part of the Contractor's ECIS Obligations. Only Issued for Construction Drawings shall be used by the Contractor in the performance and construction of the Work.

Issued for Proposal Drawings, Issued for Reference Drawings and Issued for Construction Drawings shall be hereinafter referred to collectively as "Purchaser's Drawings". Whenever reference is made to "Purchaser's Drawings" in the Technical Specification in relation to the Work, it shall mean Purchaser's Issued for Construction Drawings.

The Purchaser has provided the Contractor with the 3D Project Models for the Contractor's information and to assist in visualization in the performance of the Work. The 3D Project Models have been created as i-models in Bentley Navigator V8i and will be issued in the "i.dgn" format. The Contractor will be responsible for procuring any software required to manipulate and define features from the 3D Project Models. The 3D Project Models will be updated during the performance of the Work and such updates shall be provided to the Contractor as and when they become available.

The Work shall be executed in strict conformity with the Purchaser's Drawings and the Contract. The Contractor shall do no Work without proper regard to the Purchaser's Drawings, the Contract and the Engineer's instructions. The Purchaser shall furnish the Contractor an electronic copy in .PDF format of all Purchaser's Drawings and the Contractor shall be responsible for any additional paper or electronic copies necessary to carry out the Work.

The Contractor shall be governed by figured dimensions, as given on the Purchaser Drawings. Purchaser Drawings shall not be scaled by the Contractor. Where required dimensions are not shown in figures, the Contractor shall obtain such dimensions from the Engineer before proceeding with the construction of the portion of the Work to which they refer.

The Purchaser's Drawings and the Contract are intended to complement each other, so that if anything is shown on the Purchaser's Drawings but not mentioned in the Contract, or vice versa, it shall be of like effect as if shown or mentioned in both. If any errors, omissions or discrepancies are discovered in the figures, drawings or the Contract, or if any feature of the figures, drawings or the Contract shall appear to the Contractor to be indefinite or unclear, the same shall be referred to the Engineer whose written confirmation, correction or explanation shall be obtained before proceeding with the

Work. If the Purchaser's Drawings conflict with the Contract in any particular, the Contractor shall apply to the Engineer for an explanation. The Engineer's explanation will be provided to the Contractor via a Work Instruction.

The Contractor, who has represented to the Purchaser that through the Contractor's extensive experience in the construction of comparable projects, the Contractor is familiar with the number, type and content of additional Purchaser's Drawings that will be reasonably required to complete the Project and with the number and type of changes that will be reasonably required to existing Purchaser's Drawings, and on which representations the Contractor acknowledges the Purchaser relied in awarding the Contract to the Contractor. Accordingly, there shall be no adjustment to the Adjusted Target Price or Contract Schedule unless additional Purchaser's Drawings or the number and type of Changes to Purchaser's Drawings are material and more than could reasonably have been expected by a leading international construction contractor with comparable experience in the construction of hydroelectric projects in remote locations.

The Contractor represents that the Contract Schedule includes a reasonable allowance for additional Purchaser's Drawings and reasonably anticipated Changes to Purchaser's Drawings that are required to complete the Project.

5.5 Purchaser's Responsibilities

The Purchaser, as the project manager for the Project on behalf of the Keeyask Hydropower Limited Partnership, will be responsible for overall project management and will be ultimately responsible for the Project site as prime contractor under *The Workplace Safety and Health Act* (Manitoba). The Purchaser will employ staff to monitor construction activities and progress, to monitor the Contractor's quality management program, to coordinate interfaces between various work packages, to coordinate the interfaces between the Contractor and the Purchaser's Project Designer, to manage change, to manage the Project Comprehensive Schedule, to monitor overall Project progress and to ensure compliance with the safety and environmental programs for the Project.

5.6 Purchaser's Representative

The Purchaser appoints as the Purchaser's Representative the person named in the Articles of Agreement and gives him all authority necessary to act on the Purchaser's behalf under the Contract and during the performance of the Work, including to administer the Contract and monitor the due and proper carrying out of the Work on Site.

The Purchaser's Representative may delegate any powers, functions and authority to any competent person, and may at any time revoke the delegation. Any delegation shall be of effect only to the extent and within the powers, functions and authority expressly delegated to them. Delegation or revocation shall not take effect until the Contractor has received prior notice signed by the Purchaser's Representative, naming the person and specifying the powers, functions and authority (and any limits thereon) being delegated or revoked.

6 THE ENGINEER

6.1 Engineer's Duties and Authority

The Purchaser shall appoint the Engineer who shall carry out the duties assigned to him in the Contract in an impartial manner. The Engineer's staff shall include suitably qualified engineers and other professionals who are competent to carry out these duties, but who shall not be authorized to exercise any authority of the Engineer except to the extent the Contractor is notified by Engineer in writing that actual authority is expressly delegated to them pursuant to Section 6.2 DELEGATION BY THE ENGINEER of the General Specification.

The Engineer has no authority to amend the Contract. The Contractor acknowledges and agrees that the Engineer is an employee of the Purchaser. The Engineer may exercise the authority that is attributable to the Engineer and expressed in or implied from the Contract. Whenever the Engineer exercises an express authority for which the Purchaser's approval is required, the Purchaser shall be deemed to have given its approval.

Except as otherwise expressly stated in the Contract, including the Contractor's right to claim under Section 6.4 EFFECTS OF INSTRUCTIONS or Section 33 CLAIMS, DISPUTES AND ARBITRATION of the General Specification, the Engineer's decision shall govern in the first instance the interpretation of the Contract and anything arising out of the observance or performance or non-observance or non-performance of any of the provisions of the Contract, and he shall be the judge in the first instance of the quality, quantity, suitability and efficiency of labour, the workmanship, Materials, Plant, apparatus, equipment, and appliances and methods used, furnished or supplied by the Contractor pursuant to the Contract.

Except as otherwise expressly stated in the Contract:

(a) whenever carrying out duties or exercising authority, expressed in or implied from the Contract, the Engineer shall be deemed to act for the Purchaser;
(b) the Engineer has no authority to relieve either Party of any duties, obligations or responsibilities under the Contract; and
(c) any approval, acceptance, check, certificate, consent, examination, inspection, instruction, notice, proposal, request, test, or similar act by the Engineer (including absence of disapproval) shall not relieve the Contractor from any responsibility it has under the Contract, including responsibility for errors, omissions, discrepancies and non-compliances caused by the Contractor or any Contractor Parties.

6.2 Delegation by the Engineer

The Engineer may from time to time assign duties and delegate authority to assistants, and may also revoke such assignment or delegation. The Engineer will give both the Purchaser and the Contractor written notice of such assignment, delegation or revocation

which shall be effective as of the date specified in such notice. However, unless otherwise agreed by both Parties, the Engineer shall not delegate the authority to determine any matter in accordance with Section 33.2.2 DETERMINATION OF CLAIM of the General Specification.

Each assistant to whom duties have been assigned or authority has been delegated shall only be authorized to issue instructions to the Contractor to the extent defined in the delegation. Any approval, check, certificate, consent, examination, inspection, instruction, notice, proposal, request, test, or similar act by an assistant, in accordance with the delegation, shall have the same effect as though the act had been an act of the Engineer; provided however:

(a) any failure to disapprove any Work, Plant, equipment or materials shall not constitute approval, and shall therefore not prejudice the right of the Engineer to reject the Work, Plant, equipment or materials as provided for pursuant to the Contract; and
(b) if the Contractor questions any determination or instruction of an assistant, the Contractor may refer the matter to the Engineer, who shall confirm, reverse or vary the determination or instruction.

6.3 Replacement

The Purchaser, may, with written notice to the Contractor, replace the Engineer.

6.4 Effect of Instructions

The Contractor shall only take instructions from the Engineer, or from an assistant to whom the appropriate authority has been delegated under this Section 6.4. The Contractor shall comply with any approval, acceptance, check, certificate, consent, examination, inspection, instruction, directive, determination, notice, proposal, request, test, or similar act based on the Engineer's opinion or otherwise and given by the Engineer or its delegated assistant, on any matter related to the Contract unless and until revised pursuant to Section 33.1 CONTRACTOR'S CLAIMS, Section 33.3 PURCHASER'S CLAIMS or Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification. The Engineer will issue all instructions in writing and if applicable, using the forms designated in the Contract.

7 THE CONTRACTOR

7.1 Contractor's Performance, Representations and Warranties

The Contractor shall commence the ECIS Obligations immediately upon signing of the Contract or as otherwise directed by the Purchaser and shall commence the Phase II Work immediately upon receipt of a Notice to Proceed from the Purchaser in accordance with the dates set out therein, and shall fully and completely perform the Work in every detail by the Contract Dates and the Completion Date. The Contractor shall do or cause to

be done and shall furnish any and everything necessary for such purpose(s), all in accordance with the Contract. The Contractor shall fully and completely perform all of its covenants and obligations in, from and in respect of the Contract.

The Contractor represents and warrants that it:

(a) understands the Purchaser's requirements under the Contract, failing which it will promptly give written notice to the contrary to the Engineer;
(b) possesses the expertise, skills, personnel, equipment, materials, financial resources and borrowing capacity to properly perform the Contract and the Work;
(c) shall perform the Work in accordance with and in the manner specified in the Contract and in a good and workmanlike manner; and
(d) has the full power, right and proper authority to execute the Contract and deliver the Work.

The Contractor acknowledges and agrees that the Purchaser has entered into the Contract in reliance upon the representations and warranties contained in the Contract and that each said representation and warranty by the Contractor together with all other provisions of the Contract necessary to give effect thereto shall survive the execution of the Contract by the parties and the expiry or termination of all or any part of the Contract and the provision of some or all of the Work hereunder.

7.2 Contractor's Verification of Relevant Site Conditions

Prior to the signing of the Contract, the Purchaser has made all reasonable efforts to make available to the Contractor for its information as set out in the Contract all relevant data in the Purchaser's possession on sub-surface and hydrological conditions at the Site, including environmental aspects as set out in Appendix D - DATA FOR PROPONENTS. The Purchaser shall similarly make all reasonable efforts to available to the Contractor all such data which comes into the Purchaser's possession after the signing of the Contract. The Contractor shall be responsible for interpreting all such data.

The Contractor acknowledges and agrees that in proposing to do the Work and prior to executing the Contract, the Contractor has, to the extent possible based on the information provided by the Purchaser in the Data for Proponents and the Contractor's visual site investigations, satisfied itself as an experienced and knowledgeable construction contractor as to all relevant matters pertaining to its performance of the Work, including (without limitation):

(a) having investigated and made an examination of the Site and access to the Site;
(b) having obtained and reviewed all necessary information, including the Data for Proponents, satisfied itself as to the nature, extent and character of the Work to be done and the obstacles or difficulties that may be encountered and the risks associated therewith disclosed by such information;
(c) the form and nature of the Site, including subsurface conditions, hydrological conditions and climatic conditions as disclosed by such information, including the Data for Proponents;

(d) the Laws as they pertain to the Contract and the performance of the Work;
(e) the Plant and Materials necessary for the execution and completion of the Work and the remedying of defects;
(f) the Contractor's requirements for access, accommodation, facilities, personnel, power, transport, water and other services;
(g) the working conditions, local business and labour requirements and agreements, local labour supply and all other general and local conditions relevant to performance of the Contract; and
(h) any other matters and things necessary to a proper understanding of the Work, the Site and the conditions under which the Contract and/or the Work will be performed.

7.3 Observance of Laws and Regulations

The Contractor shall comply with all Laws, including Environmental Legislation relating to the Contract and/or the Work which are lawfully imposed by any Authority.

Until the Work shall have been fully completed and accepted by the Purchaser as confirmed by the Final Completion Certificate, the Contractor shall be liable for the due and proper observance, both by itself, and by the Contractor Parties, of all Laws, including Environmental Legislation in any way affecting or relating to the Work.

The Contractor shall fully indemnify and save harmless the Purchaser from and against any and all losses, costs, damages, expenses, suits, claims and demands which the Purchaser may suffer or be put to, or which may be brought or made against the Purchaser, as a result of the breach or non observance of all or any of such Laws, including Environmental Legislation, by the Contractor or the Contractor Parties.

7.4 Permits, Licences and Approvals for the Work

Other than as specified to be obtained by the Purchaser pursuant to Section 5.2 PERMIT, LICENCES OR APPROVALS FOR THE PROJECT of the General Specification, the Contractor will obtain any and all other permits, licences, and/or authorizations necessary for the performance of the Work as required by Laws. The Contractor shall develop a Permit Matrix as part of its ECIS Obligations and upon approval by the Purchaser, such Permit Matrix shall be incorporated by reference into the Contractor's Submission Extracts and thereafter form part of the Contract.

The Contractor shall regularly review and update the Permit Matrix as required to ensure that it is comprehensive and identifies and includes all permits, licences, approvals and authorizations required for the Project from all applicable Authorities and required under all applicable Laws, including any such new permits, licences, approvals and authorizations that may result from changes in Laws or requirements of Authorities after the date of signing of the Contract.

7.5 Conflict of Interest

For the entire duration of the Contract, the Contractor and the Contractor Parties shall not provide personnel, equipment or services to any other persons or entities in a manner which conflicts with the Contract, including but not limited to, the complete and timely performance of the Work.

Except as specifically disclosed in the Contractor's Submission Extracts under the section heading CONFLICT OF INTEREST DECLARATION/DISCLOSURE, the Contractor shall not have any Conflict of Interest (as such term is defined therein) in relation to the performance of the Work. The Contractor shall advise the Purchaser in writing of any actual or anticipated Conflict of Interest as soon as becoming aware of same.

7.6 Contractor's Representative

The Contractor appoints the Contractor's Representative named in the Articles of Agreement and gives him all authority necessary to act on the Contractor's behalf under the Contract and during the performance of the Work and to supervise the due and proper carrying out of the Work on Site.

The Contractor's Representative shall not be transferred from such Work before its completion without the written authorization of the Purchaser. Any proposed replacement personnel for such position or for any other member of the Contractor's project management team shall require the prior written approval of the Purchaser prior to such individual commencing any duties or Work at the Site or under the Contract which approval shall not be unreasonably withheld.

The Contractor's Representative shall be continuously on duty physically located at the Site during the Contractor's working hours at the Site. The whole time of the Contractor's Representative shall be given to directing the Contractor's performance of the Work. If the Contractor's Representative is to be temporarily absent from the Site during the execution of the Work, a suitable replacement person shall be appointed, subject to the Engineer's prior consent, and the Engineer shall be notified accordingly.

The Contractor's Representative shall, on behalf of the Contractor, receive all instructions and other communications of the Engineer in relation to the Work.

The Contractor's Representative may delegate any powers, functions and authority to any competent person, and may at any time revoke the delegation. Any delegation or revocation shall not take effect until the Engineer has received prior notice signed by the Contractor's Representative, naming the person and specifying the powers, functions and authority being delegated or revoked.

The Contractor acknowledges that the Key Personnel are critical to the performance of the Work. The Contractor shall use commercially reasonable efforts to ensure that all Key Personnel remain involved in the performance of the Work in the capacity set out in the Contractor's Submission Extracts and, in particular, will not, for the duration of the Work, require or request any such person to be involved in any other project on behalf of

the Contractor or any Contractor Party if, in the opinion of the Purchaser acting reasonably, such involvement would have a material adverse effect on the Project.

If the Contractor considers it necessary to replace any Key Personnel, the Contractor shall provide the Purchaser with relevant information on the proposed replacement and shall consult with the Purchaser before finalizing the appointment of such replacement. The Contractor shall not replace any of the Key Personnel without the prior written consent of the Purchaser, which consent shall not be withheld or delayed where the proposed replacement is suitably qualified and experienced.

If the Purchaser determines, acting reasonably, that it is in the best interests of the Purchaser that any Key Personnel be replaced, the Purchaser shall notify the Contractor, and, within 30 days of receipt by the Contractor of such notice, the Contractor shall provide the Purchaser with relevant information on the proposed replacement and shall consult with the Purchaser before finalizing the appointment of such replacement upon approval of the Purchaser.

7.7 Subcontractors

The Contractor shall only subcontract a portion of the Work in accordance with the terms of the Contract.

The Contractor shall bind each Subcontractor to carry out all the provisions of the Contract insofar as they can be applied to the part or parts of the Work sublet, and each Subcontractor shall agree with the Contractor that all work done by the Subcontractor shall be subject in all respects to the provisions of the Contract. The Purchaser acknowledges that the Contractor may provide a redacted copy of the Contract to its Subcontractors redacting pricing or other sensitive or confidential information of the Contractor.

Each subcontract shall include provisions which would entitle the Purchaser to require the subcontract to be assigned to the Purchaser or the Keeyask Hydropower Limited Partnership under Section 7.9 ASSIGNMENT OF BENEFIT OF SUBCONTRACT of the General Specification (if or when applicable) or in the event of termination of the Contract pursuant to Section 29.2 TERMINATION BY PURCHASER or Section 29.3 TERMINATION FOR CONVENIENCE or Section 29.4 TERMINATION BY CONTRACTOR.

The Contractor shall be responsible for the acts or defaults of any Contractor Parties as if they were the acts or defaults of the Contractor.

7.8 Process for Selection of Subcontractors

The Contractor may elect to sublet any part of the Work with a total estimated value of less than $500,000 in any manner that meets the Best-for-Project principles in relation to the Work and otherwise complies with the terms and conditions of the Contract.

All proposed subcontracts with a total value estimated at $500,000 or greater (each a "Material Subcontract"), with the exception of those existing subcontracts identified in the Contractor's Submission, must comply with the following or receive the Purchaser's prior written approval to deviate from this process:

(a) as soon as reasonably practicable, the Contractor shall submit to the Purchaser for approval, the details of the work and a list of subcontractors to be solicited through a competitive process and the standard form subcontract and/or purchaser order for all subcontracts over $500,000;
(b) prior to the award of any subcontract the Contractor shall submit to the Purchaser for approval, such documentation satisfactory to the Purchaser, that its preferred subcontractor represents Best-for-Project principles in relation to the Work, and;
(c) be awarded on a competitive basis with fully responsive submittals from no less than three proponents, or such lesser number as may have responded to the competitive process.

Any work subcontracted without receiving the required approval shall not be eligible for reimbursement and shall not be certified for payment by the Engineer, provided that the Purchaser shall not unreasonably withhold or delay any required approval.

Scope may not be added to an existing Subcontract without prior written approval from the Purchaser.

Under no circumstances whatsoever shall any approval by the Purchaser of any Subcontractor relieve the Contractor from any obligation or liability for the full and complete performance of the Work, all in accordance with the Contract.

All work done by a Subcontractor shall, for the purposes of the Contract, be deemed to be done by the Contractor and payment therefor shall be made to the Contractor. All employees of a Subcontractor and all persons operating or working in connection with rented Plant being used on the Work shall be deemed to be part of the Contractor's work force and the Contractor shall be responsible therefor. Claims against the Subcontractor, whether for wages, materials, damages, or otherwise howsoever shall, for the purposes of the Contract, be deemed to be claims against the Contractor.

The Contractor shall furnish the Purchaser with duplicate copies of all priced contracts/subcontracts placed by the Contractor with Subcontractors, complete in all respects, and all change orders issued under those contracts/subcontracts.

7.9 Assignment of Benefit of Subcontract

If a Subcontractor's obligations extend beyond the expiry date of the relevant Warranty Period and the Engineer, prior to this date, instructs the Contractor to assign the benefit of such obligations to the Purchaser or to the Keeyask Hydropower Limited Partnership, then the Contractor shall take commercially reasonable efforts to do so.

7.10 Evidence of Payments

Before certifying a Monthly Progress Statement which includes an amount payable to a Subcontractor, the Engineer may request the Contractor to supply reasonable evidence that the Contractor is up-to-date with respect to payment to its Subcontractors in accordance with the Contractor's contracts with its Subcontractors, less applicable deductions for retention or otherwise. Unless the Contractor:

(a) submits this reasonable evidence to the Engineer,

or

(b)

i) satisfies the Engineer in writing that the Contractor is reasonably entitled to withhold or refuse to pay these amounts, and
ii) submits to the Engineer reasonable evidence that the Subcontractor has been notified of the Contractor's entitlement,

then the Purchaser may withhold the aforesaid amounts for which the Contractor has failed to submit the evidence described in sub-paragraphs (a) or (b) above, from any monies due or to become due to the Contractor from the Purchaser pursuant to the Contract, until such time such reasonable evidence is provided to the Engineer to his satisfaction.

7.11 Other Payments by the Contractor

The Contractor shall promptly pay all assessments, premiums, levies, taxes, permit and licence fees imposed or levied on the Contractor and shall promptly pay for all labour obtained or required by the Contractor in the execution of the Contract.

7.12 Language, Dimensions and Weights

All communications (including without limitation all notices, documents, notes on drawings and submissions) required or permitted under the Contract shall be in English.

The design of the Work shall be executed in the SI (Metric) System of Units. Dimensions shall be shown in metres and millimetres and weights shall be shown in kilograms and metric tonnes. Where decimals are used in dimensions, the unit of measurement shall be deemed to be metres and where decimals are not used in dimensions, the unit of measurement shall be deemed to be millimetres, unless the drawing or document expressly states otherwise.

7.13 Contractor's General Arrangement and Design Obligations

The Contractor shall, whenever required by the Engineer, submit details of the arrangements and construction means, methods and plans which the Contractor proposes to adopt for the execution of the Work. Once submitted to the Engineer, no significant

alteration to these arrangements and construction means and methods shall be made without this having previously been notified to the Engineer.

Unless otherwise stated in the General Specification, for any part of the Work not designed by the Purchaser's Project Designer but designed by the Contractor:

(a) the Contractor shall submit to the Engineer the Contractor's Documents for this part in accordance with the procedures specified in the Contract;
(b) these Contractor's Documents shall be in accordance with the Technical Specification and Purchaser's Drawings, and shall include additional information required by the Engineer to add to the Purchaser's Drawings for co-ordination of each Party's designs;
(c) the Contractor shall be solely responsible for the design of this part and such design shall be performed in accordance with the standard of care of the reasonable professional performing similar design work in the geographic region at a similar time; and
(d) prior to issuance of any Completion Certificate, the Contractor shall submit to the Engineer the "as-built" documents and operation and maintenance manuals in accordance with the Contract and in sufficient detail for the Purchaser to operate, maintain, dismantle, reassemble, adjust and repair this part of the Work. Such part shall not be considered to be completed for the purposes of taking-over under Section 24 PURCHASER'S TAKING OVER of the General Specification until these documents and manuals have been submitted to the Engineer. This obligation is in addition to the Contractor's obligation to supply as-built drawings and operation and maintenance manuals for the Work as provided for in Section 21.7 CONTRACTOR'S DOCUMENTS of the General Specification.

7.14 Project Quality Management

Project quality management requirements for the Work are set out in Appendix F - QUALITY MANAGEMENT PROGRAM. The Contractor shall be responsible for all quality control requirements and responsibilities. The Contractor shall develop a Quality Management Plan as part of its ECIS Obligations and upon approval by the Purchaser, such plan shall be incorporated by reference into the Contractor's Submission Extracts and thereafter form part of the Contract.

The Engineer shall be responsible for all quality assurance requirements and responsibilities.

The Purchaser shall be entitled to audit any aspect of the Contractor's project quality management plan for the Work.

Compliance with the Engineer's quality assurance and the Purchaser's quality audit system shall not relieve the Contractor of any of its duties, obligations or responsibilities under the Contract.

7.15 Material Testing Lab

The Contractor shall supply and make available to the Purchaser a certified Material Testing Lab and laboratory testing equipment for use in carrying out the Work under the Contractor's Quality Management Plan and Purchaser's Quality Assurance Program as provided for in Appendix F - QUALITY MANAGEMENT PROGRAM. The Engineer shall have ready access to the lab and laboratory testing equipment for the purpose of performing Quality Assurance as such term is defined in Appendix F - QUALITY MANAGEMENT PROGRAM. The Contractor and Engineer shall cooperate in all regards for the purposes of successfully carrying out both QC and QA testing in accordance with the Contract.

7.16 Cooperation and Site Conditions

The Contractor shall allow appropriate opportunities and cooperate with:

(a) all Other Contractors who may be performing work at Site on behalf of the Purchaser in relation to the Project;
(b) the Purchaser's Personnel on any work at or in the vicinity of the Site; and
(c) the personnel of any Authorities, who may be employed in the execution, on or near the Site, of any work not included in the Contract.

The Contractor shall, through the Engineer, coordinate its performance of the Work with that of all Other Contractors so as to achieve Best-For-Project objectives and minimize conflicts and interferences between the Contractor and Other Contractors, and delays in the completion of the Project.

The Contractor shall perform the Work under any and all job conditions, not merely those which it considers desirable. The Contractor shall perform the Work and dispose of its Materials in such a manner as will not delay or interfere with the work or storage of the Purchaser's Materials and Purchaser's Equipment or that of Other Contractors. Similarly, the Purchaser shall ensure that Other Contractors do not unreasonably delay or unduly interfere with performance of the Work by the Contractor.

The Contractor must not, at any time, block access to those areas where work is required to be performed by Other Contractors or as directed by the Engineer.

7.17 Control Points

All baselines, benchmarks, and reference points (hereinafter "Control Points") are shown on the Purchaser's Drawings and will be maintained by the Engineer. The Contractor shall be responsible for the accurate location and setting out of the Work with reference to the said Control Points.

The Contractor, including the Contractor's Personnel and Subcontractors, shall be responsible for the preservation of all Control Points established at the Site, and for any disturbance, movement, damage or destruction thereof caused by the Contractor, the Contractor's Personnel or Subcontractors. Any errors in the Work resulting from the

Contractor's use of such disturbed, moved, damaged or destroyed Control Points or failure of the Contractor to notify the Engineer concerning the disturbance, movement, damage, or destruction of Control Points shall be corrected and made good by the Contractor without any adjustment to the Adjusted Target Price or the Contract Schedule.

7.18 Layout of Work and Surveys

The Contractor shall set out the Work from the Control Points and shall provide a competent and efficient staff for that purpose and shall be solely responsible for the accuracy of such setting out. The Contractor shall provide, fix and be responsible for the maintenance of all stakes, templates, elevation marks, profiles and batter boards and other such things, and shall take all necessary precautions to prevent their removal or disturbance and shall be responsible for the consequences of any removal or disturbance thereof caused by the Contractor or any Contractor Party and for the efficient reinstatement of all such marks so removed or disturbed. The Work shall be set out to the satisfaction of the Engineer in all respects, but his approval thereof, or his joining with the Contractor in setting out the Work, shall not relieve the Contractor of any of its responsibilities for the due fulfilment of the Contract.

No adjustment to the Adjusted Target Price or the Contract Schedule will be made to the Contractor for the cost of any Work or delay occasioned by the establishment of lines and grades by the Engineer or of the checking of same and the taking of any other measurements by the Engineer, and no extension of time will be allowed for any delay occasioned by the Engineer's process for approval or required correction of same.

7.19 Proactive Measures

The Contractor shall:

(a) take all necessary precautions for the safety of the Contractor's Personnel engaged in the performance of the Work at Site and for all persons entitled to be on the Site;
(b) take all precautions and measures to keep the Site and Work clear of unnecessary obstruction so as to avoid danger to these persons;
(c) erect and properly maintain at all times, as required by the conditions and progress of the Work at Site, all necessary safeguards for the protection of workers and the public, including fencing, lighting, guarding and watching of the Work, until a Completion Certificate is issued in accordance with Section 24.3 TAKING OVER OF THE WORK of the General Specification;
(d) post danger signs warning against unusual hazards and such other hazards as may be designated from time to time by the Engineer;
(e) provide and maintain any Temporary Works (including roadways, footways, guards and fences) which may be necessary, because of the execution of the Work, for the use and protection of the public and of owners and occupiers of adjacent land;
(f) properly and adequately protect all Work, Materials, Plant and Tools against loss, damage or deterioration during performance of the Work and take every

precaution against causing damage to property belonging to the Purchaser or to third parties located in, upon, or about the Site; and

(g) take all necessary precautions during performance of the Work so as not to trespass upon or cause damage, disturbance, obstruction of access, removal or disturbance of support to land, buildings or other structures or property beyond the Site.

7.20 Pre-Work Meetings

Approximately thirty (30) days prior to the start of any major Change in the Work or a start of a new section of the Work, a pre-work meeting shall take place.

Representatives of the Engineer, Contractor, major Subcontractors, including the appropriate health and safety inspectors, environmental inspectors, quality control representatives and supervisors will be in attendance.

The Engineer will establish time and location of meeting and notify parties concerned a minimum of five (5) days before the meeting.

Agenda to include the following:

- Identification of official representative of participants in the Work;
- Project participation and responsibilities;
- Communication;
- Site operation requirements during construction;
- Health and safety requirements;
- Security requirements;
- Environmental requirements and procedures;
- Contract Schedule for the applicable Work and progress scheduling, and work hours;
- Schedule of submissions of shop drawings and samples;
- Requirements for Temporary Works, including temporary facilities, offices, storage sheds, utilities and fences;
- Schedule of delivery of specified equipment and materials;
- Use of Work Instructions, Requests for Information, Extra Work Orders and Change Orders as provided for in the Contract;
- Required time extensions, overtime and administrative requirements; and
- Purchaser's Equipment and Purchaser's Materials.

The Engineer will:

(a) Prepare the agenda for meetings;
(b) Set-up an agreed schedule for meetings;
(c) Make physical arrangements for meetings;
(d) Preside at meetings;
(e) Prepare meeting minutes to include significant proceedings and decisions; and
(f) Reproduce and distribute meeting minutes to all relevant parties.

The Contractor will attend all meetings called by the Engineer and be prepared to discuss the major changes to the Work including, but not limited to the following:

(g) Safety and environmental procedures and requirements;
(h) Quality management program;
(i) Contract Schedule;
(j) Critical work sequences;
(k) Status of shop drawings;
(l) Delivery of Materials and equipment;
(m) Review of any observations, Work Instructions, Requests for Information, problems or conflicts; and
(n) Co-ordination which may impede progress of the Work.

7.21 Avoidance of Interference

The Contractor shall not interfere unnecessarily or improperly with:

(a) the convenience of the public; or
(b) the access to and use and occupation of all roads and footpaths, irrespective of whether they are public or in the possession of the Purchaser or of others;

and shall comply with the Engineer's instructions to stop or remedy the interference, if the Engineer determines that such interference has occurred.

7.22 Use of Private Roads or Privately Owned Property

The Contractor shall not enter upon or use private roads or other privately owned property unless and until it has obtained written permission from the owner thereof, provided the Purchaser with a copy of the written permission obtained from the owner, and received the Purchaser's approval in writing of the terms and conditions of such permission. All agreements, representations and commitments to the owner shall be confirmed in the written permission and the Contractor shall not make any arrangements or give any representations or commitments to the owner other than those contained in the written permission from the owner. If there is any breach of the foregoing, the Contractor shall be solely responsible for all liabilities and costs incurred by the Contractor and the Purchaser in meeting and fulfilling any oral representations, arrangements or commitments given by the Contractor or the Contractor's Personnel to such owners that are not confirmed in the written permission, and such costs shall be Ineligible Costs. If permission is granted, the Contractor shall maintain the private roads and property during the course of the Work and upon completion of the Work shall restore the same to their previous conditions.

During the course of the Work, the Contractor shall promptly remove from public and private roads and privately owned property, any material which has fallen from any Contractor's vehicle, including, without limitation, rocks, debris or wastes.

7.23 Access Route

The Contractor shall be deemed to have been satisfied as to the suitability and availability of access routes to the Site. The Contractor shall use reasonable efforts to prevent any road or bridge from being damaged by the Contractor's traffic or by the Contractor's Personnel or Subcontractors and shall comply with all applicable Laws and requirements of all applicable Authorities regarding the use of such access, including any restrictions, load limits and other constraints imposed in connection with such access. These efforts shall include the proper use of appropriate vehicles and routes.

Except as otherwise stated in the Contract:

(a) the Contractor shall provide all necessary signs or directions along access routes, and shall obtain any permission which may be required from the relevant Authorities for its use of routes, signs and directions; and

(b) if the Contractor determines it has suffered delay and/or additional cost as a result of the conditions of its reasonable access routes to the Site or material changes to the transportation limitations existing at the date of the Submission, it shall be entitled to proceed pursuant to Section 22.6 REQUESTS FOR EXTENSION OF TIME or Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification, as applicable.

7.24 Transport of Materials and Plant

The Contractor shall be responsible for packing, loading and transporting the Contractor's Materials and Contractor's Plant required for the Work. For all parts of the Work that are required to be transported, the Contractor shall prepare those parts of the Work for transportation and storage so as to protect them from damage or deterioration during transportation and storage.

The Contractor shall be responsible for tracing and expediting of all shipments and for obtaining all required clearances for any Materials supplied by the Contractor or for Contractor's Plant required for the Work.

The Contractor shall make all necessary arrangements to avoid delays which could arise from seasonal conditions affecting transportation.

The Contractor shall indemnify and hold the Purchaser harmless against and from all damages, losses and expenses (including legal fees and expenses) resulting from its negligent acts or omissions in the transport of Materials and Plant and shall negotiate and pay all third party claims arising from their transport and any such damages or expenses (other than insurance deductibles) for which the Contractor is liable shall not form part of the Actual Costs.

7.25 Inspection of Deliveries to Site and Storage

The Contractor shall be responsible to receive, inspect, unload and store the Materials and Plant required for the Work.

The Contractor shall give the Engineer not less than three (3) days notice of the actual arrival times of all shipments of Materials for the Permanent Works requiring inspection at the Site. The Engineer shall give the Contractor not less than three (3) days notice of the actual arrival time of all shipments of Purchaser's Materials or Purchaser's Equipment at the Site.

All Purchaser's Materials or Purchaser's Equipment will be transferred to the Contractor at a location agreed to between the Engineer and Contractor within the limits of Work Area A. The transfer point shall be on the delivery vehicle and the Contractor is then wholly responsible for the items from that point until an Interim Completion Certificate or a Final Completion Certificate is issued. This includes but is not limited to offloading, handling, transportation, disposal of all packing materials and storage requirements as outlined in the Technical Specification.

For Purchaser Materials or Purchaser's Equipment as identified in the Contract, the Contractor and Engineer shall conduct a joint inspection of all such Purchaser Materials and Purchaser's Equipment at the time of delivery to Site and before unloading commences, and shall jointly sign off on a material custody transfer sheet as to their condition on arrival and record any apparent damage and shortages and, in the event of disagreement, the Engineer's determination as to the condition and quantity of the Purchaser's Materials or Purchaser's Equipment upon delivery to Site shall prevail.

All Purchaser's Materials or Purchaser's Equipment shall be unloaded within twenty-four (24) hours upon arrival at the Site.

In addition, the Engineer reserves the right to inspect all other Materials and Plant delivered to the Site to be used in the performance of the Work or incorporated into the Work at the Site.

With respect to Purchaser's Materials procured by the Purchaser as identified in the Contract, where practicable the Purchaser shall advise the Contractor, 14 days in advance of delivery, of all special storage and handling requirements, dimensions, weights and lifting points and the Contractor shall provide appropriate storage incorporating such requirements, including a safe, secure and conditioned environment where required by the applicable manufacturers or the Engineer.

7.26 Mobilization and Demobilization of Plant and Personnel

As part of the Work, the Contractor is responsible for mobilization and demobilization of the Work including all assembly, transporting, setting up, taking down after completion of the Work and moving away from the Site, of the Contractor's Personnel, Plant and sanitary facilities, Tools and supplies necessary for the performance of the Work or maintenance and repair of the Contractor's equipment, and all items necessary or incidental thereto, and shall leave all parts of the Site used by the Contractor in a clean condition, and graded as required by the Engineer to mitigate against erosion and other adverse environmental effects.

7.27 Environmental Protection

The Purchaser will provide copies to the Contractor of all applicable and available authorizations, licences, permits and approvals obtained for the Project for which the Purchaser is responsible for obtaining pursuant to Section 5.2 PERMITS, LICENCES OR APPROVALS FOR THE PROJECT of the General Specification. The Contractor shall adhere to all of the applicable conditions, constraints and restrictions in the provided authorizations, licences, permits and approvals as well as in all those for which the Contractor is responsible for obtaining pursuant to Section 7.4 PERMITS, LICENCES AND APPROVALS FOR THE WORK of the General Specification.

A draft Environmental Protection Plan is included in Appendix C - ENVIRONMENTAL PROTECTION PLAN. This plan will be finalized after receipt all of permits and approvals outlined in Section 5.2 PERMITS, LICENCES OR APPROVALS FOR THE PROJECT of the General Specification to ensure all permit conditions are included in the plan. The Contractor shall be required to comply with the final Environmental Protection Plan when it becomes available and such final plan shall supersede and replace the draft Environmental Protection Plan in Appendix C - ENVIRONMENTAL PROTECTION PLAN at such time. Any related adjustment arising therefrom to the Contract Schedule and the Adjusted Target Price will be dealt with in accordance with Section 27 CLARIFICATIONS AND CHANGES TO THE WORK of the General Specification. Environmental aspects of the Work will be discussed during the post-contract award meeting and at Site meetings.

The Contractor acknowledges that the Purchaser's objective is for the Contractor to minimize the environmental footprint of the Work and achieve a zero tolerance for environmental mishaps. The Contractor shall at all times strive to exceed the minimum standards for environmental protection under applicable Law and shall show good faith efforts to continuously attempt to improve its performance in respect of environmental matters. The Contractor shall monitor and report such measures to the Purchaser on a regular basis and at such other times as the Purchaser may request, acting reasonably.

Without limiting or otherwise affecting the generality or application of any other term or condition of the Contract, the Contractor shall:

(a) strictly comply with all Environmental Legislation and have suitable corrective and/or preventive measures in place to address any previous environmental warnings, fines or convictions; and

(b) do or cause to be done all things required or ordered, to mitigate environmental damage caused, directly or indirectly, by itself or by the Contractor's Personnel or Subcontractors, accidentally or as a result of practices that are in contravention of the Contract, any Environmental Legislation or Project authorizations, licences, permits and approvals. To the extent the environmental damage is due to the negligent acts or omissions of the Contractor, the Contractor's Personnel or Subcontractors, the Contractor shall be responsible for all costs and expenses incurred as a direct result thereof and these shall not form part of the Actual Costs and shall not be invoiced to the Purchaser for payment.

7.28 Dedicated On-Site Environmental Supervisor

Before commencing the onsite Work, the Contractor shall identify its dedicated on site Environmental Supervisor, who shall have the necessary demonstrated knowledge and experience in project environmental management and possess the skills to effectively manage all environmental aspects of the Work. The person designated as Environmental Supervisor must be acceptable to the Purchaser, and if not acceptable replaced with someone who is acceptable to the Purchaser. The Environmental Supervisor shall attend a pre job meeting at the Purchaser's office to review environmental matters for the Work. The dedicated on site environmental supervisor shall be fully conversant with:

(a) Contractor's environmental practices and policies;
(b) All applicable Environmental Legislation;
(c) The conditions of Environmental Protection Plan, including the Contractor developed environmental protection plan (Solid waste/recycling plan; erosion and sediment control plan and emergency preparedness and response plan);
(d) Compliance with all applicable Laws regarding the storage, monitoring and containment of fuels and other hazardous materials; and
(e) Emergency spill response plan coordination, spill reporting and cleanup requirements.

7.29 Environmental Improvement Order

Failure to comply with Section 7.27 ENVIRONMENTAL PROTECTION of the General Specification or unsatisfactory performance in regards to any other environmental-related matter may result in the Engineer issuing Environmental Improvement Orders to the Contractor.

The Environmental Improvement Order, once communicated verbally (to be followed by a written communication within 24 hours) or in writing is effective immediately. A compliance date will be established by the Engineer for each Environmental Improvement Order issued. The Contractor must provide written documentation of the actions taken regarding the Environmental Improvement Order as follows:

The Contractor shall:
(a) within the compliance period specified in the order or any extension thereof, prepare a written report on the measures taken to remedy the contravention and on any measures yet to be taken;
(b) send a copy of the report to the Purchaser's representative who made the order;
(c) if applicable, provide a copy of the report to the employee(s) involved; and
(d) if applicable, review the contravention with all employees at regular weekly meetings and post in a prominent place at or near the workplace.

7.30 Environmental Stop Work Order

Where the Engineer is of the opinion that any activities which are being, or are about to be, carried on in a workplace, involve or are likely to involve an imminent risk of serious

impact to the environment, or where a contravention specified in an Environmental Improvement Order was not remedied and warning was given, the Engineer may issue an order (hereinafter called an "Environmental Stop Work Order"). The Environmental Stop Work Order, once communicated verbally (to be followed by a written communication within 24 hours) or in writing is effective immediately as stipulated with respect to any one or more of the following matters:

(a) the cessation of those activities;
(b) that all or part of the workplace be vacated;
(c) that no resumption of those activities be permitted by the Contractor;
(d) that the Environmental Stop Work Order remains in effect until it is withdrawn in writing by the Engineer; and
(e) if the Environmental Stop Work Order resulted from acts or omissions of the Contractor or any Contractor Party in breach of this Contract or applicable Law, any costs arising out of such Environmental Stop Work Order shall be considered Ineligible Costs and the Contractor will not be entitled to any Change in the Contract Schedule.

Note: An Environmental Stop Work Order does not prevent the Contractor from completing any work or activity that may be necessary in order to remove the risk of further impact referred to above.

7.31 Heritage Resources

All fossils, coins, articles of value or antiquity, and structures and other remains or items of geological or archaeological interest found on the Site shall be placed under the care and authority of the Engineer. The Contractor shall take reasonable precautions to prevent Contractor's Personnel or other persons from removing or damaging any of these finds according to the requirements stated in Appendix G - HERITAGE RESOURCE PLAN.

The Contractor shall, upon discovery of any such finding, promptly give notice to the Engineer, who shall issue instructions for dealing with it. If the Contractor suffers delay and/or additional costs are incurred from complying with the instructions, the Contractor shall be entitled to proceed in accordance with Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification.

7.32 Weather Conditions

In order to complete the Work in accordance with the Contract Schedule, the Contractor shall, at all times, be prepared to perform Work on Site in any and all weather conditions including without limitation, winter weather except as provided in the "Weather Shift" provision set out below or Workplace Safety and Health regulations regarding thermal stress. The Contractor shall make all arrangements necessary for winter weather construction as required to properly perform the Work and as directed by the Engineer.

A "Weather Shift" is defined as any shift, when atmospheric and site conditions are such that 50% of the Contractor's work force normally expected to work on Site is unable to work at least five (5) hours in a shift (either between 7:00 a.m. and 7:00 p.m. or 7:00 p.m. and 7:00 a.m., as the case may be) due to such conditions.

As soon as the Contractor reasonably believes that grounds for claim for a Weather Shift are evidenced by weather conditions at Site, it shall, on that day, notify the Engineer of the claim for a Weather Shift for the Engineer's consideration and decision. The Contractor shall confirm in writing within five (5) days of its claim for a Weather Shift.

In determining the impact of any Weather Shift, the Contractor will provide the following supporting documentation for the Engineer's consideration:

(a) The Actual Costs the Contractor will incur as a result of the Weather Shift;
(b) The Contractor's assessment of the required adjustments to the Adjusted Target Price;
(c) The total, cumulative and actual, impact of the Weather Shift on the Contract Schedule, as well as any cascading effect or impact of the time extension (e.g. if the impact includes the extension of the Contract Schedule into an additional construction season due to missed fish windows or in-stream works); and
(d) Alternative options to mitigate the impact of the associated cost or delay resulting from a Weather Shift.

Upon approval of the Engineer, compensation for a Weather Shift will be in the form of an extension to the Contract Schedule equal to the impact of the delay due to the Weather Shift as determined by the Engineer, the reasonable overhead costs of the Contractor associated with such delay and any resulting adjustment to the Adjusted Target Price. The Engineer shall document these in an Extra Work Order.

Notwithstanding the above paragraphs of this Section 7.32, the parties agree that the Contractor shall not be eligible for any adjustment to the Adjusted Target Price or extension of time for a Weather Shift until the total number of Weather Shifts exceeds four in any given calendar month during the performance of the Work.

7.33 Construction Power

After July 15, 2015, the Purchaser will provide for the Contractor, free of charge for construction purposes only, the electrical supplies outlined in the Technical Specification and as identified in the Contractor's Submission Extracts under the section heading POWER REQUIREMENTS. The Contractor shall supply, install, maintain and move extensions to this service as required during the construction period, subject to the Engineer's approval.

The supply of construction power by the Purchaser is subject to temporary outages and the historic reliability of the Purchaser's electrical system and the associated infrastructure in the immediate area of the Site. The Contractor shall supply all required back-up power for any operation that it determines cannot withstand temporary outages.

7.34 Permits to Work

No inspecting, testing or operating which is required to take place or be done in, upon, or about, the Work or equipment or facilities owned by the Purchaser and which are or may be electrically charged from any source, shall be permitted unless and until a written "Permit to Work" has been issued for the purpose by the Engineer. When the inspecting, testing or operating sanctioned by the Permit to Work has been completed, the Contractor shall give written clearance to the Engineer.

7.35 Water and Sewer Services

The Purchaser will provide for the Contractor, free of charge for construction purposes only, water and sewer services as outlined in the Technical Specification. The Purchaser can only guarantee the supply of water to limits of the water treatment plant and associated infrastructure. The Contractor shall supply all back-up water sources for any critical items that it determines cannot withstand temporary outages.

7.36 Temporary Heating and Hoarding

The Contractor shall as part of the Temporary Works design and supply all temporary heating and hoarding necessary for the performance of the Work, and as outlined in the Technical Specification. For such purposes, the Contractor shall be responsible to supply any power in excess of that supplied by the Purchaser pursuant to Section 7.33 CONSTRUCTION POWER of the General Specification.

7.37 Communications

The Purchaser will supply communication services and communication infrastructure as outlined in the Technical Specification.

The Purchaser can only guarantee the supply of communication services and communication infrastructure to the limits of the associated infrastructure and the service provided by the Purchaser's internet service provider. The Contractor shall supply any back-up communication sources it determines necessary for any critical items that cannot withstand temporary outages.

7.38 Site Security

The Purchaser will provide security for the Project. A security contractor engaged by the Purchaser shall be responsible for the maintenance of order at the Site, provision of regular fire patrol and other normal security duties.

Notwithstanding the immediately preceding paragraph, the Contractor shall be responsible for the protection, risk of loss and security of all Materials, Purchaser's Equipment, Contractor accounts and cash, Plant, Tools and all other items under the care, custody and control or under the ownership of the Contractor during the course of the Contract and the performance of the Work, including during any Work performed at Site during the Warranty Period set out in Section 25 WARRANTY of the General

Specification. The Contractor shall provide and require the Contractor's Personnel to diligently use lockable storage facilities in accordance with good construction practice to protect against loss and theft of items under its care, custody and control.

The Contractor shall be responsible for the general discipline of its employees.

The entrance to the Project site will be controlled on a 24/7 basis and not open to the public. The Contractor's Personnel and vehicles shall be required to follow identification and access procedures as determined by the Purchaser in order to gain access to the Project site for the duration of the Work, including during the Warranty Period. The Contractor shall supply identification for all of the Contractor's Personnel and vehicles working at Site and will provide lists of such personnel and vehicles daily for site check-in and check-out purposes.

7.39 Contractor's Operations on Site

The Contractor shall confine its operations to approved areas at the Site as identified in the Purchaser's Drawings, and to any additional areas which may be obtained by the Contractor and agreed by the Engineer as working areas. The Contractor shall take all necessary precautions to keep the Contractor's Materials, Plant and Contractor's Personnel within the Site and these additional areas, and to keep them off adjacent land. The Contractor shall note and adapt its construction methodology to allow for the Service Bay utilization as shown in the file included in Appendix H - SERVICE BAY UTILIZATION.

During the execution of the Work, the Contractor shall keep the Site free from all unnecessary obstructions, and shall store or dispose of any Contractor's Plant or surplus materials. The Contractor shall clear away and remove from the Site any wreckage, rubbish and Temporary Works which are no longer required.

Prior to the issue of a Completion Certificate, the Contractor shall clear away and remove, from that part of the Site and Work to which the Completion Certificate refers, all Contractor's Plant, surplus material, wreckage, rubbish and Temporary Works. The Contractor shall leave that part of the Site and the Work in a clean and safe condition. However, the Contractor may retain on Site, during the Warranty Period, such Plant and Materials as are required for the Contractor to fulfil its obligations under the Contract.

7.40 Contractor's Office Accommodation and Storage Facilities

Accommodations for the Contractor' office, lunch room, Plant, Tools, storage facilities, equipment and materials (including fuel at the Site) shall be the responsibility of the Contractor. The location of such accommodation shall be limited to the areas shown on the Purchaser's Drawings or as agreed to in consultation with the Engineer. The Contractor shall be responsible for the protection of its office, Plant, Tools, storage facilities and Materials stored on the Site including any fences or barriers required. Materials stored on the Site shall be neatly stacked and protected from the elements.

As part of its ECIS Obligations, the Contractor shall prepare a plan showing the size of all office accommodations and storage facilities, including any lay-down areas that are typically required for the Work and the general location and proximity to the location of the Work. Failure to provide these details will limit the Purchaser's ability to accommodate any future requests for space or preferred location of the Contractor's facilities during Phase II.

7.41 Roads

The Purchaser will construct the North and South Access Roads to the Site. The North Access Road incorporates a free span bridge at Looking Back Creek. The maximum vehicle load (gross vehicle weight) supported by this bridge includes one of the following (fully loaded in accordance with the manufacturer's specifications):

(a) Caterpillar 775E
(b) Caterpillar 775F
(c) Caterpillar 769D
(d) Caterpillar 740

The Contractor shall not use any other vehicles with a gross vehicle weight above 70,000 kg without the written authorization from the Purchaser.

The Contractor will maintain the North and South Access Roads as identified in the Technical Specification.

The Contractor shall construct any other haul roads, ramps, decks, and bridges which the Contractor considers necessary for its operation, within the limitations of the Footprint set out in Appendix C - ENVIRONMENTAL PROTECTION PLAN. The Contractor shall maintain these roads until the receipt of the Final Completion Certificate or until they are relieved of this duty by the Engineer. The Work shall also include the blocking of access of any temporary roads, unless otherwise directed by the Engineer, on completion of the requirement for the road.

Before commencing the construction of any of its roads, ramps, decks or bridges, the Contractor shall submit for review by the Engineer, drawings showing road construction details and location. Roads shall be constructed so as to avoid unnecessary interference with natural drainage.

Stream crossings shall be subject to the conditions outlined in the Appendix C - ENVIRONMENTAL PROTECTION PLAN and as outlined in "Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat" published by Manitoba Conservation. Any drainage required for construction of Contractor's access roads shall be addressed in its Environmental Protection Plan developed as part of the Contractor's ECIS Obligations and upon approval by the Purchaser, such plan shall be incorporated by reference into the Contractor's Submission Extracts and thereafter form part of the Contract.

All roads, ramps, decks and bridges constructed and/or maintained by the Contractor shall be made available, without charge, for use by the Purchaser's Personnel and all other contactors of the Purchaser working at Site and Authorities having jurisdiction over any part of the Work or the Site.

7.42 Contractor's Working Areas

Certain areas of the Site, as shown on the Purchaser's Drawings, will be made available to the Contractor for its use as temporary work areas during the execution of the Work. The Engineer may also approve the Contractor's use of any other areas within the Footprint. The identified areas in Work Areas A, B and C have been cleared of trees and all stumps grubbed. The Contractor will be responsible for all additional site development that may be required. Whenever the Contractor elects to work any borrow area, the area of that deposit and its immediate neighbourhood, within boundaries to be determined by the Engineer, together with the Contractor's temporary access road to the deposit, will be designated a working area and part of the Site except that the Purchaser shall not provide first aid or security services for such areas and the Contractor shall be responsible for same in accordance with applicable Laws and its own requirements. No other areas on the Site shall be used by the Contractor, except with the consent of the Engineer.

The Contractor shall note that the area within 100m of any natural water course is a restricted zone and shall ensure that its operation in a designated work area shall not disturb that area in any manner unless prior approval is obtained from the Engineer.

7.43 Material Processing Wastes

Wash water and fine materials washed from the aggregate processing shall be conveyed to and disposed of into an area or areas adjacent to the point of processing, as approved by the Engineer. They shall be disposed of in such a manner as not to interfere with roads, services, or other operations and work and in full compliance with all applicable Laws and requirements of all applicable Authorities. The Contractor is advised that local bodies of water may be used as a source of wash water subject to permits, applicable Laws and requirements of applicable Authorities; however, the Contractor shall not dispose of any waste or waste water directly into a body of water. All waste water being introduced into a body of water shall be free of excessive amounts of sediment and other contaminants as required by the Environmental Protection Plan set out in Appendix C - ENVIRONMENTAL PROTECTION PLAN. The Contractor's method for the disposal of waste water shall be subject to the Engineer's approval.

7.44 Clean-Up and Removal of Plant, Surplus Materials and Debris

The Contractor shall at all times during the course of the Work, keep the Site clean and free from fire hazards and other hazards, and accumulations of waste materials, rubbish and debris caused by the Contractor's Personnel or Subcontractors or arising from performance of the Work. Before a Completion Certificate will be issued by the Engineer pursuant to Section 24.3 TAKING OVER OF THE WORK of the General Specification in respect of the Work, the Contractor shall remove from the Site and dispose of all the

Contractor's Tools, Plant, surplus and waste materials, rubbish and debris, in, upon and about the Site, and shall leave the Work and the Site in a clean and tidy condition to the satisfaction of the Engineer. When the Work involves the construction of a building or other structure(s), the building/structure(s) shall be left "broom clean" or its equivalent, unless the Contractor is expressly directed or permitted in writing by the Engineer to do otherwise.

If the Contractor fails to maintain or leave the Site in a clean and tidy condition within a reasonable time after written notice from the Engineer, the Purchaser may remedy this default, or cause the same to be remedied and any costs incurred shall be deemed to be Actual Costs.

8 WORK SAFETY

8.1 General Requirements

The Contractor acknowledges that the Purchaser's objective is for the Contractor to achieve the highest industry standards of safety performance and to strive for zero safety related incidents. The Contractor shall at all times strive to exceed the minimum standards for safety under applicable Law and shall show good faith efforts to continuously attempt to improve its safety performance. The Contractor will proactively engage its workforce to employ best safety practices. The Contractor shall monitor and report such measures to the Purchaser on a regular basis and at such other times as the Purchaser may request, acting reasonably.

Without limiting the generality or application of any other term or condition of the Contract, the Contractor shall comply with all Laws relating to the Work and work safety and health matters and further, the Contractor shall comply with any rules, guidelines, policies, and directives set forth by the Purchaser in the Contract in respect of same or required by the Engineer to protect and enhance safety of workers.

The Contractor shall identify the dangers inherent in the Work, and shall at all times:

(a) follow safe working procedures and develop new procedures as required;
(b) employ Contractor Parties who are properly qualified and skilled to do the Work;
(c) use and maintain Plant and Tools which are in safe operating condition and appropriate for the Work to be performed;
(d) obtain all permits, licences and clearances for the performance of the Work as required by the Contract and all Authorities;
(e) establish compliance procedures and take all other necessary measures, to protect the safety of workers and all other persons who may be in the vicinity of the Site;
(f) comply with:
    i) *The Workplace Safety and Health Act* (Manitoba) and the regulations thereunder, and
    ii) Appendix I – MANITOBA HYDRO CORPORATE SAFETY AND OCCUPATIONAL HEALTH RULES;

(g) appoint the On Site Safety Supervisors in accordance with Section 8.3 DEDICATED ON SITE SAFETY SUPERVISOR of the General Specification; and

(h) carry out all requests and directions of the Purchaser's safety officer appointed pursuant to *The Workplace Safety and Health Act* (Manitoba).

The Contractor shall allow the Purchaser timely and complete access to the Contractor's records and documentation, to allow the Purchaser to confirm the Contractor's ongoing compliance with this Section 8. The Contractor shall, at the Purchaser's request, provide copies of documentation related to safety to the Purchaser, including without limitation, copies of:

i) résumés, licences, certification papers and like documentation for the Contractor's Personnel and Subcontractors engaged in the Work,
ii) specifications, permits, test results and licences, for all equipment to be used in the Work, and
iii) all other permits and licences obtained by the Contractor for the Work.

When requested by the Purchaser, the Contractor may be required to submit a safety mitigation plan for the Work.

At all times, the Purchaser's safety officer shall be entitled to inspect and test the Contractor's Plant and Tools to be used in the performance of the Work.

A safety committee will be established on Site as required by *The Workplace Safety and Health Act* (Manitoba). The Contractor shall provide representatives to participate in this committee.

8.2 Prime Contractor

The Contractor and the Purchaser acknowledge and agree that the Purchaser is the "prime contractor" as that term is defined in *The Workplace Safety and Health Act* (Manitoba) for all purposes of that Act and shall have all of the duties and responsibilities of a prime contractor as set out in that Act. The Contractor shall not do anything, or allow any of the Contractor's Personnel to do anything, that would cause the Purchaser to be in breach of its obligations under that Act.

8.3 Dedicated On Site Safety Supervisor

Before commencing the Work at Site, the Contractor shall identify its dedicated On Site Safety Supervisor, who shall attend a pre-job meeting at the Purchaser's office to review safety matters for the Work. The On Site Safety Supervisor shall be acceptable to the Purchaser and, if required by the Purchaser from time to time, replaced by someone else who is acceptable to Purchaser The dedicated On Site Safety Supervisor shall be fully conversant with:

(a) the Contractor's safety management program; and

(b) all applicable Laws and requirements of all applicable Authorities with regard to workplace safety.

The dedicated On Site Safety Supervisor shall be responsible for, but not limited to, the identification and control of potential safety hazards at the work sites. The On Site Safety Supervisor shall also be responsible for ensuring that, at the beginning of every shift or when the scope of the work or location changes, the individual work crews complete a job safety plan. The Contractor must have the completed form readily available to all employees working directly on the Work or others who may be affected by the Work. The completed job safety plans are to be collected by the Contractor's On Site Safety Supervisor at the end of each day. The forms shall remain readily available for review by the Purchaser and the Contractor shall provide the Purchaser with copies of any or all job safety plans on a weekly basis.

8.4 Safety Improvement Orders

Failure to comply with Section 8 WORK SAFETY of the General Specification or unsatisfactory performance in regards to any other safety related matter may result in the Engineer or the Purchaser's Safety Officer issuing a Safety Improvement Order(s) to the Contractor.

The Safety Improvement Order, once communicated to the Contractor verbally or in writing, is effective immediately. A compliance date will be established by Engineer or Purchaser's Safety Officer for each Safety Improvement Order issued. The Contractor must provide written documentation of the actions taken regarding the Safety Improvement Order as follows:

The Contractor shall:

(a) within the compliance period specified in the order or any extension thereof, prepare a written report on the measures taken to remedy the contravention and on any measures yet to be taken;
(b) send a copy of the report to the Engineer or Purchaser's Safety Officer who made the order;
(c) provide a copy of the report to the Contractor's workplace safety and health committee for the workplace with respect to which the order was made or to the worker safety and health representative, if no safety and health committee exists; and
(d) post in a prominent place at or near the workplace a copy of the report if there is no safety and health committee or a worker safety and health representative for the workplace.

8.5 Safety Stop Work Order

Where the Engineer or Purchaser's Safety Officer is of the opinion that any activities which are being, or are about to be, carried on in a workplace, involve or are likely to involve an imminent risk of serious physical or health injury, or where a contravention

specified in a Safety Improvement Order was not remedied and warning was given, the Engineer or Purchaser's Safety Officer may issue a stop work order (hereinafter called a "Stop Work Order"). The Stop Work Order, once communicated to the Contractor verbally (to be followed by a written communication within 24 hours) or in writing, is effective immediately, as stipulated with respect to one or more of the following matters:

(a) the cessation of those activities;
(b) that all or part of the workplace be vacated;
(c) that no resumption of those activities be permitted by the Contractor;
(d) that the Stop Work Order remains in effect until it is withdrawn in writing by the Engineer or Purchaser's Safety Officer; and
(e) if the Stop Work Order resulted from acts or omissions of the Contractor or any Contractor Party in breach of this Contract or applicable Law, any costs arising out of such Stop Work Order shall be considered Ineligible Costs and the Contractor will not be entitled to any Change in the Contract Schedule.

Note: A Stop Work Order does not prevent the Contractor from completing any work or activity that may be necessary in order to remove the risk of injury referred to above.

8.6 Worker Training and Education

The Contractor shall:

(a) Provide information, instruction and ongoing training in safe work procedures and safety documentation for the Contractor's Personnel and Subcontractors in accordance with *The Workplace Safety and Health Act* (Manitoba); and
(b) Ensure it has a system in place to track the training requirements stated above.

The Contractor shall be aware of all potential hazards (which may include but are not limited to those hazards set out below) and ensure that the Contractor's Personnel and Subcontractors have the proper training, equipment and procedures to perform the Work under these conditions when the hazard is present during performance of the Work:

i) Confined space entry
ii) Fall protection
iii) Scaffolds and other elevated work platforms
iv) Explosives
v) Chemical and biological substances
vi) Diving operations
vii) Work in the vicinity of overhead electrical lines
viii) Excavation and tunnels
ix) Welding and cutting
x) Craning, hoisting, and slinging
xi) Operation of powered mobile equipment
xii) Work alone or in isolation
xiii) Water safety, water rescue and travel in commercial vessels (barges, boats, etc.).

8.7 Safety and Environment Meetings and Project Orientations

Prior to the commencement of the Work, the Contractor and all Contractor's Personnel designated to work at Site shall attend a project safety and environment orientation. The Contractor shall work with the Purchaser's safety and environmental officers to create a joint orientation which covers safety, health and the environmental protection requirements for the Work.

During the course of the Work, all Contractor's Personnel engaged in the performance of the Work at Site shall attend a daily job planning meeting led by its respective foreman or supervisor prior to the commencement of each shift and where there has been a change introduced to the job to plan and to discuss the day's work as well as review and identify any safety or environmental protection matters, concerns, or procedures pertinent to the Work.

Over and above the daily job planning meeting, the Contractor shall institute a safety and health education program which shall include environmental protection education at the workplace at which all workers including foremen and supervisors shall attend for a period or periods equivalent to 30 minutes every two weeks, of which no period shall be less than 15 minutes.

8.8 Signage and Barricades

The Contractor shall install all necessary signage and barricades at Site during performance of the Work to indicate hazardous areas.

8.9 Emergencies

In an emergency or threatened emergency affecting or liable to affect the safety of life or property, the Engineer shall have the right and authority to stop the Work and/or order and direct such changes therein or in the methods, Plant and Tools used by the Contractor, as the Engineer deems necessary in the circumstances. Unless the emergency or threatened emergency has resulted from the negligent acts or omissions of the Contractor or any Contractor Party, the Contractor shall be entitled to proceed in accordance with Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification.

The Purchaser will create emergency response plans for conditions which present a risk to the Work and for which a response is required. The Contractor shall participate in the creation of such plans and shall have emergency response plans created for all physical areas of its performance of the Work at Site as well as its office and storage areas. As part of such plan, the Contractor shall include sufficient measures to egress its work force out of the Site if an emergency event requires the removal of the Contractor's work force from the Site. The Contractor's emergency response plans will be tested annually as determined by the Purchaser. The Contractor and the Contractor's Personnel engaged in the performance of the Work at Site shall be required to participate in the testing of such emergency response plans as required by the Purchaser.

8.10 Fall Protection

The Contractor shall comply with the requirements of the Workplace Safety and Health Division's Fall Protection Guideline.

8.11 Hearing Conservation

The Contractor shall provide to the Purchaser a complete noise audit for its work processes and procedures and work areas at Site and provide an audiometric testing program for its workers according to MR217/2006 part 12.

8.12 Toilets and Washrooms

The Contractor shall supply and maintain all necessary toilets and washrooms for all of the Contractor's Personnel engaged in the Work at Site. These facilities must comply with the requirements of *The Public Health Act* (Manitoba) and applicable regulations under *The Workplace Safety and Health Act* (Manitoba).

These facilities shall be maintained in a clean and sanitary state and supplied with the required paper goods (hand towels and toilet paper) and soap at all times. The placement of all toilets and washrooms on the Site shall be approved by the Engineer and shall be serviced according to the corresponding regulation.

8.13 Flame Resistant Clothing (FRC)

The use of flame resistant clothing (FRC) by the Contractor's Personnel will not normally be required. However, where circumstances of the Work or methods used require the use of flame resistant clothing, the Contractor shall comply with applicable Laws and Manitoba Hydro Corporate Safety and Occupational Health Rules set out in Appendix I. In such cases:

(a) areas where the Work is to be performed will be de-energized and/or barricaded to indicate the limits of any existing area where a clothing ignition hazard may exist;

(b) all individuals entering or working in an area that poses a danger of, or has been identified as, having a potential electric arc, clothing ignition or flash fire hazard shall wear flame resistant clothing that meets or exceeds the Purchaser's flame resistant clothing standards as set out in Appendix J - FLAME RESISTANT CLOTHING PROGRAM GUIDELINES;

(c) all flame resistant coveralls and overalls must have bright orange-red background material (CSA Z96 02 table 2b) with a minimum of 0.13 m2 (201 sq. in.) CSA Z96 02 (High Visibility Safety Apparel) Class II compliant reflective trim (arm, leg, front and back horizontal bands), visible from a 360 degree radius. Reflective trim must be flame resistant; and

(d) alternatively, a CSA Z96 02 Class II compliant flame resistant vest or smock meeting the Purchaser's standards set out in Appendix J - FLAME RESISTANT CLOTHING PROGRAM GUIDELINES may be worn as the outer layer over non CSA Z96 02 Class II flame resistant clothing (example: shirts and pants).

8.14 Workplace Hazardous Materials Information System

The Contractor shall comply with the Workplace Hazardous Material Information System (WHMIS) regulation MR217/2006 part 35, with respect to controlled products. The Contractor shall maintain a Workplace Hazardous Materials Information System (WHMIS) file for all controlled products used at the Site. Two weeks prior to commencement of the Phase II Work at Site, the Contractor shall:

(a) Submit an inventory of controlled and regulated products using Manitoba Hydro form H238 set out in Appendix K – WORKPLACE HAZARDOUS MATERIAL INFORMATION SYSTEM IN MANITOBA HYDRO and submit the current corresponding Material Safety Data Sheets (MSDSs) to the Purchaser for all controlled products to be used or brought on to the Site.

(b) Following the Purchaser's standard practice, all controlled products must be approved for use by the Purchaser prior to being permitted to be brought on Site. Any controlled products rejected for use shall not be brought on Site by the Contractor or its Subcontractors.

(c) In addition, all controlled products brought onto the Site without the prior approval of the Purchaser and submission of a MSDS and all waste materials shall be promptly removed by the Contractor.

(d) Chemical storage shall comply with industry best practices and the Contractor shall have an inspection process to check its work areas for the correct storage of controlled products and all products that have a UN class number regardless of the quantity.

(e) The Contractor shall supply flammable storage cabinets for storing flammable products.

(f) Warning labels which comply with WHMIS format are required on all containers of controlled products.

(g) The Contractor shall submit its controlled products evaluation process to the Purchaser for its review. The Contractor shall use its own controlled products evaluation process for all controlled products it wishes to bring to the Site.

(h) All Contractor materials and equipment to be brought on to Site shall be shipped empty of all fluids unless the Purchaser is notified in advance that new equipment is being shipped with fluids and has provided its authorization. The Contractor is responsible to ensure all Laws relating to the transportation of dangerous goods and WHMIS requirements are met when shipping materials and equipment with fluids and to provide notification of the same to the Purchaser.

(i) Any spills which occur during transportation and shipping of equipment are the sole responsibility of the Contractor and any associated mitigation, clean-up, repair or replacement costs will be at the Contractor's expense and these shall not form part of the Actual Costs and shall not be invoiced to the Purchaser for payment or result in any adjustment to the Adjusted Target Price or to the Contract Schedule.

8.15 Transportation of Dangerous Goods (TDG)

When transporting dangerous goods in Manitoba in relation to the Work, the Contractor shall comply with all applicable Laws, including the *Transportation of Dangerous Goods*

Act (Canada) and *The Dangerous Goods Handling and Transportation Act* (Manitoba), each as current at the time of such transport.

In addition, the Contractor shall ensure that each shipment of dangerous goods in relation to the Work complies with all applicable Laws, including codes and standards regarding the transportation of dangerous goods for each jurisdiction through which the shipment must pass.

8.16 First Aid and Medical Facilities

8.16.1 Purchaser Responsibilities

The Purchaser will provide at the Site:

(a) emergency response service for first aid with a nurse or certified paramedic and ambulance;
(b) a means of Emergency Medical Transport for the emergent patient to the nearest General Hospital; and
(c) all supplies for the first aid room as required by Laws or deemed advisable by the Purchaser.

8.16.2 Contractor Responsibilities

The Contractor shall comply with the Laws of Manitoba relating to the provision of first aid and medical facilities for the Contractor's Personnel, in particular *The Workplace Safety and Health Act* (Manitoba). The Contractor shall provide and maintain, including but not limited to, the following:

(a) Suitable first aid equipment in all of the Contractor's work areas including vehicles and shall attend to the treatment of first aid injuries prior to the contracted first aid attendants taking control of the injury;
(b) Ensure any worker working alone or in isolation is provided with a personal use first aid kit;
(c) Ensure all foremen and supervisors in its work force are trained as a level FA1 (minimum) and when required by regulation that the appropriate number of FA2 trained workers are on Site and provide evidence of the same;
(d) Provide transportation for its workers for Non-Emergency Medical Transport incidents to the nearest medical facility as required. The on-site Emergency Medical Services Contractor will evaluate the extent of the illness/injury and determine whether the patient will be transported by ambulance or by the Contractor; and
(e) Report to the Purchaser the occurrence, nature and apparent severity of injuries suffered by the Contractor's Personnel during performance of the Work at Site.

8.16.3 General First Aid Requirements

All residents of Manitoba are required by law to participate in the Manitoba Health Services plan which entitles members to hospital and medical benefits. All persons who take up residence in Manitoba are required to register with this plan within 30 days.

There are public hospitals in Thompson and Gillam, Manitoba. Services provided by the Purchaser and the medical officers in Thompson and Gillam, Manitoba, when used by the Contractor's Personnel, will be provided free except for the following charges which shall be considered Ineligible Costs:

(a) charges normally assessable to the employer, employee or Workers Compensation Board under *The Workers Compensation Act* (Manitoba),
(b) charges normally assessable to the Manitoba Hospital Services, Manitoba Health, or to other recognized medical service plan, and
(c) charges for drugs which are normally assessable to the patient, Workers Compensation Board, Manitoba Hospital Services, Manitoba Health, or other recognized medical service plans.

8.16.4 Emergency and Non-Emergency Medical Transport

The following terms shall have the following meanings for the purposes of this Section 8.16 FIRST AID AND MEDICAL FACILITIES of the General Specification:

(a) "Emergency Medical Transport"

Injured or ill workers will be transported to the appropriate hospital facility by the Purchaser's emergency services and ambulance services contractor, taking into account the nature of the worker/patient injury or illness assessment and regional protocols as determined by the qualified paramedic attendant and the EMS service physician Medical Director. Examples include typical cases transported by paramedic ambulance: chest pain, seizures, broken bones, back or neck injuries, seriously ill patients, or any patient requiring ongoing care or monitoring. The examples provide are not intended to be an exhaustive list.

(b) "Non-Emergency Medical Transport"

Workers who become ill or injured at the Project site who seek the services of the emergency medical paramedic attendant will be assessed and treated by the qualified paramedic attendant. After assessing the patient, if in the opinion of the qualified paramedic attendant the patient does not require emergency ambulance transport the patient will be transported by their respective employer for medical treatment at the appropriate hospital facility. Examples include:

i) Sprains, repetitive strain injuries, minor cuts, or bruising.
ii) Follow up medical visits after initial treatment for an emergency injury or illness.
iii) Ongoing treatment for chronic health problems (where the patient is not in distress or requiring active EMS care or monitoring).

The examples provide are not intended to be an exhaustive list.

8.17 Fire Protection

Suitable fire control equipment shall be provided by the Contractor for the protection of its own Materials, Plant, Tools, the portions of the Work under construction or installation and the Purchaser's Materials and Purchaser's Equipment under the care and control of the Contractor at the Site. All fire protection equipment shall meet the approval of the Engineer.

The Contractor shall be responsible for any damage resulting from its fires or the fires of its Subcontractors and shall be solely responsible for all costs which may be incurred in extinguishing such fires and these shall be considered Ineligible Costs.

No burning of any materials shall be permitted at the Site without a burn permit obtained from Manitoba Conservation and without approval of the Engineer.

The Contractor shall co-operate in every way with the Engineer to quickly report and extinguish all fires, as well as take all necessary steps to prevent their occurrence.

Fire extinguishers supplied by the Contractor will be adequate in number and type and must be in proper working order and available at all work stations including vehicles and heavy equipment for the duration of the performance of the Work at Site. The Contractor's Personnel must be trained in the proper use of extinguishers and the Contractor must provide proof of training on request by the Engineer.

The Contractor shall inspect its fire control equipment monthly and provide evidence of the same to the Engineer. The Contractor shall label all fire protection equipment with its company name or logo.

8.18 Control of Hazardous Energy

The Contractor is required to comply with CSA Z460-05 Control of hazardous energy - Lockout and other methods.

In particular in accordance with Clause 4.1 of such regulation, designers and integrators shall be responsible for designing, integrating, and building machines, equipment or processes so that the user can effectively control hazardous energy during any of the required maintenance activities.

In addition, the Contractor must have a lockout program that complies with the lockout regulation stipulated in MR 217, Part 16.14 -17, Part 38.9(b) and Part 38.14. The Contractor is required to apply its lockout program when controlling hazardous energy for equipment under its control in performance of the Work and in its work area which presents a hazardous energy source.

The Purchaser and the Contractor will discuss and agree when the lockout program will be transferred from the Contractor's program to the Purchaser's program during commissioning of equipment and acceptance of the Work from the Contractor.

8.19 Welding and Cutting

When welding or cutting is required on Site and it takes place in locations not designated as welding shops, the Contractor shall:

(a) Provide its workers with adequate ventilation for metals that produce toxic fumes or provide respirator masks with a continuous supply of fresh air. The respirator must be worn by the worker when welding or cutting metals that produce toxic fumes;

(b) Provide suitable screens or other appropriate measures to protect adjacent workers or public from injury due to thermal or light energy, molten slag and sparks;

(c) Provide a fire extinguisher of the correct fire class for the hazard present and use protective blankets and barriers to prevent fires and personal injury to workers, at the same or other elevations. The fire extinguisher must be on hand for the welder to use when required;

(d) Provide fire watch and monitoring of the welding site during and at the end of work operation, each day and before the welding crew ceases or breaks from work or leaves the job site;

(e) Investigate and keep watch using practical methods to ensure no combustion. The safety watch for fires shall be for a minimum of two (2) hours after work ceases in each work area where the hazard is present; and

(f) Provide and use heat detection equipment, which is mandatory for welding work, and such detection equipment must be located and stored on Site and readily available for use by the Engineer and designated personnel at all times during the Work.

8.20 Proximity of the Work to High Voltage Lines

The Contractor shall comply with Manitoba Regulation 217/2006 Part 25 Work in the vicinity of overhead electrical lines when Work is completed within 3 m of an overhead electrical line and switching structures or using equipment or machinery from a location from which it or any part of the equipment is capable of coming within 3 m of an overhead electrical line.

8.21 Explosives

The Contractor shall not use explosives unless it has reviewed all aspects of the blasting operations with the Engineer prior to starting and shall provide the following information to the Engineer and any other information requested by the Engineer:

(a) the type, characteristics, and quantity of the explosive which the Contractor proposes to use, and the locations for each type if different types will be used;

(b) the proposed method of transporting, storing, handling, and methods and techniques using such explosives, including without limitation, the thawing of frozen explosives;

(c) the safety procedures proposed to be followed, including without limitation, the signs, sentries and warning devices to be used;

(d) the location or locations where the Contractor proposes to use explosives;

(e) the proposed location of magazines and other storage facilities for explosives and detonators;
(f) the dates and hours during which the Contractor proposes to carry out blasting operations; and
(g) the certification of all workers handling the explosives.

The Contractor shall at all times exercise the greatest care in carrying out blasting operations and shall comply with all applicable Laws, including codes and standards, and the requirements of all applicable Authorities, with respect to the use of explosives and blasting operations.

Review by the Engineer of any of the matters in this Section 8.21 shall not relieve the Contractor from liability to the Purchaser for any loss, costs, damages or expenses which may be caused by or result from the Contractor's use of explosives and these shall not form part of the Actual Costs and shall not be invoiced to the Purchaser for payment. Nor shall such review exempt the Contractor from using its own safe work procedures for blasting work and compliance with MR217/2006 part 34, Workplace Safety and Health Code of Practice for Explosives and the *Explosives Act* (Canada).

9 NOT USED

10 NOT USED

11 HYDRO PROJECTS MANAGEMENT ASSOCIATION (HPMA)

The Purchaser has established and constituted the Hydro Projects Management Association (hereinafter called the "Association") to maintain uniform terms and conditions of employment pertaining to the Work and to promote industrial peace and harmony during the construction of the Keeyask Project.

In the Contractor's Submission Extracts under the section heading HYDRO PROJECTS MANAGEMENT ASSOCIATION MEMBERSHIP APPLICATION, the Contractor shall have signed an application for membership in the Hydro Projects Management Association and upon execution of the Contract, the Contractor is thereby deemed to be a Contractor Member of the Association, and as, Subcontractors are contracted by the Contractor to perform portions of the Work, all such Subcontractors are thereby deemed to be Contractor Associate Members.

The copy of the Constitution of the Association, set out in Appendix L – HYDRO PROJECTS MANAGEMENT ASSOCIATION CONSTITUTION, is the Constitution current at the time of signing of the Contract. In submitting the Contractor's Submission Extracts and executing the Contract, the Contractor shall be deemed to have obtained from the Association complete information concerning the Association at telephone

number (204) 360 7960, and the Contractor shall be solely responsible for any errors or misunderstandings resulting from the Contractor's failure to obtain such information.

In accordance with Article 34 of the BNA referred to in Section 12 BURNTWOOD/NELSON COLLECTIVE AGREEMENT (BNA) of the General Specification, the Association will indemnify wages to a maximum of $500,000 per contractor to ensure that the wages of an employee working for the Contractor or Subcontractor, if any, are paid and that any monies deducted from such employee's pay as defined in the applicable Appendices of the BNA will be remitted to the appropriate union, or fund, as the case may be, in accordance with the applicable Appendices. If a valid claim is made, the amount of the claim will reduce the Adjusted Target Price by such amount as part of its Actual Costs or if such amount was paid to the Contractor it may be deducted by the Purchaser from payments due or to become due to the Contractor under the Contract.

The Purchaser is responsible for negotiations and administration of the BNA. It has no control or involvement in hiring or disciplining of the Contractor's employees, or in the Contractor's performance in following the BNA. The Purchaser will provide advice on interpretation of the BNA and assist in arbitration hearings through the Association. Any compensation awards payable by the Contractor and any Contractor costs for arbitration proceedings shall be considered Ineligible Costs.

12 BURNTWOOD/NELSON COLLECTIVE AGREEMENT (BNA)

The Work shall be subject to the Burntwood/Nelson Agreement (BNA) between the Association of the First Part, the Allied Hydro Council of Manitoba (hereinafter called the "Council") of the Second Part, the Unions of the Third Part and the Contractor of the Fourth Part. The most current copy of the BNA is located at **http://www.hydro.mb.ca/projects/bna_agreement.pdf** and such copy of the BNA is hereby deemed incorporated by reference into and forms part of the Contract at the same priority level as an appendix to the Contract. The BNA may be amended from time to time.

In signing and entering into the Contract, the Contractor is deemed to have obtained from the Association complete information on the current terms and provisions of the BNA. The Contractor shall be solely responsible for any errors or misunderstandings resulting from the Contractor's failure to make a thorough investigation and to obtain the aforesaid information.

The Contractor and all its Subcontractors to be employed at the Site shall sign the BNA within seven working days after the award of the Contract for the Work or in the case of a Subcontractor within seven working days after the award of the Subcontract. For this purpose, the Contractor and all its Subcontractors shall make arrangements with the Administrator of the Association. The seven working day period may be extended by mutual agreement between the Association and the Contractor provided the BNA is signed before commencement of the Work at the Site.

12.1 Additional Provisions

In addition to the provisions of Article 4 of the BNA, the Contractor and all its Subcontractors shall comply with the following provisions:

(a) The Contractor shall be responsible for convening and chairing a pre-job conference meeting in Winnipeg at a place designated by the Contractor. This meeting shall be subsequent to the signing of the BNA and prior to the commencement of any on Site work. Subcontractors who are not in attendance at this pre job conference meeting shall convene a separate pre job conference meeting;

(b) To facilitate the designation of trade work assignments, the Contractor and all its Subcontractors shall describe in detail the assembly or construction processes and/or services that will be performed pursuant to the Contract;

(c) The Contractor shall prepare minutes of the pre-job conference meeting and forward a copy to the Association within 20 working days from the date of the meeting. The minutes shall contain, in addition to other information recorded, the following:

  i) in the case of work which is not in dispute, a description of and the union to which the work has been assigned.

  ii) In the case of work in dispute, in addition to the information set out in i) above, the name of the contesting trades and the basis on which the work assignment is made which shall be in accordance with Article 4 of the BNA; and

(d) All work assignments made by the Contractor subsequent to the pre-job conference meeting and pertaining to work in dispute which was not previously dealt with and assigned shall be recorded and distributed in the manner set out in (c) above.

12.2 Further Clarifications

(a) Qualifications at Job Order Stage 4 (Name-hire) - For further clarification, if a job qualified candidate cannot be secured at Stages 1 through 4, inclusive, the Contractor is to issue a new job order with lower qualifications or the job order re-issued with the same qualifications. On hiring, the Contractor will be responsible for filling out Stage 4 new hire information. The candidate will need to match all qualifications on the job order prior to the Job Referral Service (JRS) accepting the registration. Should it be found that a Stage 4 hire was made on lower qualifications than the job order specified, the candidate's registration will be rejected.

(b) Job Order 'Comment Box' and Length of Time between Hiring and Report Date - The Contractor is advised that the use of the 'comment box' is for the provision of extra information only and does not affect which candidates are referred by the JRS referral process. In addition, the Contractor is advised that the use of the 'comment box' does not permit the Contractor to fail to properly assess a candidate and that the Contractor's interview process is the determining factor in

assessing credentials referenced in the 'comment box'. The Contractor must provide specific, detailed information when utilizing the 'comment box'; an example would be 'experience erecting scaffolds of two stories or more' as opposed to 'dam experience'. Finally, the Contractor must be as diligent as possible in coordinating hiring dates with the earliest reasonable reporting dates, and the Purchaser requires the Contractor to indicate on job orders the expected reporting date.

(c) Lay-off Subject to Recall – The Purchaser advises the Contractor of the following directions regarding Article 12.4.2 of the BNA (Lay-off Subject to Recall). Firstly, Article 12.4.2.2 is to be utilized only in instances where employees laid-off subject to recall are to be recalled prior to the expiry of 60 days from the date of lay-off, as opposed to 120 days. If an employee is to be laid off longer than 60 days then he/she must be given an outright "lay off" and recall rights will not apply. In addition, where lay-off subject to recall is utilized, the order of recall shall, at all times, be the same as the order of employment preference set out in Article 12.1 of the BNA. In other words, in no instances shall non-Manitobans involved in a common or collective work assignment be recalled prior to that assignment's Manitobans. The result of these directions can be summarized as follows: the Contractor shall only utilize the lay-off subject to recall provisions (Article 12.4.2) where all employees will be recalled within 60 days. If the lay-off is to be more than 60 days, regular lay-off procedures apply. Sub-Article 12.4.2.3, which allows for 'out of order' recalls as long as all employees in a common or collective work assignment are all recalled within 28 days of the date of the first recall, is suspended. Therefore, in all instances, employees laid-off subject to recall must be recalled in order of employment preference.

13 COMPLIANCE WITH BURNTWOOD/NELSON AGREEMENT

With respect to the Work, the Contractor, on its own behalf or on behalf of its Subcontractors, represents and warrants to the Purchaser that no existing or pending collective bargaining rights or agreements affecting the Contractor and Subcontractors in any way impair the capacity or legal right of the Contractor or any Subcontractor to comply with the BNA and to grant and recognize the exclusive bargaining rights of the unions and Council under the BNA in respect of employees of the Contractor and any Subcontractors engaged in the Work. If, in the opinion of the Purchaser, the Contractor or any Subcontractor is unable, at any time, for any reason, to fulfil any material obligations, either as a member of the Association or under the BNA, and the Contractor does not remedy or take steps to remedy the default to the satisfaction of the Purchaser within ten (10) days of being notified by the Purchaser of such circumstances, then the Purchaser may, in its discretion, declare the Contractor to be in default, and give notice of intention to terminate the Contract, and the Purchaser shall have all remedies for the default provided by the Contract.

14 ADVISORY GROUP ON EMPLOYMENT

The Purchaser will require the establishment of the Advisory Group on Employment to monitor and address concerns about the referral and hiring process, including job order review. The terms and conditions of reference for this committee are set out in Appendix M - ADVISORY GROUP ON EMPLOYMENT TERMS OF REFERENCE.

If requested by the Association, the Contractor shall designate an individual, to represent the Contractor on the Advisory Group on Employment. The Association will reimburse the Contractor's representative on the Advisory Group on Employment for reasonable travel and accommodation expenses within Manitoba when the Advisory Group on Employment meetings are held in locations other than the location at which the individual is employed.

The Contractor shall implement programs approved by the Association and the Council in accordance with the terms of the BNA.

15 SELECTION OF PERSONNEL

The Contractor represents and warrants that in selecting persons (other than supervisory personnel not covered by the BNA) to be employed in relation to the Work at Site, those applicants for employment who have shown that they meet or exceed the Contractor's reasonable requirements as to training, experience and qualifications for the particular work to be performed, shall be given preference by following the procedure as outlined in Article 12 of the BNA and any applicable preference provisions arising from a signed Letter of Agreement under the BNA with respect to the Keeyask Project.

In addition to the selection criteria above the Contractor must adhere to the following:

(a) For every Manitoba designated trade group utilized by the Contractor in the performance of the Work at the Site there shall be a minimum ratio of one resident of Manitoba level 1 apprentice for every 10 Journeypersons employed at the Site.

(b) The minimum ratio may be waived by the Engineer if the Contractor can show that they undertook commercially reasonable attempts to fulfil this requirement but were unable to meet the minimum ratio.

(c) The minimum ratio does not apply if the Contractor does not employ at least 10 Journeypersons from any given trade group.

16 ENTREPRENEURSHIP, TRAINING AND TRADE (ETT)

The Province of Manitoba's department of Entrepreneurship, Training and Trade (ETT) will act as the employment referral agency for the Keeyask Project, including for the Work.

17 ABORIGINAL AWARENESS TRAINING

All Contractor's Personnel performing Work at Site will be required to participate in aboriginal awareness training. Sessions will be conducted at Site by the Purchaser and the training will be four (4) hours in duration for all persons included in the BNA jurisdictions and eight (8) hours in duration for all persons exempt from the BNA jurisdictions. All persons entering the Site with the intent of working 10 days or more must show proof of completion of this training. Any person unable to show proof of the training will be denied entry to the Site, with an exception given for a person's first visit to Site or as otherwise approved by the Engineer.

18 PROJECT EMPLOYMENT INFORMATION SESSIONS

As part of the Contractor's ECIS Obligations, the Contractor will be required to conduct project employment information sessions in the communities of Thompson, Gillam and Winnipeg. The Purchaser will provide the Contractor with names of local publications in which the Contractor shall advertise the sessions within the various communities.

The objective of these sessions is to allow the Contractor to identify its expectations for employment needs on the Project and also to allow local prospective employees an opportunity to meet with the Contractor and provide details of their previous work experience and competencies. The local prospective craft employees will then become educated on the hiring process and be able to register with the Job Referral Service for the Project and identify their potential job specific union jurisdiction.

19 STAFF AND LABOUR

19.1 Persons in the Service of Purchaser

The Contractor shall not recruit, or attempt to recruit, staff and labour from amongst the Purchaser's Personnel for the duration of the Work.

19.2 Labour Laws

The Contractor shall comply with all the relevant labour Laws applicable to the Contractor's Personnel, including Laws relating to their employment, health, safety, welfare, immigration and emigration, and shall allow them all their legal rights.

The Contractor shall require the Contractor's Personnel to obey all applicable Laws, including those concerning safety at work.

19.3 Work in Canada

Only Canadian citizens, permanent residents, holders of employee authorization under the Immigration Act (Canada), and certain business persons under the North American Free Trade Agreement may work in Canada. The Contractor shall ensure that all

Contractor's Personnel that perform work in Canada under the Contract are legally entitled to work in Canada.

19.4 Personnel Risk Assessment

If requested by the Purchaser, some or all personnel of the Contractor and any of its Subcontractors must be cleared by a personnel risk assessment as set out in Appendix N - PERSONNEL RISK ASSESSMENT. In such event, an Extra Work Order shall be issued directing the Contractor to proceed with such personnel risk assessment and documenting any resulting adjustment required to the Adjusted Target Price.

It shall be a condition of the Contract that the Contractor arranges submission of completed forms, described in Appendix N - PERSONNEL RISK ASSESSMENT in order for personnel risk assessments to be conducted a minimum of 30 days prior to the required access. The Contractor shall comply with all applicable privacy Laws in carrying out its responsibilities under this Section 19.4.

Any changes to the criminal background status of any of the Contractor's Personnel must be reported to the Purchaser immediately upon the Contractor becoming aware of same.

At any time during the performance of the Contract, and at the Purchaser's discretion, the Contractor may be required to conduct further personnel risk assessments on any of the Contractor's Personnel who have unescorted access to the Purchaser's facilities and an individual's existing clearance may be revoked until a follow-up personnel risk assessment is conducted and the results provided to the Purchaser.

19.5 Hours of Work

In addition to compliance with requirements for hours of work set out in the BNA, the Contractor's hours of work for Contractor's Personnel at Site shall be as set out in the Contractor's Submission Extracts under the section heading INITIAL TARGET PRICE BREAKDOWN for the duration of the Work unless otherwise approved by the Purchaser

19.6 Workers Compensation

If required, the Contractor shall at all times pay, or cause to be paid, any assessment or compensation required to be paid pursuant to *The Workers Compensation Act* (Manitoba), and any such payment shall be treated as an Actual Cost.

Upon failure to do so, the Purchaser may pay such assessment or compensation to the Workers Compensation Board and may deduct the amount thereof from monies due or to become due to the Contractor and such amounts paid shall be included as part of the Actual Cost pursuant to the Contract. The Purchaser may, at any time during the performance and upon the completion of the Work, require a declaration from the Workers Compensation Board that such assessments or compensation have been paid in full, and may withhold final payment to the Contractor until such declaration has been received.

19.7 Contractor's Superintendence

Throughout the performance of the Work, and as long thereafter as is necessary to fulfil the Contractor's obligations, the Contractor shall provide all necessary superintendence to plan, arrange, direct, manage, inspect and test the Work.

Superintendence shall be given by a sufficient number of persons having adequate knowledge of the language for communications and of the operations to be carried out (including the methods and techniques required, the hazards likely to be encountered and methods of preventing accidents), for the satisfactory and safe execution of the Work.

19.8 Contractor's Personnel

Without limiting or otherwise affecting the generality or application of any other term or condition of the Contract:

(a) All Contractor's Personnel shall be skilled in their work assignments and experienced in their respective trades or occupations. The Contractor shall not retain personnel whose skill or fitness is unsatisfactory and shall replace an unsatisfactory employee with a satisfactory employee.
(b) Key personnel, including the Contractor's Representative must be fluent in the English language, both written and verbal.
(c) The Contractor shall only employ such workers who are medically fit.
(d) The Purchaser has a zero tolerance policy on the possession or use of illegal drugs or narcotics at Site. If any of the Contractor's Personnel is found using or in possession of illegal drugs or narcotics such person shall be subject to immediate removal from the Site and dismissal from the Work as directed by the Engineer.
(e) Firearms will not be allowed on or at the Site. Persons in possession of firearms shall be subject to immediate removal from the Site and dismissal from the Work as directed by the Engineer.

19.9 Identification of Contractor's Employees

The Purchaser will provide all applicable Contractor's Personnel with numbered photo identification which also bears the Contractor's name. Such photo identification shall be carried by the Contractor's Personnel at all times during performance of the Work on Site, and will be used as means of identification for admission to the Site and must be shown upon any request by Site security personnel or the Engineer or any other of the Purchaser's on-Site representatives.

20 BOARD AND LODGING FOR CONTRACTOR'S PERSONNEL

Accommodations for craft and staff Contractor's Personnel engaged in performance of the Work at Site, shall be provided by the Purchaser at no charge subject to the following provisions.

The Purchaser's camp facility has a maximum capacity of approximately 2,000 persons and will house personnel of the Purchaser and Other Contractors working on the Project from time to time. The Purchaser has relied upon the information set out in the Contractor's Submission Extracts under the section heading CONTRACTOR'S CAMP REQUIREMENTS to set the final camp allotment and allocations of rooms and room types for the Contractor. The Purchaser shall have no obligation to make additional rooms available but, if rooms are vacant, will use reasonable efforts to accommodate the Contractor's request that additional camp rooms be made available to the Contractor for specific periods of time. The costs of providing any such additional rooms (beyond the Camp Room Surplus Allowance) shall be deemed to be Actual Costs, that have been paid to the Contractor, at a rate of $135 per person per day calculated based on the total number of man-days over the initial man-day estimates provided in the Contractor's Submission Extracts as may be adjusted in accordance with the Contract.

The Contractor will be responsible for any damage the Contractor's Personnel may cause to the camp rooms that the Contractor has been allotted except for reasonable wear and tear. The costs or expenses associated with the repair of such damage shall not be part of the Actual Costs and shall be deducted from the amount payable by the Purchaser to the Contractor arising from the Contractor's next Monthly Progress Statement submitted in relation to the Work.

All camp residents must follow the Keeyask Camp Rules outlined in Appendix O – PROJECT SITE RULES AND INFORMATION. The Purchaser reserves the discretion to evict any persons from the Keeyask camp that do not abide by the camp rules. Such eviction may be made by the Purchaser, the Engineer, or either of their authorized representatives.

All Contractor's Personnel are not permitted to stay within the Keeyask camp during their isolation leave periods and must immediately vacate their assigned room at such time including removal of all personal belongings.

20.1 Conduct of Contractor's Personnel

The Engineer shall have the right (subject to an employee's right to grieve under his or her applicable collective agreement) to require the Contractor to permanently remove any Contractor's Personnel or a Subcontractor, from the Work with reasonable justification, including, but not limited to, incompetence, disorderly conduct, insubordination, impairment due to alcohol or drugs, disciplinary suspension from employment with the Purchaser or its subsidiaries, incapacity, or inability to perform work without creating a danger to personal safety or to the safety of others or that such Contractor's Personnel or Subcontractor is on an illegal strike.

The Contractor shall engage a substitute for any Contractor's Personnel or Subcontractor removed from the Work. Substituted key personnel and any Subcontractor shall be subject to the approval of the Purchaser.

The Contractor shall not permit the Contractor's Personnel or Subcontractors, to possess or consume alcoholic beverages in the vicinity of the Work.

The Contractor shall at all times take all reasonable precautions to prevent any unlawful, riotous or disorderly conduct by or amongst the Contractor's Personnel, and to preserve peace and protection of persons and property on and near the Site.

The Contractor's Personnel and Subcontractors shall comply with all security rules and regulations which may from time to time be imposed by the Engineer on or in connection with the Work at Site or at the Purchaser's other facilities.

21 PLANT, MATERIALS AND WORKMANSHIP

21.1 Manner of Execution

The Contractor shall carry out the manufacture of Plant, the production and manufacture of Materials, and all other execution of the Work:

(a) in the manner (if any) specified in the Contract;
(b) in accordance with health and safety Laws;
(c) in a proper workmanlike and careful manner, in accordance with recognized good practice; and
(d) with properly equipped facilities and non-hazardous Materials, except as otherwise specified in the Contract.

21.2 Material, Plant and Labour

Unless otherwise specified in the Contract, the Contractor shall furnish all Plant and Materials and shall perform all labour necessary for the due, proper and safe design (in so far as the Contractor is responsible for performing any design pursuant to the Contract), execution and completion of the Work.

All Materials incorporated into the Permanent Works shall be new and all work done shall be of specified quality as set out in the Contract.

In all cases where work or Material of "approved" type or make is specified, the Purchaser's approval thereof must be obtained before such work is begun or Material ordered in accordance with Section 21.4 EQUAL ARTICLES, MATERIALS OR EQUIPMENT of the General Specification.

The Contractor shall be responsible for all of the Contractor's Plant during the performance of the Work. Materials and Plant may not be removed by the Contractor from the Site without the permission of the Engineer until the Work has been fully completed in accordance with the Contract and accepted by the Purchaser, but the Engineer may, in his discretion, give permission, which shall be in writing, at any time for the removal of any portion thereof. Notwithstanding the preceding sentence, consent shall not be required for vehicles transporting Contractor Personnel off the Site.

If the Engineer is of the opinion that the labour force or the quantity of Plant supplied for the performance of the Work is insufficient, or that the methods, Plant or Tools being employed are unsafe, unsuitable or inefficient, or are not such as to assure that the Work will be completed within the time specified in the Contract, the Engineer may so notify the Contractor in writing and the Contractor shall forthwith take steps to increase the number of persons employed on the Work, make the required additions and/or improvements to its Plant, and conform to the methods or procedures, and use such Plant and/or Tools as directed by the Engineer. The Engineer may notify the Contractor in writing to remove unsafe, unsuitable or inefficient Plant from the Site, and if the same is not removed within three (3) days thereafter, the Engineer may cause it to be removed at the Contractor's risk and expense and these costs shall not form part of the Actual Costs of the Work and shall not be invoiced to the Purchaser for payment.

If the Engineer is of the opinion that the Material required for the Work, other than the Purchaser's Materials or other materials that are supplied by the Purchaser, is not arriving at such a rate or within such a time as to indicate that the entire Work will be completed within the time specified in the Contract, the Engineer may so notify the Contractor in writing and the Contractor shall obtain such Material at the rate or within the time directed by the Engineer.

If the Contractor makes use of Material which, in the opinion of the Engineer is unsafe, unsuitable, inefficient or which will not permit the execution of the Work to his satisfaction, or the completion thereof within the time specified in the Contract, the Engineer may give the Contractor notice in writing to alter and/or improve the Material, and the Contractor, shall comply with the requirements of the Engineer without delay. The Engineer may notify the Contractor in writing to remove unsafe, unsuitable or inefficient Materials from the Site, and if the same is not removed within three (3) days thereafter, the Engineer may cause it to be removed and any costs associated therewith will be treated as an Actual Cost.

21.3 Sequence and Construction Means and Methods

The Contractor is solely responsible for all construction means, methods, techniques, sequences and procedures. The Contractor is also responsible for all safety and environmental precautions and programs as required to meet all applicable Laws and requirements of all applicable Authorities for such construction means, methods, techniques, sequences and procedures.

Without limiting the generality of the foregoing, the Contractor shall be responsible for determining the proper sequence to be followed, and the methods, Plant and Tools to be used in the execution of the Work, so as to fully and effectually carry out the intent and purpose of the Contract, subject however, to the paramount right and authority of the Engineer to direct and require the Contractor to amend the sequence to be followed and the methods, Materials, Plant and Tools to be used so as to promote the safety, economy and proper scheduling of the Work in relation to the overall Project, harmony and co-operation with the Other Contractors, and to cause as little interference as possible with ordinary traffic and public business.

If any part of the Work depends for its proper execution upon work to be done by the Other Contractors, the Contractor shall give notice in accordance with Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification, to the Engineer of any errors, omissions or defects in the work of such Other Contractors which interferes with or is likely to interfere with or prevent the proper performance by the Contractor of the Work.

The Contractor shall not be entitled to any adjustment to the Adjusted Target Price or for any additional costs or extension of time for delays relating to any permit, licence, approval, authorization or consent that is required as a result of any change in the Contractor's construction means, methods, techniques, sequences, procedures or plans of performing the Work or as set out in any ECIS Deliverable or any other submittal to the Purchaser or the Engineer.

Notwithstanding any other provision of the Contract or the ECIS Agreement, under no circumstances shall the Purchaser or the Engineer be responsible or liable for any construction means, methods, techniques, sequences, procedures or plans, or any safety precautions and programs required for the Work in accordance with applicable Laws, the requirements of Authorities or general construction practice. Without limiting the foregoing, any review, approval, acceptance, monitoring or audit of any part of the Work by the Purchaser or the Engineer shall not be:

(a) interpreted or otherwise construed to be, an acceptance of any part of the Work that is not in full conformance with all requirements of the Contract, or an acceptance or approval of any of the Contractor's construction means, methods, techniques, sequences, procedures and plans for performing the Work; or

(b) relied upon by the Contractor as evidence of or to establish any agreement by the Purchaser or Engineer of the Contractor's construction means, methods, techniques, sequences, procedures and plans for performing the Work, or to any Change, relaxation or waiver of any requirements of the Contract.

21.4 Equal Articles, Materials or Equipment

Whenever an article, Material or equipment is defined in the Contract by describing a proprietary product or by using the name of a manufacturer or vendor, the words "or equal" in the opinion of the Purchaser and acceptable to the Purchaser shall be implied. The specific article, Material or equipment mentioned shall be understood as indicating the type, function, minimum standard of design, efficiency and quality desired and shall not exclude manufacturers' products of comparable quality, design and efficiency, provided that they are acceptable to the Purchaser. Prior to incorporating an equal article, Material or equipment into the Work, the Contractor shall make a written request to the Engineer in accordance with Section 27 CLARIFICATIONS AND CHANGES TO THE WORK of the General Specification, including a justification identifying any relevant Best-for-Project principles, and the Purchaser at its discretion will decide whether to allow the substitution. The justification shall contain a comparison of the specified standard, material or component and the proposed alternative.

21.5 Building Code Compliance

All aspects of the Work shall be completed in accordance with the latest edition of the local building codes, except where the Technical Specification or the Purchaser's Drawings specifically modify or restrict the intent and application of the foregoing.

21.6 Care and Supply of Documents

The Contract and Purchaser's Drawings shall be in the custody and care of the Purchaser. Unless otherwise stated in the Contract, an electronic copy of the Contract and of each subsequent Purchaser's Drawing shall be supplied to the Contractor, who shall be responsible to make any further copies required.

Each of the Contractor's Documents shall be in the custody and care of the Contractor, unless and until taken over by the Purchaser. Unless otherwise stated in the Contract, the Contractor shall supply to the Purchaser, through the Engineer, one (1) paper copy plus a .PDF electronic copy of each of the Contractor's Documents.

The Contractor shall keep, on the Site, a copy of the Contract, publications named in the Contract, the Contractor's Documents, the Purchaser's Drawings and Extra Work Orders and Changes Orders, and Notices given under the Contract. The Purchaser's Personnel shall have the right of access to all these documents at all reasonable times.

If a Party becomes aware of an error or defect of a technical nature in a document which was prepared for use in executing the Work, the Party shall promptly give notice to the other Party and Engineer of such error or defect.

21.7 Contractor's Documents

21.7.1 Document Management and Communication

The Purchaser will utilize a web-based document management application in the performance of the Work for document management and collaboration. The Purchaser will provide the Contractor and its authorized Contractor's Personnel and Subcontractors with appropriate user identifications to permit access to, and use of the website as required. Any training required by the Contractor or its authorized Contractor's Personnel or Subcontractors on the application, initiation and maintenance of the website shall be considered included in the Initial Target Price for the Work and no separate measurement or payment to the Contractor will be made.

21.7.2 Document Submissions

As part of the Submittal Schedule to be prepared by the Contractor as part of its ECIS Obligations, the Contractor will provide a complete document submission list for the Engineer's review. The Submittal Schedule shall include all documents required for the Work and indicate the scheduled dates of issue for each document. The Submittal Schedule shall be used by the Engineer for tracking purposes and the Contractor shall maintain and update the Submittal Schedule during the course of the Work. The

Contractor shall prepare and submit documents required to be submitted by the Contractor as scheduled in its Submittal Schedule. These items shall be signed and sealed as required by Section 21.7.3 DOCUMENTS REQUIRING PROFESSIONAL SEALS of the General Specification.

The Contractor shall submit and issue for review all documents in accordance with the Contract. Documents will fall into two categories: SCI Numbered and Non SCI Numbered. These include but are not limited to:

SCI Numbered	Non SCI Numbered
Drawings	QA Inspection Sheets
Specifications	Raw Material Certificates
O&M Manuals	Certificates of Conformance
Commissioning Procedures	Non-Destructive Test Reports
Installation Instructions	Non-Conformance Reports
Design Reports	Material Test Reports
Quality Docket	Electrical Test Reports
	Corrective Action Requests
	Welding Procedure Specifications
	Procedure Qualification Records
	Personnel Qualifications
	Other Reports as Required
	Inspection & Test Plan

The SCI system is further described in Section 21.7.8 SYSTEM CLASSIFICATION INDEX (SCI) of the General Specification.

Documents shall fully describe the Work and all details contained therein including but not limited to:

(a) three dimensional models of all supplied equipment and individual components;
(b) general arrangement, size, dimensions and details of all materials and components to be supplied as part of the Work, including a reference to the related Technical Specification section and details surrounding any deviations from the specifications set out therein;
(c) specifications for the types of materials from which the parts are to be made, the methods used to test and validate the materials, the coatings to be used for all components, etc.;
(d) all construction and fabrication details showing machining requirements, welding and material specifications and tolerances;
(e) all design reports;
(f) installation and assembly; and
(g) a complete bill of materials, integral to each drawing, including mark numbers, quantities, descriptions, materials, references and specifications for each item shown on the drawing. The bill of materials shall be incorporated into the drawing itself. Separate A4 size sheets are unacceptable.

Any other information that demonstrates that the Work meets the requirements of the Contract shall also be submitted.

21.7.3 Documents Requiring Professional Seals

All documents and drawings requiring an engineer's seal or signature for revisions by *The Engineering and Geoscientific Professions Act* (Manitoba) shall be submitted in hard copy form as required by this Act and the Association of Professional Engineers and Geoscientists of Manitoba's (APEGM) by-laws and guidelines.

Only drawings appropriately sealed (and signed noting revisions) will be accepted.

Drawings bearing seals (and signatures noting revisions) from out-of-Province professional jurisdictions shall also show applicable Manitoba professional association licence number.

Electronic files of documents requiring a professional seal shall show the professional member's or licensee's name (with applicable professional suffix) that sealed the original drawing and applicable date of sealing within the seal box of the title block. Documents submitted as revisions shall additionally show the initials (with applicable professional suffix) of the member or licensee taking responsibility for the revision, in the revision approval box.

21.7.4 Document Submission and Transmittal Process

Documents are submitted, reviewed and revised throughout the course of the Work as required. SCI numbered documents have specific requirements for numbering and formatting outlined in the following table.

Description	Revision	Submission Format	Engineer's Seal	Engineer's Initials
Preliminary	A,B,C… X	PDF via collaboration tool	No	No
Issued for Manufacture	00	Hard Copy + PDF	Yes	Yes
Changes at Manufacture and/or Installation	01, 02… NN	Hard Copy + PDF	No	Yes
As-Built	NN + 1	Hard Copy + PDF	No	Yes
Final	NN +2	Hard Copy + PDF	No	Yes

The Engineer uses the Purchaser's collaboration website as a collaboration tool for review of submissions. The process outlined in Appendix P – SHAREPOINT USER GUIDE describes the requirements for the use of the Purchaser's collaboration website to transmit submissions.

The Contractor shall submit to the Engineer 'Document Review Sets' for each individual component of the Work. The Document Review Set shall include all relevant drawings, specifications, data sheets, reference documents and any other documents necessary to fully describe the component of the Work.

Document Review Set Example

The below is an example only and the Engineer shall be the sole judge of the completeness of a Document Review Set:

Component:	Gate Section
Document Set:	-Fabrication Drawings -Machining Drawings -Material Specification -FEA Report -QC/QA Inspection Sheets -Inspection and Test Plan -Welding Procedures -Shipping Drawings -Storage and Handling Procedures

Unless otherwise specified in the Submittal Schedule, the Engineer shall review the Contractor's Documents within 30 calendar days of receipt and return to the Contractor an electronic copy with notation in accordance with Section 21.7.9 ENGINEER'S REVIEW of the General Specification.

The review period is based upon the Contractor meeting the following criteria for the applicable Document Review Sets:

(a) Each drawing sheet shall be a separate file;
(b) The Contractor has included all relevant reference documents in the Document Review Set and no missing information is required to complete a review;
(c) All of the documents are legible and written in the English language;
(d) The quantity of documents within the Document Review Set does not exceed thirty sheets; and
(e) The Contractor manages the Work such that in any 14 day period the number of individual Document Review Sets under review with the Engineer is three or less.

If the above conditions are not met, the review period may take longer than 30 calendar days.

The Contractor shall not be entitled to any extension of time or adjustment to the Adjusted Target Price or Contract Schedule for any delay caused by the Contractor's failure to provide Document Review Sets within the time limits set out above or within the time periods set out in the Submittal Schedule or without the information specified in

paragraphs (a) to (d) above, with the Submittal Schedule to govern in the event of any inconsistency with the above time periods.

The Contractor, Purchaser and Engineer acknowledge that the review period and prioritization of Document Review Sets will differ for each submission depending on the critical nature of the subject review and the content of the submission. The Engineer, Purchaser and Contractor agree to work collaboratively to ensure that critical submissions and reviews are completed in a timely manner to promote the general progress of the Work and to avoid delays.

All documents shall be considered "Preliminary" with alphanumeric revision numbers (A, B, C, etc.) until the document has been returned as "Reviewed". Documents that are returned "Reviewed as Noted" or "Amend and Re-submit" shall be revised and returned for the Engineer's review.

The Contractor, upon receiving from the Engineer a Preliminary document marked "Reviewed," shall submit to the Engineer one paper copy via courier and an electronic copy of the document via the Purchaser's collaboration website. The revision block shall be marked "Issued for construction" and the revision number shall be set to 00. If the document requires an engineer's seal as per Section 21.7.3 DOCUMENTS REQUIRING PROFESSIONAL SEALS of the General Specification, the documents shall be appropriately sealed.

All changes to the Work during manufacture/construction or installation shall be recorded in revisions to the documents. The Contractor shall, within 28 days of any Change, issue to the Engineer one paper copy via courier and an electronic copy of the revised document via the Purchaser's collaboration website. The revision block and revision number shall be updated. If the document requires an engineer's seal in accordance with Section 21.7.3 DOCUMENTS REQUIRING PROFESSIONAL SEALS of the General Specification, the document shall be appropriately sealed.

Once installation of the Work has been completed, the Contractor shall submit to the Engineer for review, one paper copy via courier and an electronic copy of the document via the Purchaser's collaboration website, of the as-built version of all documents. The revision block and revision number shall be updated. If the document requires an engineer's seal in accordance with Section 21.7.3 DOCUMENTS REQUIRING PROFESSIONAL SEALS of the General Specification, the documents shall be appropriately sealed.

At the conclusion of the Work the Contractor shall submit to the Engineer electronic copies of each final reviewed document in AutoCAD .dwg format, via the Purchaser's collaboration website as well as one full size paper copy. Where applicable, 3-D models updated with the final geometry shall be included.

All hard copy submissions shall be addressed to the Purchaser's Document Control Section complete with a transmittal as outlined in Appendix Q – MINIMUM DRAWING STANDARDS FOR CONTRACTORS CAD OPTION.

All electronic submissions via the Purchaser's collaboration website shall be made as provided for in Appendix P – SHAREPOINT USER GUIDE.

21.7.5 Document Standards

All documents shall be prepared with due care, skill and diligence in accordance with the standard of care normally exercised by professionals providing similar services under similar circumstances and shall be of a high standard with respect to neatness, clarity and legibility. All documents shall be checked, approved, dated and certified correct by the Contractor prior to submission to the Engineer. Correction of spelling and grammatical errors is the responsibility of the Contractor.

All SCI numbered documents (other than drawings) shall have a title page that includes a revision block and a space reserved for an engineer's seal.

All SCI numbered documents to which revisions are made shall have the changes clearly marked in the revision column and in the SCI number. Drawings revised as a result of comments by the Engineer shall be so referenced in the revision column. The revision notes shall describe in sufficient detail the change that has been made to the drawing and reference a sheet/page number and the drawing coordinates.

21.7.6 Drawing Standards

Minimum drawing standards for the Contractor's Documents shall be in accordance with Appendix Q – MINIMUM DRAWING STANDARDS FOR CONTRACTORS CAD OPTION.

21.7.7 3D Model Standards

All 3D Project Models and 3D models submitted by the Contractor or vendors may be used as a reference for co-ordination in a central visualization package (Bentley Navigator). The Contractor shall be responsible for providing 3D model files, for all Contractor supplied equipment and all Contractor supplied designs. Models shall be submitted with a known orientation and at true scale in a format which can be imported into the Bentley environment. The format of the files shall be either: .DGN, .DWG, or Parasolid (e.g. Solid Edge). Other formats for import into the 3D Project Models may be considered by the Purchaser on a case by case basis.

(a) Content

The Contractor's 3D models are expected to be dimensionally correct showing all major components and all interface items. 3D models submitted will be verified to shop drawings and specifications, and should be appropriate for interference/clash detection. 3D models may contain geometric modelling of the following:

i) Embedments in concrete
ii) Hoists locations or lifting lugs to be used during installation or maintenance of the equipment
iii) Piping flanges or interfaces

iv) HVAC or exhaust connections/flanges/etc.
v) Electrical components including cable tray, panels and conduits
vi) Instrumentation locations
vii) Access / service space requirements – "Reserved Space" (for use in clash detection)
viii) Any items for which placement or access is critical.

(b) Identification

The Contractor's 3D models submitted for reference may be used by the Purchaser in an asset management system and as such must be capable of allowing identification tags to be assigned by structure and component. This discretization must be accomplished by the use of simplified models accompanied by all critical parametric data.

21.7.8 System Classification Index (SCI)

The Purchaser uses the System Classification Index (SCI) to identify specific drawings and documents pertaining to the Work. Each applicable drawing and document generated and submitted by the Contractor will be assigned a unique document number, which includes a SCI code, by the Purchaser on the submission outlined in the Submittal Schedule, and that number shall appear on all subsequent issues of that drawing or document. All additional documents or drawings will be assigned their own unique document number.

The document number will be marked in the space reserved for the Purchaser.

21.7.9 Engineer's Review

In all instances in the Contract, including in particular, the Technical Specification, where there is a requirement for the Engineer's review, such review shall be conducted in accordance with the following.

The Engineer will review the Contractor's Documents and return to the Contractor an electronic drawing with one of the following notations:

(a) "Reviewed"

Meaning that there are no comments to the technical and/or drafting aspects of the document and the applicable Work may proceed.

(b) "Reviewed As Noted"

Meaning that the applicable Work may proceed with the noted changes incorporated, and that the documents shall be resubmitted for the Engineer's review.

(c) "Amend and Resubmit"

Meaning that the document is technically unacceptable and the applicable Work shall not begin, and that the document shall be resubmitted for the Engineer's review.

Upon receipt of documents marked "Amend and Resubmit" or "Reviewed as Noted", the Contractor shall modify the document and any other documents affected by such modifications and, within 14 calendar days (or such shorter time as indicated by the Submittal Schedule), resubmit to the Engineer for review. The Engineer shall have 7 calendar days (or such shorter time as indicated by the Submittal Schedule) to review the modified or affected documents. Resubmission of documents for the Engineer's review shall in no way affect the Contract Schedule or result in an adjustment to the Adjusted Target Price unless such review takes longer than such 7 day period or such shorter period as indicated by the Submittal Schedule.

All drawings on which revisions are made shall have the changes clearly identified on the drawing with a revision number (or letter) directly adjacent to the change and the location of the revision shall be identified by reference to a grid system on the drawing. A brief description of the revision, including the grid location, shall be listed in the revision column.

21.7.10"As-Built" Drawings

The Contractor shall mark up one set of Purchaser Drawings as "as built" and one electronic colour scan (.PDF) to reflect any changes made during the course of the Work. Upon completion of the Work, the Contractor shall return the above information to the Engineer for review and acceptance.

Changes shall be marked as follows:

i) all revision and new installations shall be in red ink
ii) old names, titles and items replaced/removed will be highlighted in green ink
iii) use capital block text or legible printing
iv) detailed reason for mark-up shall be indicated (including RFI, EWO, CO, NCR reference)
v) unchanged Purchaser's Drawings shall be marked "As Built, No Change"
vi) sign mark-ups with initials, date revised and company name

All changes must be approved by the Engineer before incorporation in the Purchaser's Drawings.

Mark-ups shall be performed on the Purchaser's Drawings in a neat, legible manner and shall fully document the exact extent of the Work performed. If any Contractor's Documents are, in the opinion of the Engineer, incomplete or illegible they shall be completed or redone by the Contractor and these costs shall not form part of the Actual Costs and shall not be invoiced to the Purchaser for payment.

21.7.11 Responsibility for Errors and Deviations

Notwithstanding any review by the Engineer of the Contractor's Documents pursuant to Section 21.7.9 ENGINEER'S REVIEW of the General Specification, review of any Contractor's Documents submitted by or on behalf of the Contractor to the Engineer does not indicate approval, and shall not relieve the Contractor of any obligations, liability, or responsibility for the full and complete performance of the Work in accordance with the Contract. The Contractor agrees that Engineer (and any consultants involved in such review as engaged by the Purchaser) is receiving and reviewing the Contractor's Documents in a general manner only and is not acting in a role that is intended to discover all or any errors in the Contractor's Documents or any deviations from the Technical Specification or other provisions of the Contract that have not been approved through an Extra Work Order or Change Order. Sole responsibility for any such errors or deviations remains with the Contractor notwithstanding that the Contractor's Documents will be reviewed by the Engineer during the performance of the Work and regardless of any failure of the Engineer to discover any errors or deviations in the Contractor's Documents during such review.

21.7.12 Operation and Maintenance Manuals

For guidance of the Purchaser's construction, commissioning, operating and maintenance personnel, the Contractor shall prepare operation and maintenance manuals for all the equipment, plant and systems supplied by the Contractor and/or installed as part of the Permanent Works, describing in detail the construction of each part of the equipment/plant/system and the recommended procedures for installation, commissioning, operation, service and maintenance.

The operation and maintenance manuals shall be indexed in sections, as outlined below, in both the electronic and physical copies of the manuals. The manuals shall be grouped as outlined in the Submittal Schedule. Electronic copies shall be in .PDF format, text searchable and indexed as outlined below. Hard copies shall be assembled in three-ring binders, with the required indexing and labeling on the binder.

An advance, electronic copy of any operation and maintenance manual shall be submitted to the Purchaser, as outlined in the Submittal Schedule, for the Purchaser's review and comments. After final review, two physical and one electronic copy of the operation and maintenance manual shall be submitted.

The Purchaser's qualified personnel with the aid of the Contractor's operation and maintenance manuals are expected to maintain and repair the Contractor supplied equipment. Reliance will not be placed on any other form of assistance, therefore good, easy to understand operation and maintenance manuals are vitally important and required to be provided by the Contractor.

Details
The operation and maintenance manuals shall contain the following:

(a) Outside of Binder and Title Page

i) Each copy of the operation and maintenance manuals shall be clearly titled to show the part of the Work concerned, Project name(s), Purchase Order number, Contract number, Serial number(s), Contractor's reference number, name and address and the date of issue.

(b) Section 1

i) Table of Contents

ii) a spreadsheet listing all the equipment and systems supplied and/or installed as part of the Work with their respective information as follows:

(1) Name of equipment

(2) Model and serial number (or identification number)

(3) Location of the equipment and system

(4) Maintenance requirement (scope and frequency)

(5) Any additional relevant nameplate data

iii) General Information

iv) List of Drawings

v) Principle of Operation

(c) Section 2

i) Instructions for shipping, storage and handling [including environmental data, personal safety and handling instructions and all applicable Material Safety Data Sheets (MSDSs)]

ii) Instructions for assembly of parts

iii) Instructions for testing and commissioning

(d) Section 3

i) Operating instructions (including protection equipment)

ii) Descriptive bulletin on all accessories

(e) Section 4

i) Maintenance instructions (including repair, dismantling, settings of critical clearance and adjustments, oil, gaskets, lubrication, pressure tests, etc., complete with sketches and/or photographs)

ii) Guide to inspection frequency and troubleshooting

iii) Materials list

iv) Lubrication schedule (including quantities and types recommended) or a statement that no lubrication of moving parts is required

(f) Section 5

i) Recommended spare parts and a detailed list of renewable parts (complete with manufacturer's catalogue or part numbers suitably identified by illustrations or by assembly and subassembly drawings)

(g) Section 6

i) Complete set of all final drawings (preferably to a reduced scale)

21.8 Samples

The Contractor shall submit manufacturer's standard samples of Materials, samples specified in the Technical Specification and additional relevant information to the Engineer for approval prior to using the Materials in or for the Work.

Each sample shall be labelled as to origin and intended use in the Work.

21.9 Inspection

All Plant to be provided, Work to be performed and Materials and equipment to be supplied pursuant to the Contract shall at all times be subject to inspection and testing by the Engineer, the Purchaser, or QAR. Any special tests which the Purchaser requires are set forth in the Contract.

The Purchaser's Personnel shall at all reasonable times have full access to all parts of the Site and to all places from which natural Materials are being obtained and during production, manufacture and construction (at the Site and elsewhere), be entitled to examine, inspect, measure and test the materials and workmanship, and to check the progress of manufacture of Plant and production and manufacture of Materials.

The Contractor shall give the Purchaser's Personnel full opportunity to carry out these activities, including providing access, facilities, permissions and safety equipment. No such activity shall relieve the Contractor from any obligation or responsibility pursuant to the Contract.

The Contractor shall give notice to the Engineer whenever any work is ready for inspection at the witness or hold-points described in the inspection and test plan developed by the Contractor and approved by the Purchaser and before such work is covered up, put out of sight, or packaged for storage or transport. The Engineer shall then either carry out the examination, inspection, measurement or testing without unreasonable delay, or promptly give notice to the Contractor that the Engineer does not require to do so. If the Contractor fails to give the notice, it shall, if and when required by the Engineer, uncover the work and thereafter reinstate and make good such work, without resulting adjustment to the Contract Schedule and any resulting costs incurred shall not form part of the Actual Costs and shall not be invoiced to the Purchaser for payment.

If the Purchaser or Engineer shall waive its right of inspecting and testing as herein provided, it shall in no way relieve the Contractor of full liability for the quality, character and performance of the completed Work, and every part of it, nor shall it prejudice or affect the rights of the Purchaser set forth in Sections 21.14 USE OF FAULTY OR DEFECTIVE WORK, 29.1 CONTRACTOR'S DEFAULT, 29.2 TERMINATION BY PURCHASER, 30.2 CONTRACTOR'S INDEMNITY and Section 25 WARRANTY of the General Specification.

21.10 Testing

This Section 21.10 shall apply to all tests specified in the Contract (if any).

Subject to any qualifications elsewhere in the Contract, the Contractor shall provide all apparatus, assistance, documents and other information, equipment, fuel, consumables, instruments, labour, materials, and suitably qualified and experienced staff, as are necessary to carry out the specified tests efficiently. The Contractor shall comply with the instructions of the Engineer as to the time and place for the specified testing of any Plant, Materials and other parts of the Work.

The Engineer may, under Section 27 CLARIFICATIONS AND CHANGES TO THE WORK of the General Specification, vary the location or details of specified tests, or instruct the Contractor to carry out additional tests.

The Contractor shall give the Engineer not less than 24 hours' notice of the Contractor's intention to perform a test. If the Engineer does not attend at the time and place agreed, the Contractor may proceed with the tests, unless otherwise instructed by the Engineer, and the tests shall then be deemed to have been made in the Engineer's presence.

The Contractor shall promptly forward to the Engineer duly certified reports of the tests. When the specified tests have been passed, the Engineer shall endorse the Contractor's test certificate, or issue a certificate to it, to that effect. If the Engineer has not attended the tests, he shall be deemed to have accepted the readings as accurate.

21.11 Rejection

If, as a result of an examination, inspection, measurement or testing, any Plant, Materials or workmanship is found to be defective or otherwise not in accordance with the Contract, the Engineer or QAR, as applicable, may reject the Plant, Materials or workmanship with reasons. All Work, Materials and Plant condemned or rejected by the Engineer or QAR shall be promptly removed and rebuilt or replaced in accordance with the Contract and in a manner satisfactory to the Purchaser. All Work and other property of the Purchaser which is disturbed, injured, damaged or destroyed in the course of removal of the condemned or rejected Work or Materials shall be promptly repaired and made good by the Contractor.

Work performed by the Contractor pursuant to this Section 21.11 shall not result in an adjustment of the Adjusted Target Price.

If the Engineer requires this Plant, Materials or workmanship to be retested, the tests shall be repeated under the same terms and conditions. If the rejection and retesting cause the Purchaser to incur additional costs, these additional costs shall not result in an adjustment to the Adjusted Target Price and any delays shall not result in a Change to the Contract Schedule.

21.12 Faulty or Defective Work

If, in the opinion of the Engineer, the Work, or any portion thereof fails to comply with the requirements of the Contract, or if any tests prove or indicate the existence of any fault or defect in the Work, or any part thereof, the Engineer shall give the Contractor notice as herein provided, together with particulars of such failure, fault or defect, and the Contractor shall forthwith re execute or make good the faulty or defective Work or alter the same to make it comply with requirements of the Contract.

Thereafter, completely new tests shall, if required by the Engineer, or requested by the Contractor, be carried out in the manner provided by Section 21.10 TESTING of the General Specification.

If after such notification, the Contractor shall make default or delay in diligently commencing, continuing and completing the making good of the faulty or defective Work so as to make it comply with the requirements of the Contract, then the Purchaser may do so or cause the same to be done by any person, firm or corporation, in any manner and by any means which the Engineer considers expedient or advisable and recover from the Contractor any incremental costs above the Contractor's reasonable Actual Costs that would have been incurred in such situation.

Work performed by the Contractor pursuant to this Section 21.12 shall not result in an adjustment of the Adjusted Target Price and any delays shall not result in a Change to the Contract Schedule.

21.13 Exception to Payment for Rejected, Faulty or Defective Work

Notwithstanding Sections 21.11 REJECTION and 21.12 FAULTY OR DEFECTIVE WORK of the General Specification, in the event the Engineer determines, based upon supporting evidence and conduct of the Contractor, that:

(a) the Contractor is knowingly disregarding the Technical Specification or other documents comprising the Contract in the performance of the Work; or
(b) the Contractor is knowingly disregarding the Engineer's instructions with respect to the Work; or
(c) the Contractor is knowingly using unsafe or deficient products or materials in the performance of the Work; or
(d) the Contractor has failed to take reasonable steps to correct a continuing error or deficiency in the Work,

and any of the above result in a rejection of any Work in accordance with Section 21.11 REJECTION OF THE GENERAL SPECIFICATION or a finding of faulty or defective Work in accordance with Section 21.12 FAULTY OR DEFECTIVE WORK of the General Specification, then any removal, rebuilding, replacement, repair, re-execution or making good of such Work as provided for in such sections, shall be done at the Contractor's sole cost and expense and these costs shall be considered Ineligible Costs, shall not result in an adjustment of the Adjusted Target Price, and any delays shall not result in an adjustment to the Contract Schedule.

21.14 Use of Faulty or Defective Work

Until all faulty or defective Work has been made good or altered as provided by Section 21.12 FAULTY OR DEFECTIVE WORK and Section 25 WARRANTY of the General Specification, the Purchaser shall have the right to use any such faulty or defective Work and without thereby in any way affecting the Purchaser's rights under Section 21.12 FAULTY OR DEFECTIVE WORK, Section 21.13 EXCEPTION TO PAYMENT FOR REJECTED, FAULTY OR DEFECTIVE WORK, and Section 25 WARRANTY of the General Specification unless the Contractor shall have notified the Purchaser in writing that, in the opinion of the Contractor, the faulty or defective Work cannot be so used without undue risk to the Work or to persons in the vicinity of the Work.

21.15 Royalties, Rents and Other Payments

Except for Materials obtained by the Contractor from third party commercial suppliers, the Purchaser will assume responsibility for obtaining all permits necessary and for payment of royalties and mineral rights on all Materials which, with the Engineer's approval, are removed from natural deposits identified in the Contract and used in the Work.

The Contractor shall remit payment for all royalties, rents and other payments for:

(a) natural Materials obtained from outside the Site except as expressly stated in the preceding paragraph, and
(b) the disposal of material from demolitions and excavations and of other surplus material (whether natural or man-made), except to the extent that disposal areas within the Site are specified in the Contract.

All such remitted payments made by the Contractor for all royalties, rents and other payments as immediately set out above shall be considered a part of the Contractor's Actual Costs. The Contractor will remit any sales tax assessed on processed Materials. In addition, the Purchaser will report on all quantities removed from the borrow areas except for Materials obtained by the Contractor from third party commercial suppliers.

21.16 Imports

The Contractor or its Subcontractors shall be the importer of all non-Canadian goods and services required for performance of its obligations under the Contract.

The Contractor shall provide to the Engineer, on request, the name of the Contractor's Canadian customs broker, the name, address, telephone and internet e-mail address of contact persons representing such customs broker and any other information the Engineer may require in respect of same and/or Contractor's obligations in respect of importing for the Work.

21.17 Sources of Materials

Materials for cofferdams, dams and concrete aggregate shall be obtained from the borrow areas, foundation excavation or third party suppliers as approved by the Engineer or identified in the Contract.

Materials other than those obtained from third party suppliers, shall be obtained from those sources identified by the Purchaser as set out in Appendix R – QUARRY LEASES. The material sources identified have been utilized during the Keeyask Infrastructure Project and are not all in their natural state. Deposit G1 has been depleted by approximately 1,500,000 m^3 and the area currently exploited is identified in Appendix D – DATA FOR PROPONENTS.

22 COMMENCEMENT, DELAYS AND SUSPENSION

22.1 Commencement of Work

The Commencement Date for the Phase II Work is set out in the Articles of Agreement. The Commencement Date may only be modified in the Notice to Proceed referenced in Section 1 THE WORK of the Articles of Agreement or as provided for in Section 3.3 MONITORING of the General Specification.

On and following the Commencement Date, the Contractor shall proceed with the Phase II Work with due expedition and without delay.

22.2 Time for Completion

The Completion Date for the Work is set out in the Articles of Agreement. The Completion Date may only be modified as provided for in Section 3.3 MONITORING of the General Specification.

The Contractor shall complete the whole of the Work by the Completion Date evidenced by the issuance of the Final Completion Certificate in accordance with Section 24.3 TAKING OVER OF THE WORK of the General Specification.

22.3 Rate of Progress

If, at any time progress has fallen (or will fall) behind the current Contract Schedule, then the Engineer may instruct the Contractor to submit, under Section 3.4 CONTRACT SCHEDULE AND FLOAT, a revised Contract Schedule and supporting report describing the revised methods which the Contractor proposes to adopt in order to expedite progress and complete the Work by the Completion Date. The revised Contract Schedule shall not change the Contract Dates, as such dates may only be adjusted by Extra Work Order or Change Order.

As directed by the Engineer, the Contractor shall adopt these revised methods, which may require increases in the working hours and/or in the numbers of the Contractor's

Personnel, Plant and/or Materials subject to Section 27 CLARIFICATIONS AND CHANGES TO THE WORK AND ADJUSTMENTS to the extent the delays are not the responsibility of the Contractor hereunder.

22.4 Delayed Drawings or Instructions

The Contractor shall give Notice to the Engineer whenever the Work is likely to be delayed or disrupted if any necessary drawing or instruction is not issued to the Contractor within a particular time, which shall be in accordance with the Submittal Schedule or Section 21.7.9 ENGINEER'S REVIEW of the General Specification, as applicable. The notice shall include details of the necessary drawing or instruction, details of why and by when it should be issued (which date is not less than the time provided in the Contract for the Engineer to respond), and details of the nature and amount of the delay or disruption likely to be suffered if it is late.

If the Contractor suffers delay and/or additional costs are incurred as a result of a failure of the Engineer to issue any drawing or instruction within the applicable time set out in the Submittal Schedule or Section 21.7.9 ENGINEER'S REVIEW of the General Specification, the Contractor shall be entitled to proceed in accordance with Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification.

However, if and to the extent that the Engineer's failure was caused by any error or delay by the Contractor, including an error in, or delay in the submission of, any of the Contractor's Documents, the Contractor shall not be entitled to an extension of the Contract Schedule or an adjustment to the Adjusted Target Price.

22.5 Delays Caused by Authorities

If the following conditions apply, namely:

(a) the Contractor has diligently applied for all permits, licences, approvals and authorizations required from Authorities sufficiently in advance to allow Authorities the time limits specified by Authorities for their review and processing, or if no time specified then a reasonable time, and once obtained has complied fully with all terms and conditions of such permits, licences, approvals and authorizations; and
(b) these Authorities delay or disrupt the Contractor's Work,

then this delay or disruption will be considered as a cause of delay under Section 22.6(i) REQUEST FOR EXTENSION OF TIME of the General Specification.

22.6 Requests for Extension of Time

The Contractor shall be entitled, subject to Section 33.1 CONTRACTOR'S CLAIMS of the General Specification, to recovery of substantiated costs (which shall be deemed to be Actual Costs that have been paid to the Contractor) and an adjustment of the Adjusted

Target Price and/or an adjustment to the Contract Dates and/or Completion Date for any of the following causes:

(a) any peril insured against pursuant to Section 31 INSURANCE of the General Specification;
(b) unpreventable accident;
(c) terrorism, war or delay caused by war;
(d) vandalism or malicious mischief not reasonably preventable by the Contractor;
(e) riot or civil commotion, including any blockades or disruptions by third parties directed against the Project but excluding disruptions caused by the Contractor's Personnel directed at the Contractor for reasons attributable to the Contractor's failure to comply with applicable collective agreements or applicable Laws;
(f) acts of God;
(g) lawful orders of civil or military Authorities, except if such orders resulted from the failure of the Contractor to comply with the requirements of the Contract and all applicable Laws, including permits, licences, approvals and authorizations from Authorities;
(h) events beyond the reasonable control of the Contractor; and,
(i) a cause of delay for which an entitlement to extension of time is expressly given under a provision of the Contract.

If the Contractor considers itself to be entitled to an extension of Time For Completion of the Work in accordance with the preceding paragraph, the Contractor shall give written notice to the Engineer in accordance with Section 33.1.1 NOTICE OF INTENT TO CLAIM of the General Specification.

After receiving this notice, the Engineer shall proceed in accordance with Section 33.2.2 DETERMINATION OF CLAIM of the General Specification to determine:

i) whether, and (if so) to what extent the factors described in this Section 22.6 resulted in a delay to the completion of the Work;
ii) the resulting adjustment, if any, to the Adjusted Target Price for the substantiated amount of resulting Actual Costs to the Contractor and the Contractor's GA&O Percentage calculated on such Actual Costs but excluding any allowance for the Contractor's Profit Percentage; and,
iii) the resulting extension of time, if any, to be granted to the Contractor, as a result of such delay (if any) to the Time for Completion of the Work.

The Contractor shall have no further recourse or claim against the Purchaser, nor shall it have any right of action against the Purchaser for loss or damage suffered by reason of delay other than set out in this Section 22.6 REQUESTS FOR EXTENSION OF TIME or Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification.

The Contractor shall act promptly and diligently to give notice of, mitigate and, where possible, remove entirely all causes of interruption and delay affecting performance of the Work.

22.7 Purchaser Caused Delay and/or Additional Costs

If the Contractor suffers delay and/or incurs additional costs in relation to the Work as a result of:

(a) A Work Instruction with which the Contractor disagrees or an Extra Work Order issued by the Engineer and which the Contractor disputes;

(b) negligence, delay or default on the part of the Purchaser or any person for whom the Purchaser is at law responsible, including the Purchaser's Project Designer and the Engineer (including any delays and/or additional costs resulting from the Purchaser's failure to obtain or procure the permits that are to be obtained by the Purchaser in accordance with Section 5.2 PERMITS, LICENCES OR APPROVALS FOR THE PROJECT of the General Specification);

(c) Negligence, delay or default on the part of the Other Contractors for whom the Purchaser is responsible (including any defective design of any part of the Work by the Purchaser's Personnel or Purchaser's Project Designer or by others for whom the Purchaser is responsible);

(d) material deviation from the Contract or temporary suspension of the Work by direction of the Engineer that does not arise out of any fault or neglect of Contractor;

(e) a change in the Laws (including the introduction of new Laws and the repeal or modification of existing Laws) coming into force after the date of the Submission that impacts the performance of the Work by the Contractor or the Contractor's obligations pursuant to the Contract;

(f) complying with the instructions of the Engineer:

i) with respect to the discovery of heritage resources as permitted pursuant to Section 7.31 HERITAGE RESOURCES of the General Specification; or

ii) to undertake any additional work not contemplated in the Technical Specification with respect to the removal, abatement, treatment, discovery, relocation or remediation of any hazardous, noxious or otherwise deleterious substances at the Site that were not caused by the fault or negligence of the Contractor or its Subcontractors, provided that if the Engineer instructs the Contractor to so handle such hazardous, noxious or otherwise deleterious substances at the Site, the Purchaser shall indemnify and save harmless the Contractor from and against any and all losses, costs, damages or expenses (including fines and penalties) which the Contractor may suffer or be put to or arising therefrom, except to the extent caused by the Contractor's wilful misconduct or Gross Negligence;

(g) failure of the Engineer to issue notified drawings or instructions within the applicable times set out in Section 22.4 DELAYED DRAWINGS OR INSTRUCTIONS of the General Specification;

(h) failure of the Purchaser to give the Contractor such access to the Site as is required to perform the Work in accordance with Section 5.1 RIGHT OF ACCESS TO THE SITE of the General Specification;

(i) any interference, delays experienced or additional costs incurred by the Contractor that arise as a result of the application of the following clauses:

i) Section 3.9 ADJUSTMENTS TO CONTRACT DATES OR COMPLETION DATE as made by the Engineer or the Purchaser;
ii) Section 5.4 PURCHASER'S DRAWINGS - delays due to the explanation from the Engineer contemplated in such section;
iii) Section 7.32 WEATHER CONDITIONS - adjustments due to Weather Shifts except as excluded by such section;
iv) Section 21.7.4 DOCUMENT SUBMISSION AND TRANSMITTAL PROCESS - delays by the Engineer in reviewing or providing responses to Contractor's Submissions in excess of the time frames contemplated in such section;
v) Section 22.4 DELAYED DRAWINGS OR INSTRUCTIONS; and
vi) Section 22.9 CONSEQUENCES OF SUSPENSION - not caused by the Contractor; or

(j) a provision of the Contract expressly permitting the Contractor to proceed pursuant to this Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification,

then the Contractor shall give Notice to the Engineer in accordance with and within the time limits specified in Section 33.1.1 NOTICE OF INTENT TO CLAIM of the General Specification.

After receiving this Notice within the required time period, the Engineer shall proceed in accordance with Section 33.2.2 DETERMINATION OF CLAIM of the General Specification to determine:

(1) whether, and (if so) to what extent the factors described above resulted in a delay to the completion of the Work and/or a change in the cost to the Contractor to complete the Work;
(2) the resulting extension of time, if any, to be granted to the Contractor as a result of such delay (if any) to the completion of the Work and the adjustment(s) to the applicable affected Contract Dates; and,
(3) the resulting adjustment, if any, to the Adjusted Target Price for the substantiated amount of resulting Actual Costs to the Contractor.

22.8 Suspension of Work

The Engineer may, at any time, instruct the Contractor to suspend progress of part or all of the Work. During such suspension, the Contractor shall protect, store and secure such part or the Work against any deterioration, loss or damage.

The Engineer may identify and determine the cause for the suspension. If and to the extent that Contractor is notified that the cause for the suspension has been determined by the Engineer as the responsibility of the Contractor, the following Sections 22.9 CONSEQUENCES OF SUSPENSION and 22.10 PAYMENT FOR MATERIALS IN EVENT OF SUSPENSION of the General Specification shall not apply and there shall

be no adjustment to the Adjusted Target Price or Contract Schedule on account of that suspension.

22.9 Consequences of Suspension

Where the Contractor is not responsible for the suspension, and suffers delay and/or additional costs are incurred complying with the Engineer's instructions under Section 22.8 SUSPENSION OF WORK of the General Specification and/or from resuming the Work, the Contractor shall be entitled to proceed in accordance with Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification.

22.10 Payment for Materials in Event of Suspension

The Contractor shall be entitled to payment of the value (as at the date of suspension) of Materials which have not been delivered to Site, if:

(a) the work on Site or delivery of Materials has been suspended for more than 28 days, and
(b) the Contractor or its Subcontractor has marked the Materials as the Purchaser's property in accordance with the Engineer's instructions and has not previously been paid for such Materials by the Purchaser; and
(c) the Contractor provides evidence acceptable to the Purchaser that the Contractor has already paid its Subcontractors in full for such Materials.

22.11 Resumption of Work

After permission or instruction to resume the Work is given by the Engineer, the Contractor and the Engineer shall jointly examine the Work and the Plant and Materials affected by the suspension. The Contractor shall make good any deterioration or defect in or loss of the Work or Plant or Materials, which has occurred during the suspension.

Notwithstanding Section 22.9 CONSEQUENCE OF SUSPENSION, the Contractor shall not be entitled to an adjustment to the Contract Schedule and/or Adjusted Target Price for the Contractor's failure to protect, store or secure the Work in accordance with Section 22.8 SUSPENSION OF WORK of the General Specification.

23 CONTRACTOR'S REPORTING

The Engineer shall have the right to require the Contractor's timely delivery of all reports outlined in Section 3 CONTRACT SCHEDULE and Section 23 CONTRACTOR'S REPORTING of the General Specification in a form and content satisfactory to the Engineer. Notwithstanding any provisions to the contrary in the Contract, receipt of such reports within the time periods specified shall be a condition precedent to certification by the Engineer to the Purchaser of payments due to the Contractor pursuant to the Contract. The Engineer shall give the Contractor 30 days prior notice of his intention to implement this condition of the Contract.

23.1 Progress Tracking

The Contractor shall keep a daily record of the Work on Site in accordance with requirements in the General Specification which records shall be available for review by the Engineer.

23.2 Site Meetings

The Contractor shall participate in a daily site meeting with all field supervisors, the Engineer and the Other Contractors. The purpose of this meeting shall be as follows:

- report all of the tasks planned for the day,
- coordinate any interfacing Work,
- outline any issues or threats to the scope and schedule,
- identify any safety hazards related to the work to be undertaken,
- identify any witness or hold points that will require attendance by the Engineer, and
- communicate any other information that will require action by another party.

23.3 Contractor Reporting Requirements

23.3.1 Four-Week Look-Ahead Schedule

The Contractor's information required pursuant to Section 23.1 PROGRESS TRACKING of the General Specification shall be used to prepare a four-week look-ahead schedule. The Contractor shall submit, before 7:00 a.m. (Central Standard Time) on Tuesday, a .xer copy of the complete Contract Schedule showing current progress and filtered activities to display a four-week look-ahead schedule ("Four-Week Look-Ahead Schedule"). The complete Contract Schedule shall be progressed using Physical Percent Complete and submitted on a weekly basis with the Data Date being 12:00 a.m. (Central Standard Time) Sunday from the previous week. A .PDF file of the Four Week Look Ahead Schedule shall also accompany the weekly submission as well as a narrative report summarizing the deviations from the Contract Schedule from the previous week's update in accordance with Sections 3.3 MONITORING and 23.3.3 MONTHLY STATUS REPORT of the General Specification and confirmation that the Contract Dates in the Contract Schedule have been maintained. The Four-Week Look-Ahead Schedule shall show and identify:

(a) The currently approved Contract Schedule as a Primavera P6 "project baseline";
(b) The previously Primavera P6 "primary baseline";
(c) The planned activities for the previous week, indicating progress actually achieved during that week, and all planned activities and deliverables for the next three weeks. The Physical Percent Complete identified on all started activities in the weekly Four-Week Look-Ahead Schedule submissions must match the actual and planned amounts reported in the weekly S-Curve Report on Key Drivers for the same week as required in Section 23.3.2 S-CURVES FOR KEY DRIVERS of the General Specification; and

(d) All approved Changes that impact the Contract Schedule including Extra Work Orders and Change Orders as defined in Sections 27.3.3 EXTRA WORK ORDERS and 27.3.4 CHANGE ORDERS of the General Specification and all key activities that precede and succeed the initiation and approval/rejection of such Change.

The narrative report shall:

(e) Be a "report by exception";
(f) Identify all changes to baseline (the Primavera P6 "project baseline" and "primary baseline") activity durations, start and finish dates, WBS and activity, relationship deletions and/or modifications;
(g) Identify all activities planned as per the "project baseline" but not started, the reason why and the corrective actions planned;
(h) Identify issues that have occurred during the previous week that have negatively or positively affected the baseline;
(i) Identify Work planned for next three (3) weeks that is NOT as per the baseline and provide an explanation why;
(j) Identify and describe risks and/or opportunities to the Work over the next three (3) weeks and beyond;
(k) Identify implemented changes that have affected the approved baseline;
(l) Identify pending changes to the Work that will affect the approved baseline;
(m) Impact to the Float at the WBS level(s); and
(n) Identify all activity and activity relationship deletions, changes to the existing activity ID numbers and any modifications (adds, deletions, relocations) to the Contract Schedule WBS.

The Contractor shall immediately advise the Engineer, in writing, of any changes to the Four-Week Look-Ahead Schedule as soon as the Contractor becomes aware that changes will be required.

23.3.2 S-Curves for Key Drivers

On a weekly basis, the Contractor shall submit S-curves showing plan vs. actual and earned value with a forecast to complete for key drivers. The key drivers may change with the progress of the Work but at a minimum shall include the following:

(a) rock excavation by area
(b) concrete placement by structures
(c) fill placement by structures and material type
(d) craft hours by system/structures
(e) total equipment hours
(f) total cost

The Contractor shall attend weekly review meetings to review the submitted Four-Week Look-Ahead Schedule and the key driver S-curves.

23.3.3 Monthly Status Report

Not later than the seventh calendar day of each month, the Contractor shall prepare and deliver a monthly status report to the Engineer for approval that depicts the status of the Work as of the end of the previous month, in accordance with the requirements of this Section 23.3.3 and Section 3 CONTRACT SCHEDULE of the General Specification (the "Monthly Status Report").

The Monthly Status Report shall report on the progress of the Work relative to the Contract Schedule up to the end of that month. The Monthly Status Report shall describe in full detail any activity which is behind schedule, explaining the reasons and the remedial action which the Contractor is following to regain the Contract Schedule. The Monthly Status Report may, at the Engineer's option, be of the type commonly known as "report by exception" in which those activities not behind schedule are dealt with in a summary form only. The Engineer reserves the right to waive the requirement for the Contractor to submit a Monthly Status Report in periods when there is little or no Work activity.

The following documents and information shall be included in each Monthly Status Report:

(a) a transmittal letter,
(b) a description of Work performed since the last report,
(c) photographs showing the status of the Work at Site,
(d) S-curve graphs showing planned, actual and earned values and forecast to complete for major items and key drivers such as rock excavation, concrete placement, dam fill placement total contract cost and craft hours,
(e) Schedule showing the actual progress to date and projected start/completion dates compared to the Contract Schedule as a baseline,
(f) a description of the current Critical Path,
(g) a description of problems encountered or anticipated that affect the actual progress matching the Contract Schedule,
(h) a description of current and anticipated Work which do not or will not meet any dates, including Contract Dates, set out in the Contract Schedule, including:
    i) identification of the impacted activity, by activity ID and description,
    ii) Root cause of the issues resulting in the missed dates, including Contract Dates,
    iii) effect on other activities, milestones, completion dates and Contract Dates,
    iv) a statement of corrective actions to be taken,
(i) a statement that identifies and explains proposed changes to be incorporated in the next revision of the Contract Schedule (which remain subject to the approval of the Engineer), including, but not limited to:
    i) added activities
    ii) deleted activities
    iii) changed activity descriptions
    iv) changed relationships
    v) changes in the original durations of activities not started

vi) increases in the remaining duration of unfinished, previously started activities
vii) impacts on the Critical Path,

(j) the status of pending items, including, but not limited to:
i) permits
ii) Requests for Information, Work Instructions, Proposals for Extra Work, Extra Work Orders and Change Orders
iii) time adjustments
iv) non-compliance notices
v) records showing on-the-job, cross cultural, safety and environmental training,

(k) such other information as directed by the Engineer, and

(l) the Four-Week Look-Ahead Schedule, the Daily Record, and Safety Documentation and Records all as further described in this Section 23 CONTRACTOR'S REPORTING of the General Specification.

Discussion/notification of any matter or issue in a Contract Schedule update, Monthly Status Report or meeting, including with respect to any delays, will not constitute notice and will not replace the requirement for the Contractor to provide notices as required by the Contract or diminish the requirement for all changes to the Contract Schedule to be formally approved in accordance with Section 27 CLARIFICATIONS AND CHANGES TO THE WORK of the General Specification.

23.3.4 Quarterly Cash Flow Projections

Not later than the seventh calendar day of each quarter, the Contractor shall prepare and deliver a cash flow report to the Engineer for approval that depicts the status of the Contractor's monthly cash flow for the Work as of the end of the previous quarter, together with the Contractor's updated current projection of the total of the Actual Costs to completion of the Contract.

23.3.5 Daily Record

In addition to the Monthly Status Report described above, the Contractor shall keep a daily record of the Work at Site (the "Daily Record"), which shall be available for review by the Engineer. The Daily Record shall include particulars of weather conditions, number of workers at Site (by trade), details of shifts actually worked (hours/day/person), deliveries of products, amount and location of Work, procurement and delivery status, and all other pertinent information reasonably required by the Engineer. A copy of the Daily Record sheets prepared by the Contractor shall be hand delivered to the Engineer by 18:00 of the following Working Day.

The Contractor shall monitor the progress of the Work against the Contract Schedule and notify the Engineer in writing immediately upon becoming aware of any potential delays or factors that could cause a delay in achieving the Contract Dates, as well as the remedial steps the Contractor is taking or intends to take to remedy the delays.

23.3.6 Safety Documentation and Records

In relation to safety documentation and records, the Contractor shall:

(a) Maintain up-to-date records and report by the quickest means available to the Purchaser, the Project Workplace Safety and Health Committee, and the Manitoba Workplace Safety and Health Division as required by applicable Laws all incidents identified in the paragraph (b) below and follow up with investigations and reports for all items listed below. The Contractor reporting for such incidents shall require:
   i) Verbal notification, by the quickest means available, will be given to the Purchaser's safety officer or Engineer or their delegate;
   ii) Follow up written notification will occur within two hours;
   iii) Investigations of an incident will occur within 24 hours of the incident; and,
   iv) All reporting will be completed by the Contractor as required by the Purchaser and applicable Laws;

(b) Prepare and deliver to the Purchaser's safety officer a monthly safety report within its Monthly Status Report that depicts the number of:
   i) Fatalities
   ii) Dangerous occurrences (near miss events)
   iii) Medical and first aid injuries
   iv) Vehicle and heavy equipment incidents
   v) Fire incident reports
   vi) Hazardous material spill incident reports
   vii) Lost time injuries
   viii) Lost time days
   ix) Person hours worked in the month
   x) Improvement orders received by the Manitoba Department of Labour
   xi) Stop work orders received by the Manitoba Department of Labour
   xii) Workers that received the Project safety orientation
   xiii) Workplace inspections completed, and
   xiv) Weekly safety meetings held.

The Contractor will maintain a cumulative total by fiscal year starting April 1 and ending March 31 each year for this data and report variance changes with an explanation for the change by month.

(c) Submit suitable documentation proving worker qualification on the use of all services or equipment provided for their protection to demonstrate compliance with Section 8.6 WORKER TRAINING AND EDUCATION of the General Specification.

23.3.7 Employee Report – Keeyask Project

The Purchaser maintains a project database to track and report on employment statistics on the Keeyask Project.

The Contractor shall collect, on behalf of the Purchaser, all information requested on Purchaser's Form 2669b set out in Appendix S - EMPLOYEE REPORT. The collection and handling of the personal information on the Purchaser's Form 2669b shall be in compliance with the privacy provisions of *The Freedom of Information and Protection of Privacy Act* (Manitoba).

The Contractor shall facilitate the completion of Form 2669b by the Contractor's employee on the same day that the Contractor's employee commences work and promptly submit the form to the Purchaser. In addition, when the Contractor's employee has been terminated or reclassified, or the Work completed, the Contractor shall promptly forward the information contained in Part II – Separation Data or Part III – Reclassification Data of the form (as applicable) to the Purchaser.

For the purposes of this Section 23.3.7, a Contractor's employee is defined as a person employed by the Contractor or Subcontractor, as applicable, to perform the Work or part of the Work and who is on Site for one or more working days.

The Contractor shall submit the Employee Report to the Purchaser on a monthly basis in conjunction with the Contractor's Monthly Status Report as a separate document.

23.3.8 Contractor Labour Report – Keeyask Project

The Purchaser is required to collect labour data on hours worked, and labour income statistics related to the Keeyask Project, for socio-economic reporting purposes.

The Contractor shall provide the Purchaser with regular updates regarding labour data, including with respect to its Subcontractors, as requested on the Purchaser's forms set out in Appendix T - CONTRACTOR LABOUR REPORT.

These updates shall be electronically submitted to the Purchaser on a monthly basis using the method as determined by the Purchaser (in Microsoft Excel, a web based interface such as InfoPath, or other format) and in conjunction with the Contractor's Monthly Status Report as a separate document.

23.3.9 Contractor Purchasing Report – Keeyask Project

The Purchaser is required to collect data on purchasing statistics related to the Keeyask Project, for socio-economic reporting purposes.

The Contractor shall provide the Purchaser monthly updates regarding purchasing data, including with respect to its Subcontractors, as requested on the Purchaser's forms set out in Appendix U - CONTRACTOR PURCHASING REPORT.

These updates shall be electronically submitted to the Purchaser on a monthly basis using the method as determined by the Purchaser (in Microsoft Excel, a web based interface such as InfoPath, or other format) and in conjunction with the Contractor's Monthly Status Report as a separate document.

23.3.10 Contractor On-the-Job Training Report – Keeyask Project

The Purchaser is required to collect data and track on-the-job training statistics experienced on the Keeyask Project.

The Contractor shall submit to the Purchaser monthly updates regarding its On-the-Job Training Program, as requested on the Purchaser's forms set out in Appendix V - CONTRACTOR'S ON-THE-JOB TRAINING REPORT.

These updates shall be electronically submitted to the Purchaser on a monthly basis using the method as determined by the Purchaser (in Microsoft Excel, a web based interface such as InfoPath, or other format) in conjunction with the Contractor's Monthly Status Report as a separate document.

23.3.11 Workforce Monitoring Report

The Purchaser is required to collect data on the status of the workforce at Site for the purposes of reporting actual workforce information for the Keeyask Project.

The Contractor shall assemble the data showing the number of workers at Site on the 15th day of each month. The data shall include the information from all Subcontractors and shall be detailed by trade. This report is required for the duration of the Work using the Purchaser's form set out in Appendix W - WORKFORCE MONITORING REPORT.

If the 15th day of any month is a non-working day, the date to be used for the purposes of completing this report shall be the next working day.

These updates shall be electronically submitted to the Purchaser on a monthly basis using the method as determined by the Purchaser (in Microsoft Excel, a web based interface such as InfoPath, or other format) and in conjunction with the Contractor's Monthly Status Report as a separate document.

23.4 Contractor's Records

In addition to the reporting requirements set out in Section 23.3 CONTRACTOR'S REPORTING REQUIREMENTS of the General Specification, the Contractor shall:

(a) keep full and detailed records, reports, schedules, books, accounts, correspondence, instructions, drawings, receipts, vouchers, memoranda, and records of labour force, Materials, Plant, Tools, equipment, hours worked and rates required to properly appraise the progress of the Work, (herein "Contractor's Records") necessary for the proper administration of the Contract and the Work;
(b) provide the Engineer and/or the Purchaser with copies of any Contractor's Records when requested;
(c) provide the Engineer and/or the Purchaser with reasonable access to any premises to inspect and/or audit the Contractor's Records, and permit copies to be made of same; and

(d) preserve Contractor's Records for a period of not less than ten (10) years from the date of the Final Completion Certificate provided for in Section 24.3 TAKING OVER OF THE WORK of the General Specification.

24 PURCHASER'S TAKING OVER

24.1 Taking Over of Part(s) of the Work

The Engineer may issue:

(a) an Interim Completion Certificate, or
(b) a Completion Certificate,

for any part of the Permanent Works.

An Interim Completion Certificate will authorize the Contractor: (i) to cease, for a period of time determined by the Engineer, to be responsible for the care of the part of the Work handed over to the Purchaser or to another contractor for installation or other work to proceed prior to return of that part of the Work to the Contractor for completion of that part of the Work; and (ii) to retake responsibility for the care of such part of the Work.

Upon issuance of a Completion Certificate for a part of the Work, the same processes and provisions shall apply to that part of the Work as apply to all of the Work in Section 24.3 TAKING OVER OF THE WORK of the General Specification.

24.2 Conditions for Issuance of Interim Completion Certificate or Completion Certificate

The Contractor shall perform the following activities immediately prior to application for an Interim Completion Certificate or a Completion Certificate:

(a) Make a thorough inspection of all finishes, fixtures, and equipment and ensure proper workmanship and operation of the applicable Work;
(b) Carefully inspect all applicable Work and ensure that it is complete in accordance with the requirements of the Contract (except for any minor outstanding work and defects which will not substantially affect the use of the Work for their intended purpose (either until or while this work is completed and these defects are remedied) which outstanding work or defects shall be noted on a deficiency list), that all processes and related equipment is fully operational, that all major and minor construction deficiencies are complete and/or corrected, and that clean up works have been completed. Notify the Engineer in writing, of satisfactory completion of inspection and request an Engineer's inspection;
(c) In respect of a Completion Certificate only, forward to the Engineer all complete Quality Dockets, inspection and approval certificates, test reports, warranties, maintenance manuals, operating instructions, as-built drawings, and other documents specifically required by the Contract in relation to the applicable Work but not previously submitted; and

(d) During the Engineer's inspection, a list of deficiencies will be drawn up and signed by the Engineer. This deficiency list may be amended if additional deficiencies are found during future inspections.

24.3 Taking Over of the Work

Subject to the provisions of the Contract that by their nature continue to apply, as soon as the final inspection and/or tests shall have shown that the Work, or any unit section thereof, has completely fulfilled the requirements of the Contract, except for any minor outstanding work and defects which will not substantially affect the use of the Work for its intended purpose (either until or while this work is completed and these defects are remedied) which outstanding work or defects shall be noted on a deficiency list, the Engineer will issue a Completion Certificate to the Contractor, and from and after the date of said Certificate, subject to the satisfactory completion and/or correction of the outstanding work or defects, the Purchaser shall be deemed to have accepted and taken over the Work, or the unit section thereof, as the case may be. The Contractor shall complete any work on the deficiency list which is outstanding on the date stated in the applicable Completion Certificate, within a reasonable time as instructed by the Engineer.

The Purchaser will issue nine Completion Certificates upon the occurrence of the following events (as determined by the Engineer):

(a) one Completion Certificate upon the Spillway being placed in service for stage II river diversion;
(b) seven separate Completion Certificates upon the completion of all Work required to permit the start of final commissioning of each of the seven turbine-generator units; and
(c) the final Completion Certificate upon completion of the balance of all outstanding Work pursuant to the Contract, including such items on the deficiency lists (which shall be deemed to be the "Final Completion Certificate" for the purposes of the Contract).

25 WARRANTY

25.1 Warranty Period

A 24 month warranty period for the applicable Work performed and supplied by or on behalf of the Contractor (which shall not include the Purchaser's Equipment, the Purchaser's Materials or any part of the Work supplied or performed by the Purchaser) will commence on the date of the applicable Completion Certificate issued pursuant to Section 24.3 TAKING OVER OF THE WORK of the General Specification (the "Warranty Period"); provided, however, that in the case of the Spillway the Warranty Period shall expire on the later of: (i) 24 months following the issuance of the applicable Completion Certificate; and (ii) the 30th day following the Purchaser's first reasonable opportunity to inspect the Spillway structure after it is put into use.

25.2 Contractor's Warranty Obligations

If, during the applicable Warranty Period, the applicable Work or any part thereof:

(a) becomes broken or defective or fails due to faulty or improper design (in so far as the Contractor is responsible for the design of the Work pursuant to the Contract), materials, workmanship, manufacture, fabrication, shipment or delivery, or,
(b) fails due to faulty or improper construction, erection, inspection or installation, or,
(c) fails to meet the requirements of the Contract,

then the Contractor shall, upon notification in writing from the Purchaser, as soon as possible thereafter make good every such breakage, defect or failure; provided further that the applicable Work or any part thereof made good under this Section 25.2 shall be subject to all the provisions of this Section 25.2 for a further period of 12 months from the date when the same has been made good as aforesaid and the Warranty Period shall be deemed to be extended by such period in relation to the applicable Work or any part thereof made good under this Section 25.2. All costs for such repairs shall be included in the Actual Costs and the Contractor's entitlement to the Contractor's GA&O Percentage and the Contractor's Profit Percentage on such Actual Costs shall be in accordance with and subject to the Terms and Conditions of Payment.

Notwithstanding the foregoing, the Purchaser reserves the right to schedule when warranty work must be commenced and completed by Contractor to address safety concerns, potential adverse environmental effects, and to mitigate loss of revenue by Purchaser once operations commence. In such case, the Parties shall mutually agree on when and how the Contractor shall correct and remedy such defect in or failure of a part of the Work to satisfy the warranties under the Contract. If the agreed delay in commencing warranty work is more than 30 days, depletion of the warranty period shall be suspended by the length of the additional delay by which the warranty work can commence.

25.3 Failure to Remedy Defects

If, following written notification from the Purchaser, as provided for in Section 25.2 CONTRACTOR'S WARRANTY OBLIGATIONS of the General Specification, the Contractor fails to remedy any defect within a reasonable time, or within such time period as agreed pursuant to Section 25.2 CONTRACTOR'S WARRANTY OBLIGATIONS of the General Specification, a date may be fixed by (or on behalf of) the Purchaser, on or by which the defect is to be remedied. The Contractor shall be given reasonable notice of this date.

If after such written notification as provided in the immediate preceding paragraph the Contractor shall make default or delay in diligently commencing, continuing and completing the making good of such breakage, defect or failure in a manner satisfactory to the Purchaser, then the Purchaser may proceed to do so and to place the Work in good operating condition in accordance with the Contract, and the Contractor shall be liable for any incremental costs, charges and expenses incurred by the Purchaser in connection

therewith and shall pay to the Purchaser an amount equal to such costs, charges and expenses, upon receipt of invoices therefore certified correct by the Purchaser.

If the defect deprives the Purchaser of substantially the whole benefit of the Work or any major part of the Work, the Purchaser may terminate the Contract as a whole or, in respect of such major part which cannot be put to the intended use.

If the Contractor disagrees with the Purchaser's termination of the Contract as provided for above, the Contractor shall be entitled to proceed in accordance with Section 33 CLAIMS, DISPUTES AND ARBITRATION of the General Specification.

25.4 Removal of Defective Work

If, following notification from the Purchaser, as provided for in Section 25.2 CONTRACTOR'S WARRANTY OBLIGATIONS of the General Specification, a defect cannot be remedied expeditiously on the Site and the Purchaser gives consent, the Contractor may remove from the Site for the purposes of repair such parts of the Work as is or are defective.

25.5 Further Tests

If, the remedying of any defect by the Contractor during any Warranty Period may affect the performance of the Work, the Engineer may require the repetition of any of the tests described in the Contract. The requirement shall be made by notice to the Contractor within 28 days after the defect is remedied.

These tests shall be carried out in accordance with the terms applicable to the previous tests.

25.6 Right of Access

Until all Warranty Periods have expired, the Contractor shall have such right of access to the Work as is reasonably required in order to comply with this Section 25 WARRANTY of the General Specification, except as may be consistent with the Purchaser's reasonable security restrictions.

25.7 Unfulfilled Obligations

After all Warranty Periods have expired, each Party shall remain liable for the fulfillment of any obligation which remains unperformed at that time. For the purposes of determining the nature and extent of unperformed obligations, the Contract shall be deemed to remain in force.

25.8 Clearance of Site

Within a reasonable time upon completion of the Work, the Contractor shall remove any remaining Contractor's Plant, surplus material, wreckage, rubbish and Temporary Works

from the Site failing which the Engineer shall issue written notice demanding such removal.

If these items have not been removed within 28 days after the date of the Engineer's notice for removal, the Purchaser may sell or otherwise dispose of the remaining items. The Purchaser shall be entitled to be paid the costs reasonably incurred in connection with, or attributable to such sale or disposal and restoring the Site.

The Purchaser is entitled to set off its costs of such sale, disposition and restoration against any and all sums otherwise payable to the Contractor on any account whatsoever and any costs not set off in such manner, shall constitute a debt due by the Contractor to the Purchaser and the Contractor shall pay such amount to the Purchaser within 30 days following receipt of the Purchaser's written demand therefor.

25.9 Subcontractor Warranties

The Contractor shall take commercially reasonable efforts to ensure that all Subcontractor warranties provided by or obtained in relation to the Work shall be assignable to the Purchaser or the Keeyask Hydropower Limited Partnership at the Purchaser's written request, in accordance with Section 7.9 ASSIGNMENT OF BENEFIT OF SUBCONTRACT of the General Specification, without further action or expense and without conditions.

25.10 Exclusions from Warranty

The Contractor does not warrant the Work against damage caused by the Purchaser's failure to operate and maintain the completed Work in accordance with the recommendations set forth in the operation and maintenance manuals provided by the Contractor pursuant to Section 21.7.12 OPERATION AND MAINTENANCE MANUALS of the General Specification or with the written instructions, directions or recommendations provided by the manufacturer or supplier of any of the Purchaser's Equipment or Purchaser's Materials.

26 MEASUREMENT AND EVALUATION

26.1 Work to be Measured

The Work shall be measured and valued for payment in accordance with this Section 26.1.

Whenever the Engineer requires any part of the Work to be measured, reasonable notice shall be given to the Contractor's Representative, who shall:

(a) promptly either attend or send another qualified representative to assist the Engineer in making the measurement; and
(b) supply any particulars requested by the Engineer.

If the Contractor fails to attend or send a representative, the measurement made by (or on behalf of) the Engineer shall be deemed to be accepted by the Contractor as accurate.

Except as otherwise stated in the Contract, wherever any Permanent Works are to be measured from records, these shall be prepared by the Engineer. The Contractor shall, as and when requested, attend to examine the records prepared by the Engineer, and shall sign the same if and when agreed. If the Contractor does not attend, the records shall be accepted as accurate.

If the Contractor examines and disagrees with the records, and/or does not sign them as agreed, then the Contractor shall give notice to the Engineer of the respects in which the records are asserted to be inaccurate. After receiving this notice, the Engineer shall review the records and either confirm or vary them. If the Contractor does not so give notice to the Engineer within 14 days after being requested to examine the records, they shall be accepted as accurate.

26.2 Method of Measurement

Methods of measurement shall be in accordance with the Contract.

27 CLARIFICATIONS AND CHANGES TO THE WORK

27.1 General

There will be four (4) mechanisms for clarifying, documenting and making changes to the Work as summarized in the table below:

Mechanism	Initiated by	Function
Work Instruction (WI)	Engineer	Clarification to the Work
Request for Information (RFI)	Contractor or Engineer	Clarification to the Work
Extra Work Order (EWO)	Purchaser	Approves Change to the Work, related to the Contract Scope
Change Order	Purchaser	Approves Change to the Work, not related to the Contract Scope

Each of these mechanisms are described in this Section 27 CLARIFICATIONS AND CHANGES TO THE WORK AND ADJUSTMENTS of the General Specification.

In addition, the Engineer may exchange information in writing with the Contractor by way of letter on each Party's respective letterhead, transmitted as provided for in the Contract but only to communicate information that is not able to be communicated by the mechanisms identified in the table above.

The Purchaser will not recognize and neither party shall be able to enforce clarifications or changes to the Work unless they are a Work Instruction, a Request for Information, an Extra Work Order or a Change Order.

All clarifications and changes to the Work shall be performed strictly in accordance with the terms of the Contract insofar as terms of the Contract are applicable thereto.

The class and competency of employee used on changes to the Work shall be the same as that used or employed on Work of similar character done in the course of the Contract.

27.2 Clarifications to the Work

27.2.1 Work Instructions

Work Instructions are instructions and clarifications issued by the Engineer using the Work Instruction form set out in Appendix Y - STANDARD CONSTRUCTION FORMS. The Work Instruction may take the form of a specification, drawing, schedule, sample, model, written instruction, explanation, clarification, confirmation, correction or other directive containing additional information that is consistent with the intent of the Contract and that directs the proper performance of the Work.

Work Instructions are enforceable clarifications or refinements of the Contract, not amendments thereto. Work Instructions shall not be used as the basis for entitlement to an adjustment in, or to Change the scope of the Work or the Adjusted Target Price or Contract Schedule.

Upon receipt of a Work Instruction, the Contractor shall promptly proceed with the Work as clarified therein.

27.2.2 Requests for Information

Requests for Information are requests for clarifications to the Work made by the Contractor to the Engineer or the Engineer to the Contractor using the Request for Information form set out in Appendix Y - STANDARD CONSTRUCTION FORMS. The Request for Information is a written request, containing sufficient information that is necessary to fully describe the request and that will allow the recipient to respond without requiring additional clarification from the requestor.

Upon receipt of a Request for Information, the recipient shall take the time necessary to fully respond. If the time to respond will exceed 14 days, the recipient will notify the requestor in writing. The Parties may agree to reduce the time required for such response.

If the Request for Information did not contain sufficient detail to allow the recipient to respond, the Request for Information form shall be returned to the requestor within 7 calendar days with a description of the information required. Only once the required details are obtained by the recipient as attachments to the Request for Information form, will the recipient be required to respond within 14 calendar days or notify the requestor of a required extension to the response period.

Requests for Information shall not be used as the basis for entitlement to an adjustment in, or to Change the scope of the Work or the Adjusted Target Price or Contract Schedule.

27.3 Changes to the Work

The Purchaser shall have the right at any time prior to the Completion Date, and for any reason whatsoever, to make Changes to the Work or any part thereof, that are within the general scope of the Contract, either before or after the commencement thereof. Such Changes may include:

(a) Changes to the quantities of any item of the Work included in the Contract;
(b) Changes to the quality and other characteristics of any aspect of the Work;
(c) deduction or removal of any item or aspect of the Work; or
(d) addition of any work, Plant, Materials, labour or other services necessary or incidental to the Work.

The Contractor shall not make any alteration and/or modification of the Work unless and until any Change set out above has been approved in accordance with this Section 27 of the General Specification.

The process for such Changes is set out in more detail in Section 27.3.1 PROPOSAL FOR EXTRA WORK and 27.3.2 EXTRA WORK ORDERS of the General Specification.

27.3.1 Proposal for Extra Work

A Proposal for Extra Work is a request made by the Engineer or Contractor using the Proposal for Extra Work form set out in Appendix Y- STANDARD CONSTRUCTION FORMS.

When initiated by the Engineer, the Proposal for Extra Work is a formal request for an estimate of the costs anticipated to be incurred and additional time spent by the Contractor for additional work required. The Contractor's estimate shall be attached to the Proposal for Extra Work form initiated by the Engineer and the whole of the two documents together shall be treated as a Proposal for Extra Work.

When initiated by the Contractor, the Proposal for Extra Work is a formal proposal for an alternate to the Work.

Upon receipt of a Proposal for Extra Work the Contractor, in the case of a request for quotation, or Engineer, in the case of a proposal for an alternate, shall take the time necessary to fully respond. If the time to respond will exceed 28 days, the requesting party shall be notified in writing. The parties may agree to reduce this 28 day period in respect of any given Proposal for Extra Work.

If the Proposal for Extra Work did not contain sufficient detail to allow a response, the Proposal for Extra Work form shall be returned within 7 days to the initiating party with a

description of the information required. Only once the required details are obtained by the responding party, as attachments to the Proposal for Extra Work form, will the responding party be required to respond within 28 days or notify the requesting party of a required extension to the response period.

When the Contractor responds to a Proposal for Extra Work, in the case of a request for an estimate, the Proposal for Extra Work shall be valid for a period of 28 days from the date of receipt by the Engineer of the Contractor's quotation. Such Proposal for Extra Work may be accepted by the Purchaser providing written notice to the Contractor in the form of an Extra Work Order or Change Order issued by the Engineer.

When the Contractor initiates a Proposal for Extra Work, the Contractor's proposal shall be valid for a period of 28 days from the date of receipt by the Engineer. Such Proposal for Extra Work may be accepted by the Purchaser providing written notice to the Contractor in the form of an Extra Work Order or Change Order issued by the Engineer.

27.3.2 Extra Work Orders

Extra Work Orders are formal approval of Changes by the Purchaser where the Change is related to the original Contract scope of the Work. The Purchaser through the Engineer may issue a written Extra Work Order using the Extra Work Order form set out in Appendix Y- STANDARD CONSTRUCTION FORMS. The Extra Work Order must in all cases be signed by the Purchaser in order to be valid and upon such signing shall form part of the Contract.

Where time permits, the Extra Work Order shall attach or reference the Proposal for Extra Work that documents the agreed upon details regarding the Change.

Notwithstanding any provision of Section 27.3.1 PROPOSAL FOR EXTRA WORK of the General Specification or the preceding sentence, if the Purchaser requires the Contractor to proceed with a Change prior to the parties reaching agreement regarding the details of the applicable Proposal for Extra Work, or in the absence of such agreement, the Purchaser, through the Engineer, shall be entitled to issue an Extra Work Order to proceed with the Change.

Upon receipt of a written Extra Work Order from the Engineer and signed by the Purchaser, the Contractor shall promptly proceed with the Change.

An Extra Work Order may be used to Change the Adjusted Target Price and/or Contract Schedule.

Adjustments to the Adjusted Target Price as a result of the Change directed by the Purchaser in an Extra Work Order shall be determined in accordance with Section 28 PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK of the General Specification and in accordance with the Terms and Conditions of Payment. Any resulting adjustment to the Adjusted Target Price and the Contract Schedule shall be specified in the applicable Extra Work Order.

27.3.3 Change Orders

Change Orders are formal approval of Changes by the Purchaser where the Change is not related to the original Contract scope of the Work. The Change Order is issued by the Purchaser, through the Engineer, as an additional item of the Work. The Change Order shall attach or reference the Proposal for Extra Work that documented the agreed upon details regarding the Change. Change Orders must be signed by both the Purchaser and the Contractor and upon such signing shall form part of the Contract.

Upon the signature of a Change Order as set out above, the Contractor shall promptly proceed with the Change in the Work.

Adjustments to the Adjusted Target Price as a result of the Change to the Work set out in a Change Order shall be determined in accordance with Section 28 PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK of the General Specification and the Terms and Conditions of Payment. Any resulting adjustment to the Adjusted Target Price and the Contract Schedule shall be specified in the applicable Change Order.

27.4 Contract Amendments

Any amendments to the Articles of Agreement or any Sections in the General Specification, the Terms and Conditions of Payment or the ECIS Agreement shall be documented in an amending agreement signed by both Parties.

27.5 General Duty to Mitigate

Without limiting but in addition to all other duties to mitigate required by the Contract or at law, in all cases where the Contractor is entitled to receive from the Purchaser any additional compensation, expenses, costs or extensions of time, including for or resulting from Changes, Change Orders and Extra Work Orders, the Contractor shall use commercially reasonable efforts and due diligence to mitigate and reduce the amount required under the Agreement to be paid by the Purchaser to the Contractor, any adjustments to the Adjusted Target Price, and any adjustments to the Contract Schedule in consequence thereof. For purposes of the foregoing, references to commercially reasonable efforts and to the exercise of due diligence shall be construed to be those that would typically be exerted by responsible major international contractors in comparable circumstances to minimize the Actual Costs and delays in meeting the Contract Schedule. Upon request from Purchaser, the Contractor shall promptly submit:

(a) the Contractor's recommendations of reasonable measures and steps that are available to mitigate against any increase in the Actual Costs and delays in meeting the Contract Schedule; and

(b) a detailed description, supported by all such documentation as the Purchaser may reasonably require, of the measures and steps already taken or that are being taken by the Contractor to mitigate against any increase in the Actual Costs and delays in meeting the Contract Schedule.

28 PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK

The method for pricing and payment of all adjustments to the Adjusted Target Price due to Changes to the Work by virtue of Extra Work Order or Change Order pursuant to Section 27 CLARIFICATIONS AND CHANGES TO THE WORK of the General Specification or pursuant to Section 33.1 CONTRACTOR'S CLAIMS of the General Specification shall be as follows:

(a) for Extra Work Order in accordance with the Terms and Conditions of Payment.

(b) for Change Orders, in accordance with the Terms and Conditions of Payment, subject to the Change Order confirming those costs that are eligible as part of the Actual Costs, the adjustment to the Adjusted Target Price, and the adjustment to the Contract Schedule, or as otherwise agreed upon by the parties as set out in the Change Order.

29 DEFAULT AND TERMINATION

29.1 Contractor's Default

If the Contractor:

(a) abandons the Work;
(b) fails to perform any material aspect of the Work in accordance with the terms and provisions specified in the Contract;
(c) becomes bankrupt or insolvent, or makes an assignment for the general benefits of creditors;
(d) permits any execution to be levied on the Contractor's real or personal property used in the performance of the Work;
(e) assigns or sublets the Contract other than in accordance with the requirements of the Contract;
(f) refuses or neglects to follow the instructions of the Engineer in any material respect;
(g) materially fails to meet the Engineer's requirements for material, Plant, methods and/or labour within a reasonable time, or as the case may be, within the time(s) required, or that may be required, pursuant to the terms and conditions of the Contract;
(h) materially refuses or neglects to use measures to protect the Work from damage;
(i) is careless or incompetent in a material respect in the execution of the Work;
(j) delays the Work or any part thereof unnecessarily or unreasonably;
(k) fails to pay its Subcontractors in accordance with the terms of any Subcontractor agreement, except in the case of a bona fide dispute with the Subcontractor, and such non-payment has or may have a material adverse effect on the Work;

(l) fails to pay any Delay Liquidated Damages when due or has paid or has become liable for Delay Liquidated Damages in an amount equal to the Delay Liquidated Damages Cap; or

(m) is in material default of any other of its covenants or obligations in, or arising from, the Contract,

then the Purchaser may, in its discretion, and without prejudice to any other rights or remedies:

i) employ additional labour and/or purchase, lease or otherwise obtain additional or suitable material, Plant, and Tools at such price or prices as the Purchaser deems proper;

ii) remove unsuitable or inefficient material, Plant and Tools from the Site;

iii) take over and carry on any part of the Work through the Purchaser's own forces or Other Contractors; and/or

iv) give notice of intention to terminate the Contract as provided in Section 29.2 TERMINATION BY PURCHASER of the General Specification.

Any costs incurred by the Purchaser in connection with paragraphs i), ii) and iii) above shall be deemed to be Actual Costs that have been paid to the Contractor.

29.2 Termination by Purchaser

If the Contractor makes default in any manner set forth in Section 29.1 CONTRACTOR'S DEFAULT paragraphs (b), (d), (e), (f), (g), (h), (i), (j), (k), (l) or (m) of the General Specification or as set forth in Section 13 COMPLIANCE WITH BURNTWOOD/NELSON AGREEMENT of the General Specification, the Purchaser may give written notice to the Contractor of the Purchaser's intention to terminate the Contract, stating the reasons therefor. If the Contractor does not remedy or take steps to remedy the default to the satisfaction of the Purchaser (such steps to include the provision by the Contractor of a schedule to remedy the default for approval by the Purchaser), within ten (10) days of receipt of such notice, the Purchaser, may, without prejudice to any other rights or remedies, by further written notice to the Contractor, forthwith terminate the Contract.

If the Contractor makes default in any manner set forth in Section 29.1 CONTRACTOR'S DEFAULT paragraphs (a) or (c) of the General Specification, the Purchaser may, without prejudice to any other rights or remedies, by written notice to the Contractor, immediately terminate the Contract. In the event of any termination of the Contract as provided herein, the Contractor shall thereupon discontinue the Work and shall have no claim for payment for Work done or material furnished after the date of such termination. The Purchaser may, at its own option, enter into possession of all or any part of the uncompleted Work, and prosecute the same to completion by contract or otherwise as the Purchaser deems fit.

At any time after the Purchaser has terminated the Contract as a result of the Contractor's default as provided for in Section 29.1 CONTRACTOR'S DEFAULT of the General Specification, the Purchaser may, with such assistance or resort to legal process as it deems necessary, may break and force open any doors, locks, bars, bolts, fastenings, hinges, gates, fences, buildings, enclosures and places for the purpose of seizing and taking possession of the Work, and of the material, Plant and Tools pertaining to the Work. The Contractor shall not remove from the Site any Materials, Plant or Tools that have been paid for by the Purchaser pursuant to the Contract. The Contractor hereby grants the Purchaser a free and unimpeded right of access to the Contractor's facilities which shall survive any termination of the Contract, for the purpose of permitting the Purchaser to take control of and remove any Work, including but not limited to any Work for which title has vested in the Purchaser pursuant to Section 30.1 TITLE AND RISK OF LOSS of the General Specification, and the Contractor shall cooperate with the Purchaser and facilitate the Purchaser's removal of such items in such circumstances.

Upon termination of the Contract as a result of the Contractor's default as provided for in Section 29.1 CONTRACTOR'S DEFAULT of the General Specification, the Purchaser shall not be bound to make any further payment to the Contractor until the Work has been completed.

The Contractor shall be liable to the Purchaser for all losses, costs, damages, and expenses which the Purchaser may incur, suffer or be put to, for, or by reason, or on account of the Contractor's default and the subsequent termination of the Contract; provided, however that the Contractor shall only be liable for the incremental increased costs to Purchaser to have the Work completed by another contractor, having regard to any changed or altered conditions of the Work so completed.

When the Work has been completed, the Engineer shall certify the amount of all losses, costs, damages and expenses incurred by the Purchaser as aforesaid. If the total of such losses, costs, damages and expenses when added to the moneys paid to the Contractor before the termination of the Contract exceeds the total amount which would have been payable to the Contractor upon due completion of the Work in accordance with the Contract, the difference shall be a debt payable to the Purchaser by the Contractor and the Purchaser may deduct the same from any monies due or to become due to the Contractor or the same may be otherwise recovered by the Purchaser from the Contractor as damages. The Purchaser shall not be liable for any losses, costs, damages, or expenses suffered or incurred by the Contractor by reason of any termination of the Contract as a result of the Contractor's default as provided for in Section 29.1 CONTRACTOR'S DEFAULT of the General Specification except to the extent that the arbitrator may otherwise determine in an arbitration proceeding pursuant to Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification.

29.3 Termination for Convenience

The Purchaser shall have the option to terminate the Contract for any reason, in its discretion, by providing the Contractor with a written notice to such effect and termination shall be effective as of the date of such notice. The Contractor shall take all

reasonable steps to cease and wind-down the performance of the Work immediately upon receipt of such notice and to remove all Plant and Tools from the Site, except as necessary for safety, and leave the Site.

In such event, the Purchaser shall pay the Contractor on a cost-reimbursable basis in accordance with the Terms and Conditions of Payment for all expenses properly incurred by the Contractor arising out of such termination, and its obligations hereunder in connection therewith, which expenses shall be deemed to be Actual Costs, including all reasonable demobilization costs, Subcontractor breakage costs, loss of deposits plus an amount calculated in respect of the Contractor's GA&O Percentage and the Contractor's Profit Percentage as provided therein plus the applicable Break Fee. Such payment shall be conditional upon the Contractor delivering and transferring ownership to the Purchaser of all structures, materials, equipment and supplies forming part of the Work and for which the Contractor is entitled to be paid pursuant to this Section 29.3 or was previously paid pursuant to the Contract.

The Contractor shall submit to the Purchaser vouchers, certificates, timesheets, invoices and any other supporting materials or information reasonably requested by the Purchaser showing the Actual Costs of all expenses properly incurred by the Contractor for the Work to the date of termination.

The Purchaser shall not, other than as provided in this Section 29.3, be liable or obligated to the Contractor for any claims (including third party claims), costs, losses, expenses, damages (including any Indirect Damages) howsoever incurred by the Contractor as a result of such termination.

29.4 Termination by Contractor

In the event that the Purchaser wrongfully fails to make payment to the Contractor as required by the Contract, and such payment remains outstanding for 30 days, or in the event that the Engineer wrongfully fails to certify a payment as required by the Contract, and such failure continues for 30 days, then the Contractor may give written notice to the Purchaser to remedy such default within 15 days of receipt by the Purchaser of any such notice. If the Purchaser does not cure the default within the said 15 days, and provided the payment or default is or does not become the subject of a dispute under Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification, the Contractor may by further written notice to the Purchaser terminate the Contract and pursue its remedies.

In the event that the progress of all or substantially all of the Work has been suspended for a period of greater than 180 days due to a cause listed under paragraphs (a) through (g) of Section 22.6 REQUEST FOR EXTENSION OF TIME of the General Specification, then the Contractor may by written notice to the Purchaser terminate the Contract and pursue its remedies.

Without prejudice to any other rights it may have at law, the Purchaser shall pay the Contractor on a cost-reimbursable basis in accordance with the Terms and Conditions of

Payment for all expenses properly incurred by the Contractor arising out of a termination under this Section 29.4, and its obligations hereunder in connection therewith, which expenses shall be deemed to be Actual Costs, including all reasonable demobilization costs, Subcontractor breakage costs, loss of deposits, plus an amount calculated in respect of the Contractor's GA&O Percentage and the Contractor's Profit Percentage as provided therein. However, and for clarity, under no circumstances will the Contractor be entitled to any indirect or consequential damages from the Purchaser, including without limitation any loss of profit, loss of opportunity, loss of revenue or loss of production.

Notwithstanding the foregoing, nothing shall limit the right of the Contractor to suspend the work if the Purchaser does not cure the default within the said 30 days. If the Contractor suffers delay and/or additional costs are incurred as a result of any such suspension, the Contractor shall be entitled to proceed in accordance with Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification.

30 RISK AND RESPONSIBILITY

30.1 Title and Risk of Loss

Title to the Work or any part of the Work shall pass to the Purchaser upon payment by the Purchaser for such Work or part of the Work provided however, that the risk of damage or loss of the Work and the care, custody and control of the Work and all other obligations arising with respect to the Work as required by the Contract shall remain solely with the Contractor and the Contractor shall make good any loss thereof or damage thereto occurring between the date of signing of the Contract and such time as a Completion Certificate has been issued for the particular Work in accordance with Section 24.3 TAKING OVER OF THE WORK of the General Specification. In the event the Contractor is procuring permanent materials from locations outside of Canada, or from locations within the province of British Columbia or Saskatchewan, then notwithstanding when payment for said materials is made to the Contractor, the title of such materials shall not pass to Contractor until those items have been delivered to the Site.

If an Interim Completion Certificate is issued for any part of the Work, responsibility for the risk of damage or loss and the care, custody and control of the part shall then pass to the Purchaser until such time as the Contractor retakes possession of such part of the Work.

30.2 Contractor's Indemnity

Subject always to the provisions of Sections 30.4 TOTAL LIABILITY, 30.5 INDIRECT DAMAGES and 30.6 EXCEPTION OF THE GENERAL SPECIFICATION, the Contractor shall indemnify and save harmless the Purchaser from and against any and all losses, costs, damages or expenses which the Purchaser may suffer or be put to or arising from any manners of action, causes of action, suits, claims, liabilities, debts and demands

which may be brought or made against the Purchaser by any third party, in respect of any one or more of the following:

(a) bodily injury, sickness, disease or death, of any person whatsoever, and
(b) damage to or loss of any property, real or personal, including the Work,

to the extent the circumstances in paragraphs (a) or (b) above are attributable to or caused by any breach of the Contract by the Contractor, including its Subcontractors, or by any negligent acts, errors or omissions or wilful misconduct of the Contractor or any Contractor Parties in the performance of the Work, including during any Work pursuant to Section 25 WARRANTY of the General Specification,

and/or,

(c) breach or non observance of any Laws, including rules, codes, standards or Environmental Legislation to the extent caused by the Contractor or any Contractor Parties in the performance of any obligations pursuant to the Contract.

30.3 Labour and Materials

The Contractor shall assume the defence of and shall indemnify and save harmless the Purchaser from and against all suits, claims and demands which may be brought or made by any person, firm or corporation against the Purchaser for the value or price of labour performed or materials furnished to or by the Contractor for the Work.

30.4 Total Liability

The total liability of the Contractor to the Purchaser for all claims of any kind whether in contract or tort (including negligence) arising from the Contract or performance of the Work shall not exceed:

(a) subject to paragraph (b) below, twenty percent (20%) of the Adjusted Target Price at the date of any such claims, exclusive of all applicable taxes required to be collected by the Contractor from the Purchaser; or
(b) in the event the Contract is terminated pursuant to Section 29.2 TERMINATION BY PURCHASER of the General Specification, fifty percent (50%) of the Adjusted Target Price and calculated at the termination date of the Contract, exclusive of all applicable taxes required to be collected by the Contractor from the Purchaser.

30.5 Indirect Damages

Save and except as specifically provided for in the Contract, including without limitation, for the Delay Liquidated Damages as provided in the Contract, in no event shall the Contractor be liable to the Purchaser for loss of profit, loss of use, diminution in value, loss of revenues, loss of opportunity or for any other punitive, exemplary, indirect or consequential damages (the "**Indirect Damages**").

30.6 Exception

Section 30.4 TOTAL LIABILITY of the General Specification (i) shall be exclusive of any insurance proceeds received or which will be received pursuant to policies obtained and maintained pursuant to the Contract; and (ii) shall not limit liability in any case of Gross Negligence, fraud or wilful misconduct by the Contractor or any Contractor Party.

Notwithstanding any provision of the Contract, the Purchaser shall be entitled to and shall obtain the benefit of all insurance required pursuant to Sections 31.2 through 31.6 of the General Specification, and the limits of and exclusions from liability in the Contract shall be inoperative and not apply to the extent that such insurance is available to indemnify the Contractor for such damages in the absence of limits or exclusions of liability in the Contract. No such applicable insurer shall obtain, directly or indirectly and whether by subrogation or by assuming or conducting the defence of a party or otherwise, the benefit of any exclusions or limitations of liability in the Contract to reduce liability, if any, of that insurer under its policy of insurance that would exist if there were no exclusions or limitations of liability under the Contract.

30.7 Patents

The Contractor shall fully defend, indemnify and save harmless the Purchaser from and against any and all actions, claims, demands, costs, charges and expenses arising from or incurred by reason of any infringement or alleged infringement by Contractor of, any and all letters patent, registered design, trade mark, copyright, trade secret or other proprietary right of any apparatus or component part thereof forming part of or used in connection with the Work and in the subsequent use and operation thereof protected in the country in which the Work is to be used as stipulated in the Contract, but such indemnity shall not cover any use of the Work otherwise than for the purpose indicated by or reasonably to be inferred from the Contract.

In the event of any notice of alleged infringement, claim being made or action brought against the Purchaser arising out of the matters referred to in this Section 30.7, the Contractor shall be promptly notified thereof and may conduct and control all negotiations for the settlement of the same, and any litigation that may arise therefrom. The Purchaser shall not, unless and until the Contractor shall have failed to take over the conduct of the negotiations or litigation, make any admission which might be prejudicial thereto. The Purchaser shall, at the request of the Contractor, provide reasonable assistance for the purpose of contesting any such claim or action, and shall be repaid any expenses incurred in so doing.

In case any Work is in such claim or action held to constitute an infringement and its use enjoined, the Contractor shall either secure for the Purchaser the right to continue using such Work by suspension of the injunction, by procuring for the Purchaser a licence, or otherwise, or shall at the Contractor's own expense and option, replace such Work with a non infringing Work or modify it so that it becomes non infringing and capable of continued use and operation by the Purchaser, without interruption, in accordance with the purposes set out in, or reasonably intended by the terms of the Contract.

The Contractor shall not be liable to the Purchaser pursuant to this Section 30.7 to the extent that the cause of any claim being made or action being brought against the Purchaser is as a result of the Purchaser's alteration, use or operation of the Work for purposes other than that for which the Work was originally expressly provided or reasonably intended by the terms of the Contract.

30.8 Licence for Contractor's Documents

The Contractor's Documents produced or provided by the Contractor or on behalf of the Contractor in the course of the Work shall become the exclusive property of the Purchaser. Ownership of any proprietary information or intellectual property contained in the Contractor's Documents shall remain with the Contractor.

The Contractor grants the Purchaser a perpetual, royalty free, non-transferable, limited licence to use, copy, and to allow third parties to use the Contractor's Documents and all proprietary information in the Contractor's Documents as may be required for Purchaser's internal business purposes including work on any of the Purchaser's existing or future generating stations and for the purpose of tendering, installing, operating, repairing, maintaining, modifying, reconstructing, replacing and/or upgrading the Work, or any part thereof. The Contractor agrees to include the following notation on all Contractor's Documents either directly or by reference:

"[Contractor Name] hereby licenses Manitoba Hydro to use, copy and to allow third parties to use the Contractor's Documents, and all proprietary information in the Contractor's Documents as may be required for the Purchaser's internal business purposes including work on any of the Purchaser's existing or future generating stations and for the purpose of tendering, installing, operating, repairing, maintaining, modifying, reconstructing, replacing and/or upgrading the Work, or any part thereof."

30.9 Software

The Contractor shall deliver to the Purchaser all such software (in object code format only) that is required for the installation, operation and maintenance of the Work. The Contractor hereby assigns to the Purchaser a perpetual, fully paid-up, non-exclusive, transferable, royalty free, limited licence to use and copy such software for the Purchaser's internal business purposes in respect of the installation, operation and maintenance of the Work. Notwithstanding the above, for software that it is generally available, the Contractor will only be required to provide a licence to use and copy such software on generally available commercial terms and for not more than a period of one year after receipt of the Completion Certificate.

30.10 Confidentiality

The terms, conditions, rights and obligations set out in this Section 30.10 shall supersede and replace the terms, conditions, rights and obligations set out in the Confidentiality Agreement dated [**insert date**] signed between the Purchaser and the Contractor with

respect to the Request for Proposal 016203 Keeyask Generating Station Project - General Civil Works.

The Contractor shall, and shall cause the Contractor Parties to:

(a) treat as confidential all Purchaser's Confidential Information;
(b) not disclose or use, or permit to be disclosed or used, to or by any person any Purchaser's Confidential Information without prior written permission from the Purchaser except to the Contractor Parties on a need-to-know basis as reasonably required to perform the Work and the Contract;
(c) The Contractor shall ensure that the Contractor Parties comply with the confidentiality obligations set forth in this Section 30.10 and the Contractor agrees to be responsible for any breach of this Section 30.10 by itself any or any of the Contractor Parties;
(d) not directly or indirectly destroy, invalidate, or otherwise harm, or attempt or threaten to destroy, invalidate, or otherwise harm, any Purchaser's Confidential Information;
(e) ensure that any and all equipment, materials and procedures, that will, or may, be used to store, access and/or use any Purchaser's Confidential Information are, and shall continue to be, sufficiently secured to protect against unauthorized or accidental access, use, modification, damage, destruction, theft, intrusion, disclosure, transfer, disposal, copying, or reproduction, of any of the same;
(f) notify the Purchaser in writing immediately upon discovery or otherwise becoming aware of any unauthorized or accidental access, use, modification, damage, destruction, theft, intrusion, disclosure, transfer, disposal, copying, or reproduction, of any information, or threat or attempt thereof, and in any such event, shall cooperate fully with the Purchaser in connection with any and all preventive and/or remedial actions that the Purchaser may require; and
(g) from time to time perform any acts as may be requested by the Purchaser, acting reasonably, which are required to be performed by the Contractor and the Contractor Parties to ensure compliance with this Section 30.10.

The Contractor's obligations pursuant to this Section 30.10 shall not extend to Purchaser's Confidential Information which:

i) is in the public domain at the time of delivery by the Purchaser to the Contractor or that becomes, thereafter, part of the public domain otherwise than as a consequence of a breach by the Contractor of its obligations pursuant to the Contract; or
ii) was already know to the Contractor, its employees or any of its affiliates at the time of delivery by the Purchaser, as evidenced by documentation possessed by the Contractor prior to such receipt; or
iii) is received by the Contractor from a third party legally able to disclose it without infringing the title of the Purchaser; or
iv) is independently developed by the Contractor, its employees or any of its affiliates, without use of the Purchaser's Confidential Information received from the Purchaser; or

v) is subpoenaed, ordered, or required to be disclosed or made public by any Canadian regulatory or judicial authority.

Nothing in this Section 30.10 shall prevent or be deemed to prevent any future use by the Contractor of the Contractor's Intellectual Property, provided that no Purchaser's Confidential Information is disclosed to any third party as a result of such use, other than to the Contractor Parties on a need-to-know basis as reasonably required to perform the Work and the Contract unless the Purchaser's prior written approval is obtained.

In the event that the Contractor is legally required to disclose any Purchaser's Confidential Information, the Contractor shall provide the Purchaser with prompt written notice of such request prior to complying therewith so that the Purchaser may seek, with the cooperation of the Contractor at Purchaser's cost, if so requested, a protective order or other appropriate remedy.

The provisions of this Section 30.10, shall apply mutatis mutandis with respect to the Contractor's Confidential Information to the benefit of the Contractor subject to the rights granted to the Purchaser with respect to the Contractor's Documents pursuant to Section 30.8 LICENCE FOR CONTRACTOR'S DOCUMENTS of the General Specification.

31 INSURANCE

31.1 General Requirements for Insurance

Without restricting the application of Section 30.2 CONTRACTOR'S INDEMNITY of the General Specification, the Purchaser shall provide, maintain, and pay for the Wrap-up Liability and Builder's Risk Property insurance coverages specified below. Unless otherwise stipulated, the duration of each insurance policy shall be from the Commencement Date of the Phase II Work until the date of the Final Completion Certificate for the Work. Prior to the Commencement Date of the Work and upon the placement, renewal, amendment, or extension of all or any part of the insurance, the Purchaser shall promptly provide the Contractor with confirmation of coverage and, if requested, a true copy of the policies certified by an authorized representative of the insurer together with copies of any amending endorsements. The Purchaser will ensure that any property insurance that it obtains in respect of the Work contains a waiver of subrogation in favour of the Contractor and the Contractor Parties.

All insurance policies and coverage required under this Section 31.1 and provided by the Contractor, except for any supplementary insurance purchased by the Contractor pursuant to Section 31.11 SUPPLEMENTARY INSURANCE of the General Specification shall be reimbursable by the Purchaser as an Actual Cost to the Contractor.

31.2 Wrap-up General Liability Insurance Provided by the Purchaser

Wrap-up General Liability insurance under which the Purchaser, the Contractor, and all Subcontractors involved with the Work will be named, unnamed or additional insureds, with limits of not less than $50,000,000 per occurrence and with a property damage deductible not to exceed $25,000. To achieve the desired limit, umbrella, or excess liability insurance may be used. Coverage under this policy shall be maintained for completed operations hazards on an ongoing basis for a period of twenty-four (24) months following issuance of the Final Completion Certificate.

31.3 Aircraft and Watercraft Liability Insurance (provided by the Contractor)

Aircraft and watercraft liability insurance with respect to owned or non-owned aircraft and watercraft if used directly or indirectly in the performance of the Work, including use of additional premises, shall be subject to limits of not less than $2,000,000 inclusive per occurrence for bodily injury, death, and damage to property including loss of use thereof and limits of not less than $2,000,000 for aircraft passenger hazard. Such insurance shall be in a form acceptable to the Purchaser. The policies shall be endorsed to provide the Purchaser with not less than 30 days notice in writing in advance of cancellation or amendment restricting coverage in respect of aircraft or watercraft used in the performance of the Work.

31.4 Builder's Risk Property Insurance Provided by the Purchaser

"All risks" - Course of Construction (including flood and earthquake) property insurance shall be in the joint names of the Purchaser, the Contractor, and all Subcontractors involved with the Work, insuring not less than the full replacement value of the Work, with a deductible not to exceed $250,000. The coverage shall be maintained continuously until the date of the Final Completion Certificate for the Work.

Operational testing, (start-up and test) insurance shall be included in the joint names of the Purchaser, the Contractor, and all Subcontractors for not less than the full replacement value of the Work. The insurance provided shall be maintained throughout the period of operational testing.

The policies shall allow for partial or total use or occupancy of the Work.

The policies shall provide that, in the case of a loss or damage, payment shall be made to the Purchaser and the Contractor as their respective interests may appear. At the direction of the Engineer, the Contractor shall act on behalf of the Purchaser for the purpose of adjusting the amount of such loss or damage payment with the insurers. When the extent of the loss or damage is determined, the Contractor shall proceed to restore the Work. Loss or damage shall not affect the rights and obligations of either party under the Contract except that the Contractor shall be entitled subject to Section 22.6 REQUESTS FOR EXTENSION OF TIME of the General Specification to such reasonable extension of time for any such delay.

31.5 Automobile Liability Insurance Provided by the Contractor

Automobile liability insurance in respect of licensed vehicles shall have limits of not less than $2,000,000 inclusive per occurrence for bodily injury, death, and damage to property, covering all licensed vehicles owned or leased by the Contractor and used in the performance of the Work, and endorsed to provide the Purchaser with not less than 30 days notice in writing in advance of any cancellation or amendment restricting coverage. Where the policy has been issued pursuant to a government-operated automobile insurance system, the Contractor shall provide the Purchaser with confirmation of automobile insurance coverage for all automobiles registered in the name of the Contractor.

31.6 Contractors' Equipment Insurance Provided by the Contractor

"All risks" contractors' equipment insurance covering construction machinery and equipment used by the Contractor for the performance of the Work, including boiler insurance on temporary boilers and pressure vessels, shall be in a form acceptable to the Engineer and shall not allow subrogation claims by the insurer against the Purchaser. The policies shall be endorsed to provide the Purchaser with not less than 30 days notice in writing in advance of cancellation, change, or amendment restricting coverage. Subject to satisfactory proof of financial capability by the Contractor for self-insurance, the Purchaser agrees to waive the equipment insurance requirement.

31.7 Deductible Payment Obligations

The Contractor shall pay the deductible amounts under the above described insurance policies except where such amounts may be excluded from the Contractor's responsibility by the terms of the Contract. It is expressly understood and agreed that the Contractor shall be responsible for any deductible amounts under the Builders Risk policy and under the Wrap-Up Liability policy arranged by the Purchaser. Such payments shall be included in the Actual Costs.

31.8 Reporting Obligation

In the event of an incident, occurrence or loss that may result in a claim under any of the above policies, including injuries to the public, or loss or damage to the Work, the Contractor shall immediately report the incident, occurrence or loss in writing to the Purchaser and the Engineer.

31.9 Policy Requirements and Notices

All required insurance policies shall be with insurers licensed to underwrite insurance in the jurisdiction of the Province of Manitoba. All policies provided by the Purchaser shall be endorsed to provide the Purchaser and Contractor with not less than 30 days notice in writing in advance of any cancellation, and of change or amendment restricting coverage.

31.10 Subcontractor's Insurance

The Contractor shall be responsible for ensuring all of its Subcontractors comply with or secure and maintain the insurance coverage as set forth above as applicable, and any deficiencies in the coverage or policy limits of such Subcontractor's insurance coverage shall be the responsibility of the Contractor.

31.11 Supplementary Insurance

Should the Contractor deem the insurance arranged by the Purchaser or any supplemental coverage included to be purchased by the Contractor in the Initial Target Price to be inadequate in any way, the Contractor may supplement the insurance policies by the purchase of additional insurance, but any such supplementary insurance so purchased shall be Ineligible Costs and these costs shall not form part of the Actual Costs and shall not be invoiced to the Purchaser for payment.

32 CHANGED PHYSICAL CONDITIONS

Notwithstanding Section 7.2 CONTRACTOR VERIFICATION OF RELEVANT SITE CONDITIONS but subject to Section 2.5 DATA FOR PROPONENTS of the General Specification, if the Purchaser or the Contractor discovers conditions at the Site which are subsurface, geotechnical, hydro-logical or otherwise concealed physical conditions (but not climatic conditions) which existed before the commencement of the Work which are materially different from the Data or were not reasonably inferable, readily apparent or readily discoverable from the Data, then the observing Party shall notify the other Party in writing, with specific details on how the actual physical conditions differ from the specific information indicated in the Data in Appendix D - DATA FOR PROPONENTS, before conditions are disturbed and in no event later than three (3) working days after first observance of the conditions.

The Engineer will promptly investigate such conditions and make a finding. In the interim period, the Contractor shall comply with any instructions which the Engineer may give with respect to the changed conditions, including continuing to execute the Work, using such proper and reasonable measures as are appropriate for the physical conditions, if so directed by the Engineer.

If the finding is that the conditions differ materially from the Data or were not reasonably inferable, readily apparent or readily discoverable from the Data and this would cause and increase or decrease in the Contractor's cost or time to perform the Work, the Engineer, will issue appropriate instructions for a Change through an Extra Work Order as provided in Section 27 CLARIFICATIONS AND CHANGES TO THE WORK AND ADJUSTMENTS of the General Specification. In the event the Contractor is in disagreement with such Extra Work Order, the Contractor shall be entitled to proceed in accordance with Section 33 CLAIMS, DISPUTES AND ARBITRATION of the General Specification.

33 CLAIMS, DISPUTES AND ARBITRATION

33.1 Contractor's Claims

33.1.1 Notice of Intent to Claim

If the Contractor deems itself to be entitled to additional costs to perform the Work, an adjustment to the Adjusted Target Price or for an extension of the time required to perform the Work under any provision of the Contract, the Contractor shall give written Notice of Intent to Claim in the form set out in Appendix Y - STANDARD CONSTRUCTION FORMS TO THE ENGINEER, describing the event or circumstance and provision of the Contract giving rise to the claim. The written notice shall be given as soon as practicable, and no later than seven (7) days after the Contractor became aware, or should have become aware, of the event or circumstance. If the Contractor fails to give written notice of a claim within such period of seven (7) days, the Contractor shall not be entitled to any adjustment to the Adjusted Target Price or to any adjustment to the Contract Schedule.

The Contractor's Notice of Intent to Claim shall include all of the following information with respect to the event or circumstance giving rise to the claim:

(a) a description of the event or circumstance;
(b) the date upon which or the dates during which the event or circumstance is said to have occurred; and,
(c) the date upon which the event or circumstance first came to the attention of the Contractor.

33.2 Claim Documentation and Determination

33.2.1 Claim Documentation

Within 21 days after the Contractor has given written Notice of Intent to Claim in accordance with Section 33.1.1 NOTICE OF INTENT TO CLAIM of the General Specification, the Contractor shall prepare and update its Notice of Intent to Claim and re-submit with the following additional information:

(a) the claimed impact of the event or circumstance on the Contractor with all substantiating and supporting documentation reasonably available, and any requested adjustment to the Adjusted Target Price, the Contract Schedule and ability to claim costs as part of the Actual Costs;
(b) the clauses of the Contract relied upon by the Contractor; and
(c) any proposed resolution.

The Contractor shall also provide the Engineer with such further information and records as the Engineer may reasonably request.

All subsequent communications with the Engineer respecting a claim shall reference the description and date of the original Notice of Intent to Claim or such other identifier as the Engineer may subsequently require.

The Contractor shall control, track and fully document all claimed matters and alleged impacts on performance from first notice. All such documentation shall be submitted daily to the Engineer for review, or at such other periodic interval as the Engineer may direct.

With respect to claims made in accordance with this Section 33.2.1, each Party shall take reasonable steps to mitigate its losses.

33.2.2 Determination of Claim

The Engineer shall proceed in accordance with this Section 33.2.2 to determine:

(a) the adjustment, if any, to the Contract Schedule and the extension (if any) of the Time For Completion of the Work in accordance with Section 22.6 REQUESTS FOR EXTENSION OF TIME or Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification;
(b) the extent to which costs may be charged by Contractor as Actual Costs and those that are ineligible to be included as Actual Costs; and
(c) the adjustment (if any) to the Adjusted Target Price to which the Contractor is entitled to pursuant to the Contract.

(the "Determination").

Whenever a provision of the Contract provides that the Engineer shall proceed in accordance with this Section 33.2.2 to determine any matter, the Engineer shall employ collaborative claim resolution practices to jointly seek to cap unintended Contractor costs or other impacts and to jointly seek resolution of all potential claims with minimal negative consequences for the Work.

Prior to making a Determination pursuant to this Section 33.2.2, the Engineer shall request that the Contractor submit any further documentation that the Contractor considers relevant to the Determination of the claim along with a reasonable deadline for such submission. The Engineer shall consult with each party in an effort to reach agreement. If for any reason agreement is not achieved, the Engineer shall make an objective Determination on a timely basis in accordance with the Contract, taking due regard of all relevant circumstances.

The Engineer shall give written notice to both parties of each Determination of a claim, with supporting particulars and if an adjustment to the Contract Schedule, an adjustment to the Adjusted Target Price, or any combination thereof, are warranted in the opinion of the Engineer. The Engineer shall document such changes in his written Determination and shall either direct the Purchaser to authorize an Extra Work Order or that the Purchaser and Contractor authorize a Change Order corresponding to the Determination as applicable.

Notwithstanding any other provision of the Contract, the Contractor and the Purchaser shall give effect to each such Determination unless and until revised pursuant to Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification.

For any claims made in accordance with this Section 33.2.2 that are unable to be resolved by agreement of the parties, either party shall have the right to refer the Determination of the Engineer to arbitration in accordance with Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification.

The Contractor shall have no further recourse or claim against the Purchaser, nor shall it have any right of action against the Purchaser for loss or damage suffered by reason of a claim other than that set out in Section 33.1 CONTRACTOR'S CLAIMS and this Section 33.2 of the General Specification.

The Contractor shall not delay or hold up performance of the Work during resolution of a claim pursuant to Section 33.1 CONTRACTOR CLAIMS and this Section 33.2 of the General Specification or originating pursuant to Section 22.6 REQUESTS FOR EXTENSION of Time or Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification or during referral of any such claim to arbitration as permitted above.

33.3 Purchaser's Claims

If the Purchaser considers itself to be entitled to:

(a) any payment from the Contractor or adjustment to the Adjusted Target Price under any Section of the Contract or otherwise in connection with the Contract,
(b) any adjustment to the Contract Schedule by reason of schedule enhancements for which the Contractor has no claim for credit,
(c) for an extension of any Warranty Period, or
(d) any determination of the Engineer that the Purchaser is in disagreement with,

the Purchaser or the Engineer shall give notice and particulars to the Contractor.

The notice shall be given as soon as practicable after the Purchaser became aware of the event or circumstances giving rise to the claim. A notice relating to any extension of any Warranty Period shall be given before the expiry of the applicable Warranty Period.

The particulars shall specify the Section of the Contract or other basis of the claim, and shall include substantiation of the amount in question and/or reduction or extension of time to which the Purchaser considers itself to be entitled in connection with the Contract. The Engineer shall then proceed in accordance with Section 33.2.2 Determination of Claim of the General Specification to determine the matters set out in Section 33.3(a) to (d) and the corresponding (if any) adjustments, payments or extension to the applicable Warranty Period resulting therefrom.

Any amounts determined to be payable by the Contractor to the Purchaser pursuant to this Section 33.3 may be included as a deduction in making payment of the Contractor's

Monthly Progress Statement(s) or may be deducted and retained from the Performance Holdback. Any remaining amounts outstanding after such deductions, shall be a debt due and payable by the Contractor to the Purchaser and shall be paid by the Contractor to the Purchaser within 30 days of receipt of the Purchaser's invoice therefor.

33.4 Dispute Resolution and Arbitration

33.4.1 Notice of Dissatisfaction

A Party shall be conclusively deemed to have accepted a Determination by the Engineer issued under Section 33.2.2 DETERMINATION OF CLAIM of the General Specification, and to have expressly waived and released the other Party from any claims in respect of the particular matter dealt with in that Determination unless, within 15 days after receipt of that Determination, the Party sends a notice of dissatisfaction to the other Party and to the Engineer which contains the particulars of the matter in dispute and of the relevant provisions of the Contract.

33.4.2 Reply

The responding Party shall send a notice in reply within fifteen days after receipt of the notice of dissatisfaction setting out particulars of response and any relevant provisions of the Contract.

33.4.3 Amicable Settlement

The Purchaser and the Contractor shall make all reasonable efforts to resolve their dispute by amicable negotiations and each Party agrees to provide, without prejudice, frank, candid and timely disclosure of relevant facts, information and documents to facilitate the negotiations.

In the event that the responding party and the dissatisfied party fail to resolve the dispute within thirty (30) days from the date of the notice of dissatisfaction, the matter shall next be considered by the Purchaser and appropriate member of the Contractor's executive, and if they fail to resolve the matter, the last attempt at amicable negotiations shall involve the Senior Vice President, Power Supply for the Purchaser and the equivalent senior executive of the Contractor.

33.4.4 Final and Binding Arbitration

If the dispute has not been resolved within a reasonable time following the steps set out in Section 33.4.3 AMICABLE SETTLEMENT of the General Specification, or such period of time as the Purchaser and the Contractor may have agreed, the dispute shall be finally resolved by binding arbitration before a single arbitrator.

Arbitration proceedings shall be commenced by either Party serving upon the other a written notice to arbitrate entitled "Request for Binding Arbitration" together with a concise statement of the matters in dispute.

33.4.5 Appointment of Arbitrator

The Contractor and the Purchaser shall attempt to agree upon the appointment of a single arbitrator. If the Contractor and the Purchaser are unable to agree on the choice of a single arbitrator within twenty-five (25) days of commencing arbitration proceedings, either the Contractor or the Purchaser may apply to a Judge of the Court of Queen's Bench of Manitoba to appoint a single arbitrator.

33.4.6 Proceedings

The arbitrator shall, as soon as possible, examine the matters in dispute, hear evidence and argument from both the Contractor and the Purchaser, and issue an award in writing. An award by the arbitrator shall be final and binding upon the Purchaser and the Contractor and not subject to appeal to any court of law.

33.4.7 Authority of the Arbitrator

The Arbitrator shall not have the authority to modify, amend, add to or delete any provision of the Contract or to make any award contrary to the provisions of the Contract. With respect to determinations made by the Engineer pursuant to the Contract that become the subject of a dispute pursuant to this Section 33.4.7, the arbitrator shall have no authority to overturn the determination of the Engineer but shall be entitled, if the arbitrator considers such determination to be improper, inconsistent with the terms of the Contract, unreasonable or unwarranted, to award the Contractor either an adjustment to the Adjusted Target Price or Contract Schedule (or any combination thereof), if such a remedy or remedies are warranted in the arbitrator's opinion, acting in accordance with this Section 33.4.7.

33.4.8 Rules and Statutes to Apply

The Rules for Arbitration of Construction Disputes set out in the Canadian Construction Documents Committee Standard Construction Document CCDC 40 – 2005, as updated from time to time, shall apply and all references therein to 'the Contract' shall mean the Contract between the Purchaser and the Contractor.

To the extent and in the manner provided in CCDC 40, provisions of *The Arbitration Act* (Manitoba) shall apply.

33.4.9 Costs

The costs of arbitration shall be assessed and apportioned between the Contractor and the Purchaser in such manner as the arbitrator may determine.

33.4.10 Venue

Arbitration proceedings shall be conducted at Winnipeg, Manitoba.

33.4.11Work to Continue

The Contractor shall not suspend, delay or interfere with the progress of the Work because of dissatisfaction with a Determination of the Engineer or because of any dispute, nor during any of the notice or negotiation periods set out in this Section 33.4 Dispute Resolution and Arbitration of the General Specification, nor during any arbitration proceedings.

33.4.12Equitable Relief

Nothing in this Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification shall prevent, or be deemed to prevent, either Party from seeking and/or obtaining interlocutory or permanent injunctive relief from any court of competent jurisdiction identified pursuant to Section 1.4 APPLICABLE LAW of the General Specification to restrain any anticipated, present or continuing breach of a provision of the Contract with respect to confidentiality, intellectual property, patent, or other similar breach where such Party, acting reasonably, is of the view that such breach will cause irreparable harm to it which cannot be adequately compensated for in damages.

33.4.13Confidentiality

All negotiations and matters relating to any claims procedure, dispute resolution or arbitration as permitted pursuant to the Contract will be kept confidential by each Party and will not be disclosed to any other persons except to each Party's authorized advisors or consultants who are bound by similar confidentiality provisions or those persons authorized by both Parties or as required by Law.

ECIS OBLIGATIONS TERMS AND CONDITIONS OF AGREEMENT

ECIS OBLIGATIONS TERMS AND CONDITIONS OF AGREEMENT

OVERVIEW:

The scope of services, responsibilities, deliverables, obligations and terms and conditions set out in these ECIS Obligations Terms and Conditions of Agreement shall apply only to the Contractor's performance of the attached Schedule A - ECIS OBLIGATIONS and Schedule B - MONITORING AND CONTROL REQUIREMENTS. The ECIS Deliverables will be used and complied with by the Contractor in the performance of the Phase II Work, but the terms and conditions of these ECIS Obligations Terms and Conditions of Agreement shall not apply to the Contractor's performance of the Phase II Work.

BACKGROUND:

A. The Purchaser has engaged the professional engineering services of the Purchaser's Designer under a design services agreement, and together they have developed the design concepts for the general civil works package for the Keeyask Generating Station Project;

B. The Purchaser has determined that the Project offers a timely opportunity for use of a two-phase non-traditional early contractor involvement (ECI) delivery model which requires the knowledge and expertise of a general civil contractor participating early in the design refinement and further development process as one of a three member Early Contractor Involvement Team which process includes the detailed refinement design of the general civil works package and planning of various Project interfaces and phases;

C. The Purchaser requires the Contractor to perform the ECIS Obligations set out herein to support the ECI methodology for the Project;

TERMS AND CONDITIONS:

SECTION 1 – TERM, DEFINITIONS AND GENERAL INTEPRETATION

1.1 **Term.** The term of the performance of the ECIS Obligations by the Contractor shall be from and after the signing date of the Articles of Agreement of the Contract until the completion of all tasks and deliverables by the Contractor as set out in this ECIS Agreement and any ESCA (the "Term"). The Contractor acknowledges that the ECIS Obligations will extend into Phase II of the Keeyask Generating Station Project. The Purchaser also retains the right to suspend or terminate the ECIS Obligations and/or this ECIS Agreement as set out in Sections 12 SUSPENSION AND DELAY and 13 TERMINATION of this ECIS Agreement.

1.2 **Definitions.** Capitalized terms within this ECIS Agreement and defined herein shall have the meanings ascribed to them in the ECIS Agreement, and capitalized terms not defined herein but defined in Section 1.1 DEFINITIONS of the General Specification shall have the same meanings as set out in Section 1.1 DEFINITIONS of the General Specification.

1.3 **Incorporated Schedules.** The following Schedules are attached to and form part of this ECIS Agreement:

Schedule A - Scope of ECIS Obligations
Schedule B - Monitoring and Controls Requirements
Schedule C - ECIS Basis for Compensation

1.4 **Priority of ECIS Agreement Documents.** Each of the documents forming a part of this ECIS Agreement are, or with regard to an ESCA shall be, incorporated by reference herein with the same effect as if at length set forth herein, in each case as they may be amended or supplemented from time to time. All the terms, and conditions, provisions and requirements of this ECIS Agreement, Schedules A, B and C and any ESCA shall apply to and have effect in connection with this ECIS Agreement as if the said documents were contained in the one instrument, provided however, that in the event of any inconsistency between this ECIS Agreement, Schedules A, B and C, and an ESCA, the priority of same for the purposes of the interpretation and application of this ECIS Agreement shall be as follows:

i) this ECIS Agreement;
ii) the applicable ESCA; and
iii) Schedules A, B and C, in descending order of priority.

1.5 **Calendar Days.** All references to days in this ECIS Agreement are to calendar days.

1.6 **Headings.** Except for the headings in Schedule A, headings in this ECIS Agreement are used for convenience only, and they shall not affect the interpretation or meaning of the clauses, terms and conditions.

SECTION 2 - EARLY CONTRACTOR INVOLVEMENT SERVICES

2.1 **General Retainer.** The Purchaser hereby retains the Contractor to provide the ECIS Obligations generally described in Schedule A and the Contractor agrees to provide and perform such ECIS Obligations, all in accordance with the terms and conditions set forth in this ECIS Agreement.

2.2 **ECI Team.** The ECI Team will consist of the Purchaser, the Purchaser's Project Designer, the Contractor and any other members required by the Purchaser.

2.3 **Contractor's ECI Team Representatives.** The Contractor shall be required to dedicate a senior representative, to serve on its behalf as a member of the ECI Leadership Team for the term of this ECIS Agreement. The Contractor shall be required to assign dedicated personnel, to participate as and when required in the ECI Team, each with requisite experience, skills, knowledge and appropriate civil contractor expertise. The Contractor will further assign additional personnel as required by the ECI Leadership Team to facilitate timely performance of tasks and initiatives of the ECI Team.

2.4 **Overview of Contractor's ECIS Obligations.** The Contractor, through the representatives identified in the Submission at Section 5 – ECI TEAM or their replacements as approved in advance by the Purchaser, shall be engaged at the start of Phase I to i) provide constructability inputs to the design that will result in Best-for-Project changes for Phase II of the Project and ii) to undertake all planning and activities to prepare a detailed construction management program for the Contractor's Phase II Work.

2.5 **Contractor's ECIS Deliverables.** The Contractor will work collaboratively in the ECI Team to provide input into the design by reviewing all design documents for clarity and constructability, and on a timely basis, to complete all activities necessary to finalize the detailed design for the Project and provide the Contractor's required ECIS Deliverables as set out in Schedule A to this ECIS Agreement. All ECIS Deliverables identified in Schedule A, once prepared or delivered by the Contractor shall be subject to the review and approval of the Purchaser, and upon such approval, will form part of the Contractor's Submission Extracts included in the Contract.

2.6 **Phase II - Project Designer's Involvement.** The Purchaser's Project Designer will provide technical support during construction, including any design changes, maintain the 3D Project Models and respond, through the Purchaser, to clarifications and Requests for Information.

2.7 **Contractor's Representation.** The Contractor agrees and represents that it understands and has the capability to comply with the Purchaser's requirements to perform the ECIS Obligations in the context of the early contractor involvement methodology outlined in Sections 2.2 to 2.5 of this ECIS Agreement during the Project. Any work performed by the Contractor outside the scope or terms and conditions of this ECIS Agreement, without the prior written approval of the Purchaser, shall be gratuitous and the Purchaser shall have no liability or obligation to the Contractor with respect to such work or services.

SECTION 3-FORMATION OF AN ESCA

3.1 **Initiation of an ESCA.** If and when the Purchaser may desire having the Contractor perform additional work, activities or services related to, but not originally contemplated as part of the ECIS Obligations, the Purchaser may:

(a) if the work, activities or services are generally contemplated by this ESIC Agreement, advise the Contractor of its requirements in a draft ESCA document, including a description of the work and services proposed to be done, any personnel, labour, equipment, apparatus, machinery and materials proposed to be furnished and supplied and a proposed work schedule; or

(b) if the work, activities or services are not generally contemplated by this ECIS Agreement, advise the Contractor of its requirements, and in a timely manner the Contractor shall submit a proposal ("Proposal") to the Purchaser in response to such requirements including a description of work and services proposed to be done, any personnel, labour, equipment, apparatus, machinery and materials proposed to be furnished and supplied, and proposed work schedule.

3.2 **Process for Acceptance.** Upon the Contractor's acceptance in principle (non-legally binding) of a draft ESCA document as contemplated by Section 3.1(a) INITIATION OF AN ESCA of this ECIS Agreement or upon the Purchaser's acceptance in principle (non-legally binding) of a Proposal as contemplated by Section 3.1(b) INITIATION OF AN ESCA of this ECIS Agreement, whether an original or revised version thereof, the Purchaser may issue a final written ESCA in relation to the additional ECIS Obligations and attach the applicable Proposal and any other documents, all of which shall form part of such ESCA. Notwithstanding the foregoing, no ESCA shall be binding upon the Contractor or the Purchaser until it has been executed by both Parties and each Party has received a copy of the fully signed ESCA.

An ESCA may be executed in any number of counterparts, including counterparts signed and sent by electronic means (including email), each of which shall be deemed an original and all of which together shall constitute one and the same instrument. A photocopied or electronic copy of an ESCA bearing the signature of the Contractor, or both Parties, in a single document or as counterparts thereof as provided herein, shall be deemed an original execution version of the applicable ESCA.

SECTION 4 – COMPENSATION AND PAYMENT

4.1 **Rates.** In respect of the ECIS Obligations performed by the Contractor during the Project, compensation (plus applicable taxes) shall be calculated using the applicable classification rates attached hereto as Schedule C (collectively the "Rates"). The Rates shall be all-inclusive, firm and, subject to the provision for annual escalation for Staff Labour as set out in the Submission at Section 23 – ESCALATION METHODOLOGY, shall not be subject to adjustment for changes or unexpected contingencies of any kind

whatsoever, including changes in payroll benefits and burdens, overhead or material costs.

4.2 **Taxes.** The Rates are exclusive of all taxes or other governmental or regulatory levies that are applicable on fees for the ECIS Obligations (e.g., applicable sales taxes). If any such taxes or levies are levied on or applicable to amounts payable to the Contractor, they will be added to amounts invoiced and paid by the Purchaser. For greater certainty, all taxes or levies generally applicable to the Contractor's operations (e.g., property taxes, payroll taxes and levies, corporate income tax) are included in the Rates and any increases or decreases in such taxes or levies will not result in any change to the Rates.

4.3 **Expenses.** The Contractor shall be expected to locate its personnel engaged in the performance of the ECIS Obligations in Manitoba for the duration of these services (approximately April, 2014 to August, 2015). If and when pre-authorized by the Purchaser, costs pertaining to economy-class airfare, meals and accommodations for all traveling required to and from Manitoba in the performance of the ECIS Obligations will be reimbursed by the Purchaser to the Contractor at actual cost upon receipt of an invoice and satisfactory receipts or supporting documentation, in accordance with the provisions of this Section 4 COMPENSATION AND PAYMENT of this ECIS Agreement.

4.4 **Invoices.** The Contractor shall provide itemized invoices outlining ECIS Obligations performed in the previous month to the Purchaser on a monthly basis cross-referencing, on the face of any invoice, the applicable Purchaser Order number assigned to the Contractor for the Project. All invoices shall be satisfactory to the Purchaser, acting reasonably, in both form and content and the Contractor shall provide to the Purchaser such supporting documents, vouchers, statements and receipts as may be reasonably requested by the Purchaser. All applicable taxes payable pursuant to any invoice shall be shown as separate line items on an invoice.

4.5 **Payment.** Subject always to satisfactory performance of the ECIS Obligations in accordance with the terms of this ECIS Agreement, the Purchaser shall pay the Contractor all undisputed compensation due within 30 days after the receipt by the Purchaser of an invoice from the Contractor and accompanied with all supporting materials requested pursuant to Section 4.4 INVOICES of this ECIS Agreement.

4.6 **Interest on Overdue Accounts.** The Contractor may charge interest on overdue accounts, including the disputed portion of an invoice withheld which is subsequently found to have been properly due and payable, at an annual rate of interest of 1.5% above the prime rate of lending as established by the Royal Bank of Canada, in effect at the time such amount initially became due, calculated and payable monthly from the date initially due to the date of final payment.

4.7 **Ineligible Costs.** Subject to Section 4.3 EXPENSES of this ECIS Agreement, the Contractor shall not be entitled to any payment in respect of:

i) any costs incurred by the Contractor outside of Manitoba unless such costs were pre-authorized by the Purchaser;

ii) costs unrelated to the performance of the ECIS Obligations or the ECIS Agreement; or

iii) costs incurred by the Contractor to remedy any negligent act or omission, or wilful misconduct of the Contractor or any Subcontractor in the performance of the ECIS Obligations or pursuant to the terms of this ECIS Agreement.

SECTION 5 – REPRESENTATIONS AND GENERAL OBLIGATIONS

5.1 **General Representation.** The Contractor represents and agrees that the Contractor understands the Purchaser's requirements under this ECIS Agreement and possesses the required and necessary skills, experience, and expertise to fully and effectively perform the Contractor's obligations under this ECIS Agreement.

5.2 **General Obligations.** The Contractor shall:

(a) in accordance with this ECIS Agreement, perform the ECIS Obligations;

(b) to the Purchaser's satisfaction, perform the ECIS Obligations required by this ECIS Agreement in a collaborative manner;

(c) unless otherwise agreed in writing, ensure that the ECIS Obligations shall be provided personally by the persons listed in the Submission at Section 5 – ECI TEAM;

(d) assign the personnel, time, attention, resources, abilities and expertise necessary to fully and properly perform the Contractor's obligations under this ECIS Agreement to the satisfaction of the Purchaser;

(e) perform all obligations and provide the ECIS Obligations in a timely, competent and professional manner;

(f) use due care in the performance of its obligations under this ECIS Agreement to ensure that no person is injured, no property is damaged or lost and no rights are infringed by such performance;

(g) provide written progress reports (in addition to any reports that may be specified in Schedule A or an ESCA with respect to the provision of the ECIS Obligations) at the Purchaser's request;

(h) not employ or engage any subcontractors in relation to the ECIS Obligations without the prior written approval of the Purchaser, provided further that any approval of any subcontractor by the Purchaser, as provided herein, shall not relieve the Contractor of any liability or responsibility for the full performance of the ECIS Obligations and its obligations hereunder;

(i) ensure that any contract between the Contractor and any subcontractor of the Contractor in relation to the ECIS Obligations conforms with the terms and

conditions of this ECIS Agreement and is assignable by the Contractor to the Purchaser on notice of demand of same from the Purchaser at the Purchaser's discretion;

(j) comply with all reasonable directions and requests by the Purchaser;

(k) comply with all applicable federal, provincial, municipal or other applicable laws, by-laws and regulations which are, or may hereafter become, applicable to this ECIS Agreement and the Contractor's performance of the ECIS Obligations;

(l) during the term of this ECIS Agreement, retain all records, documentation, memoranda and other materials relating to, prepared by, obtained or attained by, the Contractor, in the course of performing the ECIS Obligations (hereinafter "Records"). The Contractor shall permit the Purchaser to review and copy any Records upon reasonable notice being provided to the Contractor. Upon the expiry or termination of this ECIS Agreement, the Contractor shall transfer all Records to the Purchaser, at the Purchaser's discretion and direction;

(m) comply with any Purchaser policies which are referred to attached to, contained in, or incorporated by reference into this ECIS Agreement, any ESCA and of which the Purchaser has provided a copy to the Contractor;

(n) without limiting or otherwise affecting the generality or application of any other term or condition of this ECIS Agreement, including Section 5.2(i) GENERAL OBLIGATIONS of this ECIS Agreement, the Contractor shall bind each of its subcontractors to carry out all the provisions of this ECIS Agreement insofar as they can be applied to the part or parts of the ECIS Obligations subcontracted, and each subcontractor shall agree with the Contractor that all work done by the subcontractor shall be subject in all respects to the provisions of this ECIS Agreement and upon the Purchaser's request, the Contractor agrees to furnish the Purchaser with duplicate copies of all contracts placed by the Contractor with subcontractors; and

(o) at the request of the Purchaser as may be required from time to time, and at the Contractor's hourly Rates plus reasonable disbursements, appear and give expert testimony on behalf of the Purchaser at any environmental or other regulatory hearings which may occur in relation to the Project.

SECTION 6 – CONFLICT OF INTEREST

6.1 **No Financial Interest in Project.** The Contractor represents and agrees that the Contractor has and shall continue to have no financial or other interest in the Project that would jeopardize the objectivity and integrity of its performance of the ECIS Obligations.

6.2 **Provision of Services to Others.** While this ECIS Agreement is in effect, the Contractor and any Contractor Parties shall not provide services to any other person, firm,

corporation or organization in a manner which interferes or conflicts with the proper performance of the Contractor's obligations under this ECIS Agreement.

SECTION 7 – ASSISTANCE OF THE PURCHASER

7.1 **Provision of Information or Property.** The Purchaser may, in its discretion, make available to the Contractor such documents and records or Purchaser' Property as may be reasonably necessary to assist the Contractor in the performance of the ECIS Obligations and its obligations pursuant to this ECIS Agreement; provided further, however, that any assistance or lack thereof from the Purchaser to the Contractor, as provided herein, shall not relieve the Contractor of any liability or responsibility for the full performance of the ECIS Obligations and its obligations hereunder.

7.2 **Return of Information or Property.** Any Information (including Purchaser's Property) provided by or on behalf of the Purchaser to the Contractor for use in the performance of the ECIS Obligations shall remain the property of the Purchaser and shall immediately be returned, without cost, to the Purchaser upon request.

SECTION 8 – USE OF PURCHASER'S PREMISES

8.1 **Safety and Security Rules.** To the extent required in Winnipeg, the Purchaser shall provide the basic rental of up to 2,800 square feet of office space for the Contractor for the purposes of ECI Team meetings and performance of the ECIS Obligations. When using the premises of the Purchaser or the Purchaser's Project Designer, the Contractor and all Contractor Parties shall comply with all Purchaser or Purchaser's Project Designer's corporate safety and security rules and/or regulations, as applicable and as provided to the Contractor.

SECTION 9 -CONTRACTOR'S EMPLOYEES, AGENTS AND SUBCONTRACTORS

9.1 **Approval of Replacement Personnel.** The Contractor's personnel identified in the Submission at Section 5 – ECI TEAM shall not be changed without written approval from the Purchaser. If any of the Contractor's employees assigned to perform the ECIS Obligations should leave the employment of the Contractor, or for any cause beyond the reasonable control of the Contractor be unable to perform the ECIS Obligations requested, then the Contractor shall use its best efforts to provide timely replacement of such personnel without any impact on the performance or the ECIS Obligations or on the Contractor's Rates set out in the Submission at Section 4 – Phase I – ECIS BASIS FOR COMPENSATION. Such replacement shall be subject to the prior approval of the Purchaser.

9.2 **Removal of Contractor's Personnel.** The Purchaser shall have the right to require the Contractor to permanently remove an employee, agent or Subcontractor, or any employee

or agent of a Subcontractor, from representing the Contractor for any reason whatsoever, including but not limited to, incompatibility with the ECI Team, incompetence, disorderly conduct, insubordination, impairment due to alcohol or drugs, a record of disciplinary suspension from employment with the Purchaser or its subsidiaries, incapacity, or inability to perform the ECIS Obligations without negative impact on the collaborative efforts of the ECI Team, creating a danger to personal safety or to the safety of others or that the employee, agent or Subcontractor of the Contractor, or any employee or agent of the Subcontractor, is on lawful or illegal strike or lockout with or from the Purchaser. The Contractor shall engage a substitute for any such employee, agent or Subcontractor removed from the Contractor's list of representatives assigned to perform the ECIS Obligations, at no additional cost to the Purchaser and which substitute shall be subject to the approval of the Purchaser as set out in Section 9.1 APPROVAL OF REPLACEMENT PERSONNEL of this ECIS Agreement.

SECTION 10 - INSURANCE

10.1 **General Liability Insurance.** The Contractor shall maintain comprehensive general liability insurance in the minimum amount of two million ($2,000,000) dollars at its own cost, for the duration of the performance of the ECIS Obligations. The said comprehensive general liability insurance shall include coverage for premises property and operations, products and completed operations, blanket contractual liability, cross liability, non-owned automobile liability and occurrence property damage. The policy shall be endorsed to provide the Purchaser with not less than 30 days written notice in advance of cancellation and to show the Purchaser as an additional insured.

10.2 **Automobile Liability Insurance.** The Contractor shall maintain automobile liability insurance in the minimum amount of two million ($2,000,000) dollars, at its own cost, in respect of licensed vehicles owned or operated by Contractor and used in the performance of the ECIS Obligations.

10.3 **Deductibles.** The Contractor shall be responsible for any deductible amounts under the said insurance policies.

10.4 **Certificates.** The Contractor shall, upon request by the Purchaser, provide certificates of insurance to the Purchaser with respect to the above policies.

10.5 **Workers Compensation.** The Contractor shall at all times pay, or cause to be paid, any assessment or compensation required to be paid pursuant to The Workers Compensation Act (Manitoba). Upon failure to do so, the Purchaser may pay such assessment or compensation to The Workers' Compensation Board, and may deduct the amount thereof from monies due or to become due to the Contractor. The Purchaser may, at any time during the performance and upon the completion of the ECIS Obligations, require a declaration from The Workers' Compensation Board that such assessments or compensation have been paid in full, and may withhold final payment to the Contractor until such declaration has been received.

SECTION 11 – LIABILITY AND INDEMNIFICATION

11.1 **Liability and Indemnity.** The Contractor shall be liable for and shall indemnify and save the Purchaser and the Keeyask Hydropower Limited Partnership harmless from and against any and all manners of action, causes of action, losses, costs, damages, expenses, suits, claims, liabilities, debts and demands which the Purchaser or the Keeyask Hydropower Limited Partnership may suffer or be put to, or which may be brought or made against the Purchaser by any third party, to the extent caused by the Contractor, any Contractor Party and/or their respective officers, employees, subcontractors and agents arising out of any breach of this ECIS Agreement, or the negligent acts, errors or omissions or wilful misconduct of the Contractor, any Contractor Party and/or their respective officers, employees, subcontractors and agents in relation to the performance of the ECIS Obligations.

11.2 **Consequential Damages.** Notwithstanding any other term or condition of this ECIS Agreement to the contrary, with respect to the ECIS Obligations, under no circumstances and under no legal theory, tort, contract or otherwise, shall either Party have any liability to the other Party or any other person or entity for any consequential damages or for loss of revenue or profit, lost or damaged data, business interruption, or other commercial or economic loss (but shall not include amounts payable to either the Contractor or the Purchaser under the ECIS Agreement), even if either Party has been advised of the possibility of such damages; nor shall either Party's officers, employees, agents or subcontractors have any such liability.

11.3 **Aggregate Liability of the Purchaser.** The maximum aggregate uninsured liability of the Purchaser to the Contractor and its officers, employees, agents and subcontractors for direct damages in connection with this ECIS Agreement, whether in tort, contract or otherwise, shall not exceed two million ($2,000,000) dollars. The limitation stated in the preceding sentence is an aggregate limit and shall not be expanded, and no exception shall be made, on account of the existence of multiple claims, whenever and howsoever arising, regardless of the nature of extent of such claims or regardless of the Purchaser being warned of the possibility thereof in advance.

11.4 **Aggregate Liability of the Contractor.** The maximum aggregate liability of the Contractor to the Purchaser and its officers, employees, agents, affiliates and representatives for direct damages in connection with this ECIS Agreement, whether in tort, contract or otherwise, shall not exceed two million ($2,000,000) dollars. The limitation stated in the preceding sentence is an aggregate limit and shall not be expanded, and no exception shall be made, on account of the existence of multiple claims, whenever and howsoever arising, regardless of the nature of extent of such claims or regardless of Contractor being warned of the possibility thereof in advance. For certainty, under no circumstances shall the aforesaid limit of liability be relevant or apply to any liability of the Contractor to the Purchaser arising out of or resulting from the performance by the Contractor of the Phase II Work.

11.5 **Application.** This Section 11 applies regardless of the basis on which the Parties are entitled to claim, including breach of contract or tort, even if the damages are caused by

breach of contract (including fundamental breach), or by the negligence, Gross Negligence, negligent misrepresentation or other fault of either Party, and even if either has been advised of the possibility of these damages.

11.6 **Survival.** The Parties agree that the limitations specified in this Section 11 shall survive and apply even if any limited remedy specified in this ECIS Agreement is found to have failed of its essential purpose.

11.7 **Insurance Proceeds.** The intent of Sections 11.3 AGGREGATE LIABILITY OF THE PURCHASER and 11.4 AGGREGATE LIABILITY OF THE CONTRACTOR of this ECIS Agreement is that the Party claiming damages from the other Party shall be entitled to and shall obtain the benefit of all insurance that is available to indemnify the other Party against liability that it may have to the Party claiming damages, and that the limits of and exclusions from liability in the ECIS Agreement shall be inoperative and not apply to the extent that insurance is available to indemnify a Party for such damages in the absence of limits or exclusions of liability in the ECIS Agreement. No insurer shall obtain, directly or indirectly and whether by subrogation or by assuming or conducting the defence of a Party or otherwise, the benefit of any exclusions or limitations of liability in the ECIS Agreement to reduce liability, if any, of that insurer under its policy of insurance that would exist if there were no exclusions or limitations of liability under the ECIS Agreement.

SECTION 12– SUSPENSION AND DELAY

12.1 **Ability to Suspend or Delay ECIS Obligations**. Upon providing notice to the Contractor, the Purchaser may, in its discretion and for any reason:

(a) delay or suspend the Contractor's performance of any or all of the ECIS Obligations, or

(b) extend the time required to perform any or all of the ECIS Obligations

for such period of time as the Purchaser may in its discretion, deem necessary. The Contractor shall, as soon as possible, resume performance of any ECIS Obligations previously delayed or suspended by the Purchaser in accordance with the Purchaser's directions.

12.2 **Payment of Costs for Suspension or Delay.** The Purchaser shall make settlement with the Contractor for such costs and expenses actually incurred by the Contractor which are directly attributable to the interruption, extension or suspension of the ECIS Obligations in accordance with Section 12.1 ABILITY TO SUSPEND OR DELAY ECIS OBLIGATIONS of this ECIS Agreement, but not for lost profit.

12.3 **Force Majeure.** Neither the Contractor nor the Purchaser shall be deemed in default of this ECIS Agreement where the failure to perform or the delay in performing any obligation under this Agreement is due wholly or in part to a cause beyond its reasonable control, including but not limited to, unusual inclemency of weather, legal strikes or

lockouts, unpreventable accident, war or delay caused by war, vandalism or malicious mischief, riot or civil commotion, lawful orders of civil or military authorities, acts of God or any other circumstances beyond the reasonable control of either the Contractor or the Purchaser, as the case may be (hereinafter referred to as "Force Majeure").

12.4 **Consequences of Force Majeure.** The Party subject to an event of Force Majeure shall promptly notify the other of its inability to perform or of any delay in performing its obligation due to an event of Force Majeure and shall provide an estimate of when it will perform the obligation. The time for performing the obligation shall be extended for a period equal to the time during which the Party was subject to the event of Force Majeure. Both Parties shall be prompt and diligent in exploring all reasonable avenues available to avoid or resolve events of Force Majeure as quickly as possible.

SECTION 13 - TERMINATION

13.1 **Termination Without Cause.** The Purchaser may, at its sole option and for any reason whatsoever, terminate this ECIS Agreement or terminate this ECIS Agreement with respect to a specific part of the ECIS Obligations, at any time by giving thirty (30) days notice in writing to the Contractor. Any termination of a specific part of the ECIS Obligations shall not terminate or otherwise invalidate this ECIS Agreement. Any termination of this ECIS Agreement by the Purchaser as provided in this Section 13.1 shall not be justiciable in any court of competent jurisdiction or subject to review by an arbitrator.

13.2 **Termination With Cause.** In addition to its rights under Section 13.1 TERMINATION WITHOUT CAUSE of this ECIS Agreement, and without restricting any other rights or remedies available in contract, law, equity or otherwise, the Purchaser may, at its sole option and in writing, immediately terminate this ECIS Agreement and/or terminate this ECIS Agreement with respect to a specific part of the ECIS Obligations if:

(a) in the reasonable opinion of the Purchaser, the ECIS Obligations provided by the Contractor are inadequate or improperly performed and the Contractor fails to remedy such defect, failure or default to the Purchaser's satisfaction, acting reasonably, within (30) days of written notice thereof from the Purchaser; or

(b) in the reasonable opinion of the Purchaser, the Contractor has failed to comply with any term or condition of this ECIS Agreement and the Contractor fails to remedy such defect, failure or default to the Purchaser's satisfaction, acting reasonably, within thirty (30) days of receipt of written notice thereof from the Purchaser; or

(c) the Contractor becomes bankrupt or insolvent.

13.3 **Consequences of Termination.** Upon any termination of this ECIS Agreement or of a specific part of the ECIS Obligations, the Contractor shall cease to perform any such terminated ECIS Obligations and the Purchaser shall be under no obligation to the

Contractor other than to pay such fees and expenses as the Contractor is entitled to receive under Section 4 COMPENSATION AND PAYMENT of this ECIS Agreement for affected ECIS Obligations performed to the satisfaction of the Purchaser up to the date of such termination and, in the case of termination by the Purchaser pursuant to Section 13.1 TERMINATION WITHOUT CAUSE of this ECIS Agreement, the reasonable, actual expenses of the Contractor necessary for the winding down of the performance of the terminated ECIS Obligations.

SECTION 14 – INDEPENDENT CONTRACTOR

14.1 **No Other Relationship.** The Contractor is an independent contractor. This ECIS Agreement shall not create the relationship of employer and employee, principal and agent, partnership, joint venture or any other fiduciary relationship between the Purchaser and the Contractor or between the Purchaser and any officers, employees or agents of the Contractor.

14.2 **Contractor's Deductions at Law.** The Contractor is responsible for any deductions or remittances which may be required by law in relation to its performance of the ECIS Obligations.

14.3 **Contractor Shall Not Bind the Purchaser.** In performing the ECIS Obligations, the Contractor shall not incur any expenses or debts on behalf of, nor make any commitments for or on behalf of, the Purchaser without first obtaining the prior written permission of the Purchaser.

SECTION 15 – DISPUTE RESOLUTION

15.1 **Dispute Resolution**. The Parties acknowledge and agree that disputes under this ECIS Agreement may be referred for resolution in accordance with the provisions of Section 33 CLAIMS, DISPUTES AND ARBITRATION of the General Specification.

SCHEDULE A

CONTRACTOR'S SCOPE OF ECIS OBLIGATIONS

A. GENERAL OVERVIEW

Reporting to the Purchaser's Project Engineer and working collaboratively with the Purchaser's Project Designer and the Purchaser on the ECI Team, the Contractor shall serve as an advisor to the Purchaser providing the services and deliverables and completing the tasks set out below and in the ECIS Agreement solely for the benefit of the Purchaser and in support of Best-for-Project principles and objectives.

B. PROPOSED DETAILED SCOPE OF SERVICES

Below is a proposed detailed scope of the tasks, participation, responsibilities and deliverables required of the Contractor in the performance of the ECIS Obligations. All deliverables set out below shall be provided to the Contractor in advance of the associated dates set out below for the Purchaser's review and approval. Any deficiencies in such deliverables shall be rectified by the Contractor to the satisfaction of the Purchaser prior to approval. Upon such approval and as required by the Purchaser, such deliverables shall form part of the Contractor's Submission Extracts and be thereby incorporated by reference into the Contract.

C. ECI TASK LIST

ECI TASK #1 - Workshop 1 (On or About March 18th, 2014)

Overview:

This workshop will serve as the kickoff meeting and commencement of execution of Phase I of the Project. The preliminary design of the Project has been completed by the Purchaser and the Purchaser's Project Designer. It is essential that the Contractor's knowledge of the Project is brought to the same level as quickly as possible. At this workshop, the Purchaser and the Purchaser's Project Designer will provide a detailed overview of the Project background and basis of decisions to this point in time. The goal from this point forward is for the Purchaser, the Purchaser's Project Designer and the Contractor to function as a team to develop a Best-for-Project detailed design for the Project.

A number of key design decisions have been made which cannot be changed. These items will be identified and areas where change can occur will be highlighted. In addition, specific areas requiring Contractor input will be highlighted.

Meeting attendees will include the Purchaser's Project Engineer as chair, other Purchaser's Project staff, the Purchaser's Project Designer and Contractor's key staff for the concrete structures, mechanical and electrical, earthworks, river management, schedule and costs.

Key Contractor Preparation Activities:

In preparation for Workshop 1 the Contractor shall have:

(a) a detailed understanding of Technical Specification, Construction Schedule and Contractor's Methodology; and

(b) Reviewed the following Purchaser's documents to be supplied at or shortly after Contract signing:
   i) updated 3D Project Models
   ii) proposed additions to the scope of work
   iii) facility descriptions

Detailed Activities:

- Project team introductions and development of a Project charter, including review of Project objectives/goals, and development of a communication plan.
- Review of Project requirements by the Purchaser and the Purchaser's Project Designer including:
  - Review of key elements and known constraints on the construction sequence and schedule.
  - Review design rationale for all the key elements and identify fixed and flexible design parameters.
  - Identify key elements perceived to have the most benefit from Contractor input.
  - Review Project challenges.
  - Present key dates in the Phase I ECIS Obligations schedule and describe how the Phase I ECI process is intended to work. This will include definition of Design Freeze activities (refer to Task #5).
  - The principle that open dialogue will be encouraged with an expectation that the Contractor may see other areas for significant value input in addition to those that have been identified.
- The Purchaser will summarize key points at the end of the meeting and the ECI Team will define the work plan for Phase I and expectations for subsequent meetings. This will include a prioritization of design assist activities based on the Design Freeze schedule.
- ECI Team to establish frequency and agenda for future ECI Team workshops.

ECI TASK #2 – Prepare Stage I Cofferdam Construction Management Plan (Completed before June 1, 2014)

Overview:

The Contractor is to prepare the following plans specific to the Work to be undertaken for the Stage I Cofferdams to enable the start of the Phase II.

- Construction Schedule
- Environmental Protection Plan that aligns with the Purchaser's Environmental Protection Plan
- Safety and Health Management Plan
- All aspects of the Contractor's Quality Control Management Plan
- Communications Plan
- Accounting system that aligns with the Purchaser's Project cost accounting, tracking of contractor activities, cash flows, earned value reporting format and projection to completion.

ECI TASK #3 – Contractor to Develop Concrete Mix-Designs (To be completed by April 1st 2016)

Overview:

There are six concrete mix-types identified and required for the Project for the purposes of strength, durability, performance and, placing and finishing. To satisfy the concrete requirements for the Project, concrete fine and coarse aggregates will be supplied from local sources near the Project site. Currently, the borrow source for concrete aggregate which have been identified are Granular Deposit G-3 for the production of fine aggregates. The prime sources for coarse aggregates will be supplied from Quarry Q-7 and from the rock excavations for the powerhouse and associated excavated channels.

The Purchaser has conducted fielding testing on the coarse aggregate from the sources noted above and has identified Aggregate Alkali-Reactivity (AAR) of various degrees. The Contractor will be required to develop concrete mix-designs that must satisfy CSA 23.2-27A and CSA 23.2-28A. For the purposes of this submission, all aggregate sourced from the powerhouse channel is moderately reactive while all aggregate sourced from the spillway channel and from west side of Q-7outside of the powerhouse channel is highly reactive. Refer to drawing 7-00195-DE-01210-0004 SHT 0001 set out in Appendix A - PURCHASER'S DRAWINGS.

Key Contractor Activities:

- The Contractor will be required to develop and submit a minimum of four concrete-mix designs for each of the six concrete types listed below for review on or before April 1st, 2014.
  - Type A: Structural reinforced concrete exposed to chloride with or without freezing and thawing conditions
  - Type B: Structural reinforced concrete exposed to freezing and thawing in a saturated condition but not to chlorides
  - Type D: Concrete in unsaturated condition exposed to freezing and thawing but not to chloride (exterior walls and columns)
  - Type E: Secondary concrete
  - Type G: All interior reinforced concrete
  - Type H: Dental concrete. The Contractor will test the mix-designs complying to the requirements of CSA 23.2-27A and CSA 23.2-28A.

This testing program time period is from April 15th, 2014 to April 15th, 2016.

ECI TASK #4 - Contractor Input to Design Refinement and Freeze Point Activities (To be completed by Nov 1, 2014)

Overview:

The objective for the tasks below is to receive pertinent inputs from the Contractor to advance and refine the Project design, where possible, to meet the specific methodology to be implemented by the Contractor. This will further the details in the Submission, where the Contractor has defined its methodology (construction sequencing, construction methods, alternative construction materials, material innovation/improvement, and any other means and methods as identified). These further details will include the cost, schedule and risk mitigation benefits to illustrate how a design change can result in a Best-for-Project decision.

Detailed Activities:

RIVER MANAGEMENT

Overview:

A two-stage program of river management (referred to as Stage I and Stage II) will be implemented to divert the Nelson River allowing for the construction of the Project. The first stage (Stage I) involves blocking off the north and central channels of the river to facilitate construction of the central dam and powerhouse cofferdam. Included in Stage I is the construction of the spillway cofferdam in the south channel diverting the river towards the southern banks and permitting the construction of the spillway structure, its approach and discharge channels.

Stage II of river management is the diversion that requires the removal of the spillway cofferdam and construction of the south dam Stage II upstream and downstream cofferdams to force the river flow to pass through the partly completed spillway (prior to rollway construction). Construction of the south dam across the southern portion of the river will then proceed between the two south dam Stage II cofferdams (upstream/downstream).

Drawings and 3D Project Models showing cofferdam options with quantity estimates, and river management schematics to assist in the completion of river management activities are set out in Appendix A - PURCHASER'S DRAWINGS and Appendix B – 3D PROJECT MODELS.

Key Contractor Activities:

- Stage I cofferdam construction comparative analysis which includes materials management, construction costing, schedules, and risk analysis.
- Review construction sequencing, material placement methodology and configuration of the Stage I spillway cofferdam as the impervious core section of the cofferdam remains as a part of the impervious core of the south dam.

- Review of Stage II cofferdam construction methods, materials sources and handling/transport requirements.
- Identification of any other potential options.
- Input into the design and sequence of tie-in structure during the transition between Stage I and Stage II cofferdam.
- Input into sequencing and methodology for spillway rollway construction.

REVIEW TECHNICAL SPECIFICATION

Overview:

The Purchaser has used a standard Master Format for the Technical Specification included in the Contract. The Contractor shall review the Technical Specification and work with the Purchaser to identify any items that may lead to increased costs, with little or no Project benefit and to identify improved material technologies and/or performance items that would result in benefit to the Project. The Purchaser's primary objective is to meet the standard of quality defined by the Purchaser in the Technical Specification but in the most efficient and cost-effective manner.

Key Contractor Activities:

- Review and comment on the Master Format Technical Specification as included in the Contract.

PRINCIPAL CONCRETE STRUCTURES

Overview:

The principal concrete structures for the Project consist of the powerhouse, intake, tailrace, service bay, spillway, all transition structures (powerhouse: north/south transition, and spillway: north/south transition) and walls (spillway: A/B/C/D walls and powerhouse: walls E and F). The Purchaser's Drawings, the 3D Project Models and the Technical Specification shall be referenced by the Contractor to assist in the completion of concrete arrangement activities.

Key Contractor Activities:

- Concrete production and placement plan development
- Concrete technical specification review
- Concrete mix design for AAR/ASR mitigation and concrete aggregate sources review
- Pour joint locations, lift heights, and base slab contraction joints review
- Transition and wall structures review
- Coordination with "work by others"
- Schedule / cost risk review – mitigation strategies and contingency analysis

SUPERSTRUCTURE STEEL

Overview:

The powerhouse and service bay will be framed by the superstructure steel which will support two 205-Mg electric overhead travelling bridge cranes that travel the full length of the powerhouse and service bay. Insulated metal cladding supported by the superstructure steel will enclose both the powerhouse and service bay except along the downstream wall in the area of the generator transformers, where the cladding will consist of precast concrete wall panels. The Purchaser's Drawings, the 3D Project Models and the Technical Specification shall be referenced by the Contractor to assist in the design refinement of the superstructure steel.

Key Contractor Activities:

- Superstructure steel review
- Review the building cladding envelope
- Coordination with "work by others"
- Schedule / cost risk review – mitigation strategies and contingency analysis
- Cladding and/or temporary enclosure strategies/scheme to allow for uninterrupted continuous concrete operations

SPILLWAY UPSTREAM AND DOWN STREAM SUSPENDED ROADWAY DECKS (BRIDGES)

Overview:

There are two spillway suspended road decks (bridges) one upstream and the second downstream of the spillway gates. The strength requirement of the suspended roadway deck must support the heaviest Contractor's vehicle and loaded equipment (loaded rock wagons, or operating crane positioned on suspended road deck) or the Purchaser 150 tonne lowbed tractor trailer, whichever vehicle loading governs. The Purchaser's Drawings, the 3D Project Models and the Technical Specification shall be referenced by the Contractor to assist in the completion of spillway bridge activities.

Key Contractor Activities:

- Evaluate construction cost and schedule impacts related to the suspended roadway deck and deck types
- Evaluate the width of roadway, earth dam widths and impacts to construction traffic

EARTH STRUCTURES

Overview:

The earth structures consist of three dams (north dam, central dam and south dam) that will be constructed across Gull Rapids on the Nelson River. There are two dykes (north dyke and south dyke) that will be constructed along both sides of the river, extending 11.6km on the north and

11.2km on the south side of the river. The dams and dykes generally define the boundary limits of the upstream water reservoir. The dams and dykes will be zoned earth fill embankments consisting of an impervious core with granular and crushed rock filters and outer rock fill shells. The Purchaser's Drawings, the 3D Project Models and the Technical Specification shall be referenced by the Contractor to assist in the completion of earth structures activities.

Key Contractor Activities:

- Confirm material sources and logistics for earth fill structures, north, central and south dams including the north and south dykes
- Review instrumentation requirements to confirm best time / methods for installation
- Overall constructability review including earth fill zone widths, equipment utilization and sizing, evaluation of placement times, impervious moisture content suitability, and construction schedule review
- Schedule / cost risk review – mitigation strategies and contingency analysis

ENVIRONMENTAL MITIGATION AND COMPENSATION MEASURES

Overview:

The Purchaser has developed preliminary engineering for several potential environmental mitigation and compensation measures to address adverse effects of the Project. These measures require a constructability review to determine the Best-for-Project options that meet the conditions of the Environmental Act License for the Project.

The Environmental Protection Plan, the Purchaser's Drawings, the 3D Project Models and the Technical Specification shall be referenced by the Contractor to assist in review of environmental mitigation and compensation measures.

Key Contractor Activities:

- Mitigation and compensation review
- Design refinement of measures
- Prepare cost estimates
- Develop logistical constructability of mitigation and compensation measures
- Mitigation and compensation measures schedule development that meets the requirements of the Project schedule

ELECTRICAL AND MECHANICAL SYSTEMS AND FACILITIES

Overview:

The electrical and mechanical systems and facilities capture the processes and systems within the plant (Powerhouse Complex and spillway). The Contractor will be required to design a portion of this scope, while the majority of its effort will lie in the procurement of materials for this work and the associated installation activities required to ready the systems for commissioning.

The Contractor's electrical/mechanical Work will include the majority of the Station AC and DC distribution systems, including the installation of the following key equipment and systems:

- auxiliary processes including:
  - pumped water
  - compressed air
  - oil distribution piping
  - fire suppression
- the control, monitoring and communications systems associated with the above

Key Contractor Activities:

- Review and advise on the routing of cable tray and raceways to optimize installation.
- Review and comment on pipe routing and supports/brackets to improve installation efficiencies, detect conflicts and assure integration with the civil work.
- Provide input on the selection of material, and/or alternatives that are Best-for-Project.
- Schedule / cost risk review – mitigation strategies and contingency analysis.

ECI TASK #5 – Construction Planning Contractor Deliverables (to be completed by August 1, 2015)

Overview:

The following deliverables are necessary to provide certainty that the Contractor has solid plans for execution of Phase II Work. The Contractor shall be responsible to identify any other additional deliverables it determines are required as part of its planning.

Detailed Activities:

MATERIAL BALANCE PLAN

The Purchaser has supplied the Data which outlines all of the material sources and the geotechnical data collected for the Contractor to interpret and make determinations regarding the use of these sources.

Using the information in the Data, the Contractor has developed a preliminary materials management plan and this will require additional details to fully define the material requirements.

Key Contractor Activities:

Review, plan and/or provide feedback on:

- Additional geotechnical investigations
- Materials balance plan
- Proposed borrow and quarry sites and use of excavated materials
- Aggregate site processing operations

SITE TEMPORARY INFRASTRUCTURE PLAN

The Contractor shall prepare site infrastructure plans with phases/stages showing all work, activities and features necessary for the Contractor to operate throughout the entire construction site. The Purchaser will provide the Contractor with a site plan in the form of an updated 3D Project Model.

Key Contractor Activities:

The Contractor is required to develop a site Temporary Infrastructure plan detailing the items that will be required to complete the Work. The plan at a minimum shall show:

- Offices and shops
- Access roads and ramps
- Drainage ditches
- Erosion and sedimentation mitigation measures
- Work storage, maintenance and marshalling yards
- Material processing and impervious conditioning areas
- Material stockpile and borrow areas
- Dewatering areas
- Tower crane(s) limits
- Provide input on the location of construction power for the Contractor's use and review capacity assumptions
- Equipment and material mobilization
- All other required construction operation features

ROCK BLASTING PLAN

Rock blasting is required to construct the channels and principal concrete structure. The Purchaser requires stringent controls to eliminate the risk of blast damage to the immediate environment and surrounding areas which include the completed phases of work of the principal concrete and earth structures. The Purchaser will provide the Contractor with the final grades and a 3D Project Model of the existing terrain to assist in the completion of rock blasting plan activities.

Key Contractor Activities:

Develop a blasting plan to achieve the following:

- maximize efficiency to construction operations
- produce the maximum quantity that meets the gradation required for rock fill materials
- meet all lines and grades with minimum overbreak
- comply with all safety and environmental criteria

CONCRETE PLAN

Concrete is one of the most challenging tasks to keep the Project on schedule. The Contractor will bring to the ECI Team its expertise and knowledge to develop a strategic and efficient detailed concrete production, delivery and placement system plan. The updated 3D Project Model shall be referenced by the Contractor to assist in the completion of the concrete planning activities.

Key Contractor Activities:

- Review the updated 3D Project Model
- Select concrete equipment on a Best-For-Project basis to produce, deliver and place the concrete
- Establish the concrete placement rates
- Provide suggestions to overcome risks based on the Contractor's experience and quantify potential savings

CONSTRUCTION MANAGEMENT PLAN

Key Contractor Activities:

The Contractor will develop a detailed construction management plan that shall identify and include the following:

- Environmental Protection Plan that aligns with the Purchaser's Environmental Protection Plan
- Safety and Health Management Plan
- All aspects of the Contractor's Quality Control Management Plan
- Staff and Craft Labour Attraction and Retention Strategy
- Contractor Purchasing/Procurement Plan
- Communications Plan
- Organizational Plan
- On-the-Job Training Program
- Accounting system that aligns with the Purchaser's Project cost accounting, tracking of contractor activities, cash flows, earned value reporting format and projection to completion.

ECI TASK #6 - Contract Schedule for Phase II (To be completed before the start of rock excavation for the Spillway)

Key Contractor Activities:

The Contractor will provide a complete construction schedule, integrated with the 3D Project Models (4D schedule), that is based on the dates and logic included in the construction schedule included with the Contractor's Submission at Section 17 - CONSTRUCTION SCHEDULE and that complies with the Contract Dates set out in Section 3.7 CONTRACT DATES of the General Specification. During the Phase I ECIS Obligations, the Contractor's revised construction

schedule will be supplemented with additional details and any improvements developed throughout the Phase I ECIS Obligations. This will then, upon approval of the Purchaser, become the Contract Schedule to assess the progress of the Phase II Work.

ECI TASK #7 - Risk Mitigation Plan (To be completed by August 1, 2015)

Overview:

Throughout Phase I, risks to the Contractor's scope of Work and to the Project will be continually identified and evaluated by the ECI Team. The Contractor is key to help identify and quantify risks and develop mitigation plans related to the Phase II activities. Risk analyses will be performed throughout the process. The Purchaser will maintain the comprehensive Project risk management plan with input from the Contractor and the Other Contractors.

Key Contractor Activities:

- Risk analyses and mitigation plans

ECI TASK #8 - Permit Matrix (To be completed by August 1, 2015)

Overview:

The list below shows the Purchaser and Contractor submission/application responsibilities. Further to Section 5.2 PERMITS, LICENCES OR APPROVALS of the General Specification, the Contractor and the Purchaser will work together to prepare a matrix of the permits required for the Project and define when the permits are required and the Party responsible for acquiring the permit in accordance with the below:

The Purchaser is responsible to apply for and obtain:

- *Environment Act* License
- *Water Power Act* License
- *Fisheries Act* Authorizations
- *Navigable Water Protection Act* Approval

The Contractor is responsible to apply for and obtain all other licenses and permits, including but not limited to the following:

- *Dangerous Goods Handling and Transportation Act* (Storage and Handling of Gasoline and Allied Products Regulation) Permits
- *Explosives Act* License
- NOTAM (Nav Canada Notice to Airmen for Blasting Operations, etc.)
- *Highway Traffic Act* (Vehicle Weights and Dimensions on Classes of Highways Regulation) Permits
- The *Environment Act* (Onsite Wastewater Management Systems Regulation, etc.) Permits

- Building Permits: For various Contractor site offices, storage buildings, shops, garages and other required Contractor building facilities
- Occupancy Permits: For various Contractor site offices, storage buildings, shops garages and other required Contractor building facilities
- Plumbing Permits: For various Contractor site offices, storage buildings, shops garages and other required Contractor building facilities
- Electrical Permits for connections to Manitoba Hydro services
- Any other required permits, licenses, approval and authorizations to complete the Work

ECI Task #9 - Submittal Schedule (To be completed by August 1, 2015)

The Contractor, the Purchaser and the Purchaser's Project Designer will work together to prepare a deliverable/submission schedule for all known items to be exchanged between parties in the course of the Work. This shall include all Issued for Construction (IFC) drawings, shop drawings, cut sheets, technical data/product sheets and any review periods required as set out in the General Specification of the Contract.

Key Contractor Activities:

- Contractor will be required to identify all submittals required to meet the timelines established in the General Specification and prepare a submittal schedule that matches the construction activities in the Contract Schedule.
- Schedule the contractor's review of IFC drawings at the 50% and 90% levels and work with the Purchaser's Project Designer to incorporate the durations required to complete the design and issue IFC drawings to meet the requirements as outlined in the General Specification.
- For IFC drawings, the submittal schedule shall show both the target date agreed by the Contractor and Purchaser's Project Designer for receipt by the Contractor of each IFC drawing, and also the latest date that each IFC drawing must be received to avoid delay in the Work.

ECI Task #10 - Monitoring and Control for ECI Tasks #1 to #9

The Contractor as part of these ECIS Obligations shall monitor the progress and cost of performing ECI Tasks #1 to #9 and provide to the Purchaser the monthly reports required by Schedule B - Monitoring and Control Requirements. These monthly reports are solely for monitoring the progress and cost of the Contractor providing ECI Tasks #1 to #9 and shall not be an ECIS Deliverable for purposes of the Phase II Work.

SCHEDULE B

MONITORING AND CONTROL REQUIREMENTS

- Progress reports (monthly)
  - Consists of two items:
    - i) A narrative on the work performed for the reporting period, work planned for the next reporting period and issues/changes that may impact schedule, cost and/or quality and a project-to-date status. The narrative should include the following:
      1. a table listing all ECIS Deliverables, identifying for each the status of that deliverable (% complete), original required date and the anticipated delivery date.
      2. a table identifying all matters of which the Contractor is aware for which the Contractor may be entitled to an Extra Work Order or Change Order for extensions of time or adjustment to the Initial Target Price or the Adjusted Target Price for the Phase II Work.
    - iv) An invoice summarizing the dollars spent on hours worked (hours worked x charge out rate) and all disbursements incurred, broken down by the appropriate work breakdown structure.

  - To be submitted five (5) business days after end of reporting period.
  - The form and content of the monthly progress reports shall be as required by the Purchaser, which as a minimum will include the following a narrative describing significant events accomplished, concerns, critical items required (IFC drawings, equipment, materials or work areas), and items planned for the following month.

- Review meetings to review progress report.
  - Need to occur four (4) business days after end of reporting period.
  - Need to record meeting minutes and distribute shortly after the review meeting.

SCHEDULE C

ECIS BASIS FOR COMPENSATION

To attach Section 4 – Phase I – ECIS Basis for Compensation of the Submission

TERMS AND CONDITIONS OF PAYMENT

KEEYASK GENERATING STATION
GENERAL CIVIL WORKS
CONTRACT 016203

TERMS AND CONDITIONS OF PAYMENT

NOTE: When the term "Work" is used within these Terms and Conditions of Payment, it shall be deemed to mean the Contractor's performance of the Phase II Work and shall exclude the ECIS Obligations and any other work and services performed or provided by the Contractor as required by the ECIS Agreement.

These Terms and Conditions of Payment apply only to the Phase II Work and not to the ECIS Obligations. Terms and conditions for payment for the ECIS Obligations are included instead in the ECIS Agreement.

1. PRICES AND RST

Prices in the Contract are stated in Canadian currency.

For the Work, the Contractor is undertaking what is considered to be a real property contract for Manitoba Retail Sales Tax (RST) purposes. In general terms, under a real property contract, the Contractor will be required to pay or to self-assess RST on materials and taxable services acquired in performance of the Work. If the Manitoba Ministry of Finance or any other Authority determines at any time that any component of the Work provided by the Contractor requires the Contractor to collect or pay any RST for the performance of any services for the Purchaser in connection with the Work, such RST shall be paid to the Contractor in addition to all other amounts payable to the Contractor pursuant to the Contract.

Where the Contractor is being reimbursed by the Purchaser for materials or services incurred in performing the Work, copies of supporting invoices from the Contractor's Subcontractors shall be provided to support the amount invoiced by the Contractor to the Purchaser. GST paid by the Contractor to Subcontractors will not be reimbursed to the extent such tax will be recoverable by the Contractor. Manitoba Retail Sales Tax (RST) and any other taxes paid to Subcontractors or required under applicable Laws to be self-assessed and paid by the Contractor directly to the Manitoba Ministry of Finance shall be considered an Actual Cost.

Where the Contractor is being reimbursed by the Purchaser for RST that was self-assessed by the Contractor, supporting documentation shall be provided to support the amount of additional RST to be reimbursed.

2. GOODS AND SERVICES TAX (GST)

GST will apply to the Work. Where the Contractor is carrying on business in Canada and therefore required to register under the *Excise Tax Act of Canada*, the GST shall be paid by the Purchaser to the Contractor in addition to all other charges billable by the Contractor pursuant to the Contract when required under applicable Laws and the Contractor shall show the GST as a separate amount on each invoice and any invoice issued shall also include the Contractor's GST registration number.

3. OUT OF PROVINCE CONTRACTOR

If the Contractor is based outside of Manitoba and has no permanent place of business in Manitoba, it must comply with Section 14 of *The Tax Administration and Miscellaneous Taxes Act* (Manitoba) and *The Retail Sales Tax Act* (Manitoba) when operating in Manitoba. The provisions under *The Tax Administration and Miscellaneous Taxes Act* (Manitoba) outline the extra-provincial Contractor's responsibilities with respect to reporting business activity in Manitoba and the conditions under which the Contractor may be required to provide security to the Province of Manitoba.

The *Retail Sales Tax Act* (Manitoba) imposes Manitoba provincial retail sales tax (RST) on the temporary use of equipment by non-resident contractors who bring such equipment into Manitoba to perform work in the province. Additional information with respect to the application of the RST to the Plant or equipment of non-resident contractors can be found in Information Bulletin No. 005 – Information for Contractors as issued by Manitoba Finance.

Information with respect to the Contractor's responsibilities under *The Tax Administration and Miscellaneous Taxes Act*, *The Retail Sales Tax Act* or any other tax related provincial legislation can be obtained from:

Manitoba Finance, Taxation Division
Telephone: (204) 945-5603
FAX: (204) 948-2087
Email: MBTax@gov.mb.ca

4. WITHHOLDING TAX

If the Contractor is, or at any time becomes, a "non-resident person" (as that term is defined in the *Income Tax Act* (Canada)) and provides or performs any part of the Work in Canada directly for the Purchaser, and if the Contractor has not received and provided the Purchaser with a copy of a written exemption from Canada's Customs and Revenue Agency under any applicable tax treaty between Canada and a foreign country, or a letter of credit in the amount required to be remitted by the Purchaser pending the date such remittance is required by applicable Laws, the Purchaser shall deduct and withhold 15% of each payment to the Contractor, or such other amount as may be specified by the Customs and Revenue Agency from time to time, and remit the same pursuant to section

105 of the Income Tax Regulations of the *Income Tax Act* (Canada) as same may be amended, replaced or substituted hereafter. If Customs and Revenue Agency assesses the Purchaser for a failure to withhold pursuant to such section 105 (or any successor legislation), the Contractor shall indemnify the Purchaser against all taxes, penalties, fines, interest and costs resulting therefrom.

For further information concerning withholding tax, contact Canada Customs & Revenue Agency at:

Canada Customs & Revenue Agency
Winnipeg Tax Services Office
International Tax Unit
325 Broadway Avenue
Winnipeg, Manitoba R3C 4T4
Canada
Telephone: (204) 983-3969
FAX: (204) 984-6746

5. INITIAL TARGET PRICE

5.1 Initial Target Price

The initial target price for the estimated Actual Costs to be paid to the Contractor for the scope of Work as set out in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE at the date of signing of the Contract is $[**to be inserted**] (the "Initial Target Price").

The Initial Target Price represents only the agreed estimated Actual Costs of the Phase II Work at Contract signing and does not include:

(a) any amount for the Contractor's profit, which profit shall be paid using the Contractor's Profit Percentage in accordance with and subject to these Terms and Conditions of Payment; and

(b) any amount for the Contractor's GA&O, which GA&O shall be paid using the Contractor's GA&O Percentage in accordance with and subject to these Terms and Conditions of Payment.

The Initial Target Price for the Work was established by the Contractor and agreed to by the Purchaser as the estimate for the total of all Actual Costs to be paid by the Purchaser to the Contractor for the Work.

5.2 Sufficiency of the Initial Target Price

The Contractor is deemed to:

(a) have satisfied itself as to the correctness and sufficiency of the Initial Target Price for its intended purposes under this cost reimbursable and target price Contract;

(b) have based the Initial Target Price on the Data, interpretations, necessary information, inspections, examinations and satisfaction as to all relevant matters referred to in the documents comprising the Contract;

(c) acknowledge that circumstances arising after the signing of the Contract under which the Purchaser or others independently bring enhancements to the Project or Contract Schedule or improvements to conditions under which the Contractor performs the Work are not intended by the Parties to provide unearned benefits to the Contractor, so that the Purchaser shall be entitled to claim and obtain such adjustments as may be necessary to remove such unearned benefits from calculation of the Contractor's entitlement to Shared Savings or calculation of the Contractor's requirement to pay any portion of Actual Cost Overruns; and

(d) have included within the Initial Target Price the cash allowances set out in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES PRICES AND TARGET PRICE ESTIMATE forming part of the Work (the "Cash Allowance Items"):

The Contractor's Actual Cost in respect of the Cash Allowance Items shall be charged against the particular cash allowance referable to the item as the Work proceeds. In the event that the total amount of the Actual Costs of all of the Cash Allowance Items exceeds the cash allowance total noted above in this Section 5.2(d), then the Adjusted Target Price shall be adjusted to account for any overrun amount. In the event that the total amount of the Actual Costs of all of the Cash Allowance Items is less than the cash allowance total noted above in this Section 5.2(d), then the Adjusted Target Price shall be adjusted to account for any surplus amount. The Purchaser shall effect any such adjustments to the Adjusted Target Price, and any required changes to the Contract Dates and the Completion Date, through the issuance of an Extra Work Order.

5.3 Target Price Assumptions

The following baseline assumptions and methodology in the Contractor's Submission Extracts documents which were used to establish the Unit Prices for the items of the Work will not be subject to change for the duration of the Work and the performance of the Contract, and changes to such assumptions and methodology shall not be used to determine the adjustments, if any, to the Adjusted Target Price unless the Contractor is otherwise entitled to an adjustment in accordance with Section 6 ADJUSTMENTS TO THE TARGET PRICE of the Terms and Conditions Payment:

(a) The Contractor's construction methodology to undertake the Work including equipment and crew selection, unless otherwise directed by the Engineer or the Purchaser;

(b) The Contractor's productivity rates (Units/hr.) and man-hour factors (Man hr./Unit) of all crews as set out in the printout of the Contractor's estimating

software in the Contractor's Submission Extracts under the section heading INITIAL TARGET PRICE BREAKDOWN;

(c) The Contractor's supply cost of all temporary/permanent materials and equipment as set out in the printout of the Contractor's estimating software in the Contractor's Submission Extracts under the section heading INITIAL TARGET PRICE BREAKDOWN;

(d) The Contractor's hourly rates for all craft and supervisory staff wages as set out in the printout of the Contractor's estimating software in the Contractor's Submission Extracts under the section heading INITIAL TARGET PRICE BREAKDOWN;

(e) The Contractor's rates for all equipment set out in the Contractor's Submission Extracts under the section heading EQUIPMENT RATES;

(f) The Contractor's small tools and supplies factors as set out in the printout of the Contractor's estimating software in the Contractor's Submission Extracts under the section heading INITIAL TARGET PRICE BREAKDOWN; and

(g) The Contractor's assumptions used to develop the costs in Item Number 01 10 05 a) - Indirect Costs as set out in the printout of the Contractor's estimating software in the Contractor's Submission Extracts under the section heading INITIAL TARGET PRICE BREAKDOWN as follows:

i) Supervisory staff to craft ratio;
ii) Staff vehicle allotment;
iii) Travel assumptions;
iv) Assumptions for craft and staff flights; and
v) Assumptions for quantity and scope of Temporary Works and the Contractor's facilities at Site such as offices, shops, warehousing and work areas.

6. ADJUSTMENTS TO THE TARGET PRICE

During the performance of the Work and the Contract, the Initial Target Price for the Work may be adjusted (the "Adjusted Target Price") as a result of any of the following:

(a) for escalation as provided for in Section 6.1 ESCALATION ADJUSTMENT of the Terms and Conditions of Payment;

(b) for an in-scope Change authorized by Extra Work Order for any aspect of the Work including variations to the quantities set out in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE as provided for in Section 27 CLARIFICATIONS AND CHANGES TO THE WORK AND ADJUSTMENTS of the General Specification;

(c) for additional scope to the Work as a result of a Change Order of any aspect of the Work as provided for in Section 27 CLARIFICATIONS AND CHANGES TO THE WORK AND ADJUSTMENTS of the General Specification;

(d) for any of the reasons set out in Section 22.6 REQUESTS FOR EXTENSION OF TIME or Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification; and

(e) an overrun or surplus in the Actual Costs of all Cash Allowance Items as compared to the cash allowance total as set out in Section 5.2(d) SUFFICIENCY OF THE INITIAL TARGET PRICE,

and upon adjustment for any of the above reasons, the most recent Adjusted Target Price for the Work shall be referred to as the "Adjusted Target Price".

6.1 Escalation Adjustment

For all craft labour, the Escalation Adjustment will be calculated as the actual year to year difference in hourly wage rates negotiated between the Allied Hydro Council and the Hydro Projects Management Association pursuant to the Burntwood Nelson Agreement. Additionally any Letters of Agreement signed under the conditions of the BNA that result in changes to hourly wage rates will also be treated as an Escalation Adjustment.

For all other items in the Contractor's Submission Extracts under the section heading INITIAL TARGET PRICE BREAKDOWN, and for any Extra Work Order or Change Order that resulted in an adjustment to the Adjusted Target Price, the applicable Escalation Adjustment will be as outlined in the Contractor's Submission Extracts under the section heading ESCALATION METHODOLOGY.

The Adjusted Target Price will be subject to upward or downward adjustment by Extra Work Order to reflect changes in market pricing for:

(a) all labour, equipment and material costs identified in the Contractor's Submission Extracts under the section heading INITIAL TARGET PRICE BREAKDOWN to account for the difference in such costs between the date of the signing of the Contract and the date the applicable Work is actually performed; and

(b) all labour rates, equipment rates and material costs of any Work due to Extra Work Order or Change Order that resulted in an adjustment to the Adjusted Target Price to account for the difference in such costs between the date of issuance of the Extra Work Order or Change Order and the date the applicable Work was actually performed.

(hereinafter referred to as the "Escalation Adjustment").

6.2 Adjustments due to Changes in the Work

6.2.1 No Guarantee of Estimated Quantities

The quantities provided by the Purchaser that were utilized in developing the Initial Target Price, as reflected and stated in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE,

are estimates only. The Purchaser makes no guarantee of any stated quantities, and will pay for actual quantities incorporated into the Work as measured and evaluated by the Engineer in accordance with Section 26 MEASUREMENT AND EVALUATION of the General Specification and certified, invoiced and paid for in accordance with these Terms and Conditions of Payment.

6.2.2 Adjustment of Target Price for Changes in Quantities

Notwithstanding Section 6.2.1 NO GUARANTEE OF ESTIMATED QUANTITIES, the Adjusted Target Price shall be subject to adjustment whenever the estimated quantities for any aspect of the Work as set out in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE or any estimated quantities set out in an Extra Work Order or Change Order vary from the actual installed quantities for the Work, as measured and evaluated by the Engineer in accordance with Section 26 MEASUREMENT AND EVALUATION of the General Specification, provided that there shall be no changes to the Unit Prices originally submitted by the Contractor, unless the actual quantities vary from the estimated quantities by +/- 15% of the estimated quantities in which event the Contractor shall proceed in accordance with Section 22.7 PURCHASER CAUSED DELAY AND/OR ADDITIONAL COSTS of the General Specification.

The Adjusted Target Price shall be adjusted as follows for such variation in quantities:

(a) Unit Prices submitted by the Contractor for Direct Costs in Items 01 51 00 to 43 20 00 in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, PRICES AND TARGET PRICE ESTIMATE shall be used to calculate the Direct Costs of each such variation in quantities; and

(b) the Site Indirect Cost Percentage shall be calculated on such Direct Costs of each such variation in quantities as follows:

  i) for a Change in quantities related to Work performed by the Contractor's own forces, at the corresponding percentage set out in the Contractor's Submission Extracts under the section heading SITE INDIRECTS; and,

  ii) for a Change in quantities related to Work performed by a Subcontractor, at the corresponding percentage set out in the Contractor's Submission Extracts under the section heading SITE INDIRECTS; and

  iii) for a Change in quantities related to Work performed both by the Contractor's own forces and by one or more Subcontractors, at the percentages set out in paragraphs i) and ii) above, prorated based upon the percentage of the Direct Costs of such work performed by each,

and the Adjusted Target Price shall be accordingly adjusted by the sum of paragraphs (a) and (b) above. An Extra Work Order shall be issued to confirm the Adjusted Target Price resulting from the Change in quantities.

6.3 Adjustments to Target Price due to Changes in the Work

To the extent that additions or deletions are made to the original scope of the Work (other than for a variation in quantities) pursuant to Extra Work Order or Change Order which results in an increase or decrease of the Actual Costs, the Adjusted Target Price shall likewise be adjusted as follows:

(a) For any portion of the new scope of Work included in the Extra Work Order or Change Order for which Unit Prices are not set out in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, UNIT PRICES AND TARGET PRICE ESTIMATE, and no Proposal for Extra Work is attached to the Extra Work Order or Change Order, by the Actual Costs as certified by the Engineer in respect of such Work;

(b) For any portion of the new scope of Work included in the Extra Work Order or Change Order for which Unit Prices are not set out in the Contractor's Submission Extracts under the section heading BILL OF QUANTITIES, UNIT PRICES AND TARGET PRICE ESTIMATE, but a Proposal for Extra Work is attached to the Extra Work Order or Change Order, by the amount set out in the Extra Work Order or Change Order; and

(c) the Site Indirect Cost Percentage shall be calculated on such Actual Costs of the new scope of work as follows:

i) for any new scope of Work related to work performed by the Contractor's own forces, at the corresponding percentage set out in the Contractor's Submission Extracts under the section heading SITE INDIRECTS; and,

ii) for any new scope of Work related to work performed by a Subcontractor, at the corresponding percentage set out in the Contractor's Submission Extracts under the section heading SITE INDIRECTS; and

iii) for any new scope of Work related to work performed both by the Contractor's own forces and by one or more Subcontractors, at the percentages set out in paragraphs i) and ii) above, prorated based upon the percentage of the Actual Costs of such Work performed by each,

and the Adjusted Target Price shall be accordingly adjusted by the sum of paragraphs (a) to (c) above.

7. REWORK AND WARRANTY COSTS

Subject to Section 21.13 EXCEPTION TO PAYMENT FOR REJECTED, FAULTY OR DEFECTIVE WORK of the General Specification, the Actual Costs incurred by the Contractor in removal, rebuilding, replacement, repair, re-execution or making good of Work as provided for in Section 21.11 REJECTION or Section 21.12 FAULTY OR DEFECTIVE WORK of the General Specification or during the performance of warranty work as provided for in Section 25 WARRANTY of the General Specification will be captured and documented by the Contractor on a separate account and reimbursed as an Actual Cost in accordance with these Terms and Conditions of Payment.

The Contractor's GA&O Percentage on such Actual Costs (except for the first $1,000,000 of such work) set out in the preceding paragraph shall not be calculated on or invoiced to the Purchaser by the Contractor.

8. VALUE ENGINEERING

The Contractor may, at any time, submit to the Engineer a written proposal which, in the Contractor's opinion will, if adopted:

(a) accelerate completion of the Work;
(b) reduce the cost of executing, maintaining or operating the Work;
(c) improve the efficiency or value of the completed Work, or
(d) otherwise be of benefit to the Purchaser,

(the above referred to as a "Value Engineering Proposal").

The Contractor's Value Engineering Proposal shall set out in detail:

i) the Contractor's proposed concepts and ideas;
ii) how the proposal would be implemented;
iii) the proposed impact on the Contract Schedule or Project Comprehensive Schedule;
iv) the proposed impact on the cost of the Work; and
v) the particulars of the benefits to be derived by the Purchaser, the Keeyask Hydropower Limited Partnership as the owner and operator of the Work, and/or the Contractor.

The Purchaser, in its discretion, shall determine whether to consider, accept and implement any Value Engineering Proposal and any such accepted Value Engineering Proposal shall require the written approval of the Purchaser to proceed, in the form of an issued Extra Work Order.

If a Value Engineering Proposal, which is approved by the Purchaser issuing an Extra Work Order implementing the Value Engineering Proposal, includes a Change in the design of part of the Permanent Works, then unless otherwise agreed by both Parties:

(1) the Purchaser shall design this part, and all resulting design costs shall be deemed to be Actual Costs that have been paid to the Contractor that for the purpose of determining if the Actual Costs exceed or are less than the Final Target Price, and
(2) if the approved Value Engineering Proposal would result in a reduction in the Adjusted Target Price, notwithstanding the above Section 6.3 ADJUSTMENTS TO TARGET PRICE due to Changes in the Work, there shall be no adjustment to reduce the amount of the Adjusted Target Price.

Any net savings after accounting for the Purchaser's design costs which accrue from the approved Value Engineering Proposal will be used to off-set Actual Cost Overruns, or

contribute to Shared Savings as outlined in Section 9.5 TOTAL CONTRACT PRICE of the Terms and Conditions of Payment.

9. BASIS FOR PAYMENT

9.1 Actual Costs

Subject to these Terms and Conditions of Payment, the Purchaser shall pay the Contractor the Contractor's Actual Costs incurred in the performance of the Work.

The Contractor shall not include any hidden profit, charge, fee or mark-up in any Actual Costs invoiced to the Purchaser in the performance of the Work.

9.2 Contractor's GA&O

Subject to these Terms and Conditions of Payment, the Purchaser shall pay the Contractor's GA&O Percentage calculated as a percentage of the Actual Costs as the Contractor's fee for GA&O less any deductions properly made to such calculation as permitted by the provisions of the Contract.

9.3 Contractor's Profit

Subject to these Terms and Conditions of Payment, the Purchaser shall pay the Contractor its Contractor's Profit Percentage calculated as a percentage of the Final Target Price as the fee to be earned by the Contractor for the performance of the Work less any amount owed to the Purchaser by the Contractor for its portion of Actual Cost Overruns as set out in Section 9.5 TOTAL CONTRACT PRICE of the Terms and Conditions of Payment.

9.4 No Hidden Fees

The Contractor's Profit Percentage and Contractor's GA&O Percentage shall not be applied to any Actual Cost element for the Work which already includes an allowance, fee or mark-up for the Contractor's profit, general administration or overhead.

9.5 Total Contract Price

If the Final Target Price is more than the total Actual Costs, the Contractor shall be entitled, in addition to the Actual Costs of the Work, to receive a portion of the Shared Savings. If the Final Target Price is less than the total Actual Costs, the Contractor shall be entitled to receive the Actual Costs less a portion of the Actual Cost Overruns, provided that such portion shall not exceed an amount equal to the Contractor's Profit Percentage on the Final Target Price plus any bonus paid.

Upon the Final Target Price being calculated for the Work as at the date of the Final Completion Certificate, the Engineer shall determine and advise the Purchaser and the

Contractor in writing of the amount, if any, by which the Actual Costs varied from the Final Target Price.

The total compensation paid by Purchaser to the Contractor for the performance of the Contract (the "Contract Price"), other than the ECIS Obligations for which the compensation is governed by the ECIS Agreement, shall be the following:

(a) If the Actual Costs are less than or equal to the Final Target Price, then the Contract Price shall be equal to the Actual Costs plus the GA&O, plus the Contractor's Profit Percentage on the Final Target Price, plus twenty percent (20%) of the Shared Savings, calculated as follows:

Contract Price = AC + [GA&O% x (AC-RW)] + [Profit% x FTP] + [0.20 x (FTP - AC)]

Where:

i) AC = Actual Costs

ii) RW = Actual Costs incurred for rework and warranty work pursuant to Section 7 of the Terms and Conditions of Payment over $1,000,000

iii) FTP = Final Target Price

iv) GA&O% = Contractor's GA&O Percentage

v) Profit% = Contractor's Profit Percentage

(b) If the Actual Costs are more than the Final Target Price but less than or equal to 130% of the Final Target Price (i.e. less than 1.3 x Final Target Price), then the Contract Price shall be equal to the Actual Costs plus the GA&O, plus the Contractor's profit calculated as the greater of (i) 0$ and (ii) the product of the Contractor's Profit Percentage by the Final Target Price less eighty percent (80%) of the Actual Cost Overrun, calculated as follows:

greater of:

(i) Contract Price = AC + [GA&O% x (AC - RW)]; or

(ii) Contract Price = AC + [GA&O% x (AC - RW)] + [Profit% x FTP] - [0.8 x ACO]

Where:

i) AC = Actual Costs

ii)	RW	=	Actual Costs incurred for rework and warranty work pursuant to Section 7 of the Terms and Conditions of Payment over $1,000,000
iii)	FTP	=	Final Target Price
iv)	GA&O%	=	Contractor's GA&O Percentage
v)	Profit%	=	Contractor's Profit Percentage
vi)	ACO	=	Actual Cost Overrun (i.e. equal to AC - FTP)

(c) If the Actual Costs are more than 130% of the Final Target Price (i.e. more than 1.3 x Final Target Price), then the Contract Price shall be equal to the Actual Costs plus the GA&O, calculated as follows:

Contract Price = AC + [GA&O% x 1.3 x FTP] – [GA&O% x RW]

Where:

i)	AC	=	Actual Costs
ii)	FTP	=	Final Target Price
iii)	GA&O%	=	Contractor's GA&O Percentage
iv)	RW	=	Actual Costs incurred for rework and warranty work pursuant to Section 7 of the Terms and Conditions of Payment over $1,000,000

10. RECONCILIATION OF FEE TO ADJUSTED TARGET PRICE

Subject to subsequent reconciliation and adjustment as provided in Section 9.5 TOTAL CONTRACT PRICE of the Terms and Conditions of Payment if the Actual Costs exceed the Final Target Price and as provided in Section 7 REWORK AND WARRANTY COSTS of the Terms and Conditions of Payment if any Actual Costs are incurred in the performance of re-work or warranty work, the Contractor shall claim both its Contractor's Profit Percentage and Contractor's GA&O Percentage as percentages of the Actual Costs of the Work claimed in each Monthly Progress Statement. Certification of the amount calculated using the Contractor's Profit Percentage by the Engineer shall always be subject to verification that the Actual Costs are projected to be less than the projected Final Target Price at the time of certification. The Engineer shall be entitled to undertake such verification as frequently as he deems fit, but in any event, not less frequently than once per year on the anniversary of the date of the first progress payment made by the Purchaser to the Contractor for Phase II Work, and each year thereafter until the Final Accounting for the Work.

In addition, the amount in any Monthly Progress Statement calculated to be payable using the Contractor's Profit Percentage shall be reduced in accordance with Section 9.5 TOTAL CONTRACT PRICE of the Terms and Conditions of Payment any time the projected Actual Costs exceed the Adjusted Target Price. This amount shall be deducted by the Purchaser from the amount payable using the Contractor's Profit Percentage on subsequent Monthly Progress Statements.

11. ACTUAL COSTS

11.1 Definition of Actual Costs

"Actual Costs", for the purposes of the Contract, shall mean only the following:

(a) all actual, indirect and direct costs incurred by the Contractor in performing the Work including, but not limited to (and specifically excluding GST and RST required to be collected from Purchaser by Contractor but including any RST required to be paid by Contractor to its suppliers or required to be self-assessed and paid by Contractor), all costs incurred for all labour (including the cost of workers' compensation assessments, vacation pay, employment insurance, pension plan payments, payroll taxes, and any other employee benefits paid by the Contractor), equipment rentals, all supplies and materials, services, delivery and transportation, or any other direct, indirect and actual cost incurred by the Contractor in the performance of the Work as is more fully set out in this Section 11;

(b) all actual, indirect and direct costs incurred by the Contractor (in accordance with paragraph (a) above) resulting from an addition to, deletion from or modification of the Work as documented in an Extra Work Order or Change Order; and

(c) all actual, indirect and direct costs incurred by the Contractor (in accordance with paragraph (a) above) resulting from a termination for convenience by the Purchaser of the Contract in accordance with Section 29.3 TERMINATION FOR CONVENIENCE of the General Specification,

each of the above having been reasonably and properly incurred by the Contractor, but such amounts shall not include any allowance to the Contractor or any affiliate of the Contractor, including without limitation for profit or GA&O.

The following categories in Sections 11.2 to 11.13 of the Terms and Conditions of Payment inclusive, all of which are subject to Section 11.14 INELIGIBLE COSTS of the Terms and Conditions of Payment, are appropriate categories of Actual Costs that may be incurred by the Contractor in the performance of the Work (without duplication between categories) and exclude GA&O and Ineligible Costs.

11.2 Mobilization and Demobilization Costs

Actual Costs include all costs incurred by the Contractor in delivery, transporting, installation, dismantling and removal of equipment and materials or establishing the Site office, temporary storage areas, laydown areas and other preliminary services required to

establish a presence at the Site and all costs actually incurred by the Contractor to demobilize its operations from the Site at the completion of the Work with any required transportation costs limited to the costs of transportation to the closer of the Contractor's Canadian Office and the actual location to which the equipment, materials and facilities are demobilized.

11.3 Contractor's Salaried Employees

Actual Costs include all amounts incurred by Contractor for salaries payable to the Contractor's employees (excluding craft labour) who are assigned full time to the Work and are performing the Work at the Site or such other location within the Province of Manitoba, including statutory payroll deductions, taxes and customary employee benefits (pro-rated for the time they are performing Work at the Site or such other location within the Province of Manitoba).

11.4 Contractor's Craft Labour

Actual Costs include all amounts incurred by the Contractor related to the Work for the Contractor's craft labour, including actual payroll burdens and deductions, approved overtime premiums, and all other charges contained in, or required to be paid by the Contractor to the craft labour pursuant to applicable collective bargaining agreements.

11.5 Subcontractor Costs

Actual Costs include all amounts incurred by the Contractor in respect of the payment of any Subcontractors for the elements of the Work performed pursuant to a subcontract, purchase order, material contract or other similar document, which has been procured in accordance with the terms of the Contract.

11.6 Materials and Equipment incorporated into or required to complete the Work

Actual Costs include all amounts incurred by the Contractor for all materials and equipment incorporated into the Work by Contractor, including the costs of transportation and temporary storage (including any materials stored off-Site), which has been procured in accordance with the terms of the Contract.

11.7 Materials and Equipment Consumed at the Site

Actual Costs include all amounts incurred by Contractor for all materials, equipment, supplies and small tools which are provided by Contractor at the Site and fully consumed during the performance of the Work, including all costs associated with transportation to and temporary storage at the Site, which has been procured in accordance with the terms of the Contract.

11.8 Equipment

[NTD: Equipment provisions subject to change based on content of Proponent's submission]

Subject to limiting provisions of this Section 11.8 on Actual Costs that may be charged or recovered for construction machinery and equipment, all amounts incurred by Contractor, including taxes, for all necessary construction machinery and equipment used at the Site, exclusive of small tools defined in Section 11.6 MATERIALS AND EQUIPMENT INCORPORATED INTO OR REQUIRED TO COMPLETE THE WORK and Section 11.13 PURCHASER'S DESIGN COSTS FOR ACCEPTED VALUE ENGINEERING PROPOSALS FROM CONTRACTOR of the Terms and Conditions of Payment, but including the costs of company rent, operation and maintenance. Rates and charges for all rental equipment (including the Company Rental Rate as defined below in this Section 11.8) for any machinery and equipment owned by Contractor or an affiliated entity and for which a rental rate is not specified in the Submission must be approved by the Purchaser before their mobilization to Site.

For purposes of the Contract, the "Total Ownership Costs" for each item of equipment owned by Contractor or any affiliate of Contractor is defined as the total equipment ownership cost calculated based on purchase price (or actual cash value if previously used), applicable taxes, insurance, reasonable financing charges, storage cost and salvage value.

The "Total Ownership Costs" and the company rental rate for each item of equipment owned by the Contractor or an affiliate ("Company Rental Rate") to be used in the performance of the Work and charged on a rental basis are included in the Contractor's Submission Extracts under the section heading EQUIPMENT RATES.

No equipment owned by Contractor or its affiliates for which the Total Ownership Costs and Company Rental Rate are not specified in the Contractor's Submission Extracts under the section heading EQUIPMENT RATES shall be mobilized to Site or used unless and until the Total Ownership Costs and Company Rental Rate have been given to the Purchaser and demonstrated by the Contractor to Purchaser's satisfaction are reasonable and accepted in writing by the Purchaser.

The cost (including cost of repairs and refurbishment) for all rental equipment owned by Contractor or its affiliates will only be reimbursed as an Actual Cost in accordance with the following:

(a) The operating and maintenance costs of the rental equipment including parts, fuel, oil, grease, tires, tracks and all maintenance hours will be charged at direct cost (without markup for overheads and profit) incurred by Contractor, and included as an Actual Cost as incurred in performance of the Work;
(b) All rental equipment shall have a condition report at the time of arrival and before the Engineer authorizes its removal from Site. The report must contain a status of

the main features (tire tread depth, undercarriage %, bushings, glass etc.). Final accounting will be required to assure no net loss/gain on the condition of each piece of equipment;

(c) Once the rental charges for any such rental equipment reaches its Total Ownership Costs, such equipment shall be charged at 0% of the applicable Company Rental Rate; and

(d) Rental equipment shall not be removed from the Site or replaced until it has reached the end of its useful life as approved by the Engineer.

Where construction machinery and equipment is required for performance of the Work that is not owned by the Contractor or an affiliate, the Contractor shall rent such equipment at the lowest competitive price in the region from an arms-length, third party supplier, taking into account condition and availability of that equipment. If the anticipated rental cost for a piece of equipment exceeds $500,000, then the Contractor shall comply with Section 7.8 PROCESS FOR SELECTION OF SUBCONTRACTORS of the General Specification.

11.9 Site Office Costs

All amounts incurred or paid by the Contractor for Site (or any other office in Manitoba to the extent related to this Project) office general expenses, including telephone services, long distance phone calls, fax machines, photocopiers, computers, postage, satellite phone services (if required), internet connection and establishment costs, office supplies, custom printing required by the Contract (if any), express and air courier delivery services and other similar items used in order to perform the Work. Unless the Purchaser otherwise agrees, all such fax machines, photocopiers, computers and other office equipment and supplies shall be purchased new at competitive prices in Manitoba and not rented from suppliers.

11.10 Remediation of Hazardous Materials

All amounts incurred or paid by Contractor in remediating, or attempting to remediate, any hazardous or toxic materials or substances discovered at the Site, as contemplated in the General Specification or directed by the Engineer in an Extra Work Order. The Actual Costs shall not include any amounts incurred or paid by the Contractor in remediating or attempting to remediate, any hazardous or toxic substances spilled that are not used, stored or contained by the Contractor in compliance with applicable Laws or are otherwise present at the Site due to the Contractor's or any Subcontractor's negligent acts or omissions.

11.11 Small Tools, Supplies and Equipment under $20,000

The following general items of equipment are to be purchased by the Contractor for the performance of the Work and the purchase price will be an Actual Cost:

(a) Small tools and supplies; and

(b) All equipment with a purchase price under $20,000 including:

i) light plant;
ii) welders;
iii) heaters;
iv) compressors;
v) pumps;
vi) fax machines;
vii) photocopiers;
viii) computers; and
ix) other office equipment and supplies.

Title to such items shall vest in the Purchaser at the time of purchase; however, risk of loss or use of such items shall rest with the Contractor until they are disposed of in accordance with the next paragraph.

The Contractor will, at the Purchaser`s option and at a mutually agreeable time, either offer to purchase the above items from the Purchaser at their then current fair market value or to take commercially reasonable steps to sell these items at fair market value and to charge the Purchaser the Contractor's reasonable Actual Costs of doing so. All sale proceeds shall be provided to the Purchaser by way of credit on the Contractor`s next Monthly Progress Statement following such sale or purchase by the Contractor by reducing the Contractor`s Actual Costs by the actual sale value of these items such that the Purchaser is not paying the Contractor the Contractor's GA&O Percentage or the Contractor's Profit Percentage on the value of the sale proceeds. Or, in the event the Contractor does not provide the credit to the Purchaser as set out above, the Purchaser may deduct and retain the amount of such sale proceeds from the Performance Holdback provided for in Section 16 PERFORMANCE HOLDBACK of the Terms and Conditions of Payment or the Letter of Credit provided for in Section 15 PERFORMANCE SECURITY of the Terms and Conditions of Payment. Any amounts not so recovered by the Purchaser shall be a debt due and payable by the Contractor to the Purchaser within 30 days of the Purchaser's written demand therefor.

11.12 Miscellaneous Costs

Actual Costs will include miscellaneous costs incurred by the Contractor as follows:

(a) for clean-up and removal of debris from the Site;
(b) in responding to an emergency affecting the safety of persons or property, provided that the Actual Costs shall not include any costs in responding to an emergency that results from any act, error or omission of the Contractor or any Subcontractor or any party for whom the foregoing are responsible at law or under the Contract;
(c) in obtaining, or providing assistance at the Purchaser's request to the Purchaser in securing, any of the Permits listed in the Permit Matrix to be provided by the Contractor in the ECIS Obligations;
(d) in transporting its employees from their usual place of work to and from the Site;
(e) subject to pre-authorization by the Purchaser, for its indirect costs not otherwise described herein incurred by the Contractor in respect of any off-Site employees

in the Province of Manitoba and consultants who perform elements of the Work, including all costs actually incurred by the Contractor for off-Site accommodation for such employees and consultants, when they are required to travel in relation to the Work;

(f) all customs duties, surcharges, insurance deductibles, permit and license fees, transportation and delivery costs resulting from the performance of the Work; and

(g) other Actual Costs incurred in the performance of the Work, but limited to those costs that are approved in writing in advance by the Purchaser.

11.13 Purchaser's Design Costs for Accepted Value Engineering Proposals from Contractor

As provided in Section 8 VALUE ENGINEERING of the Terms and Conditions of Payment, all design costs incurred by Purchaser in relation to a Value Engineering Proposal from Contractor that is accepted and implemented by Purchaser shall be included in the Actual Costs.

11.14 Ineligible Costs

Notwithstanding the definition of Actual Costs and the listing of permitted categories of Actual Costs set out above, any costs incurred by the Contractor that are:

(a) unrelated to the performance of the Work or the Contract;

(b) incurred by the Contractor to remedy any negligent act or omission, or wilful misconduct of the Contractor or any Subcontractor in the performance of the Work or pursuant to the terms of the Contract;

(c) included in GA&O;

(d) paid to the Purchaser as direct damages pursuant to Section 3.7 CONTRACT DATES or Delay Liquidated Damages pursuant to Section 3.10 FAILURE TO MEET TURBINE-GENERATOR READY FOR COMMISSIONING DATE of the General Specification; and

(e) included in those items set out in Sections 7.22, 7.24, 7.30, 8.5, 8.16.3, 8.17, 11 and 21.13 of the General Specification and as specified under Section 15 PERFORMANCE SECURITY of these Terms and Conditions of Payment;

shall not be considered Actual Costs and will not be included in the calculation of Actual Costs for any purpose pursuant to the Contract (the "**Ineligible Costs**"). The Contractor has the onus to demonstrate to the Purchaser's satisfaction, acting reasonably, that any costs incurred are not Ineligible Costs.

12. GENERAL ADMINISTRATION AND OVERHEAD (GA&O)

"GA&O" for the purposes of the Contract shall mean the Contractor's general overhead and administrative cost for the performance of the Work as outlined in this Section 12 and calculated as a percentage of the Actual Costs. The Contractor's GA&O percentage for the Work shall be the percentage set out in the Contractor's Submission Extracts under the section heading CONTRACTOR'S FEE COMPONENTS for the duration of the Contract (the "Contractor's GA&O Percentage").

The Contractor's GA&O is an all-inclusive amount for all overheads and costs incurred by the Contractor dedicated to the Work for the duration of the Contract that are performed from any office of the Contractor outside of Manitoba, including such items as the following:

(a) Home Office Executive Management, Project Sponsors and Managers
(b) Corporate Office /Shop/Warehouse Costs
(c) Corporate Safety, Quality and Environmental Programs
(d) Corporate and Off-Site Training
(e) Human Resource Management
(f) Marketing
(g) Corporate Risk Management/Insurance
(h) Corporate Tax
(i) Corporate Legal
(j) Corporate Accounting/Financial Reporting
(k) Internal Audit
(l) Business Management
(m) Corporate Procurement
(n) Corporate Treasury/Cash Management
(o) I.T. Support

13. NOT USED

14. ACCOUNTING AND AUDIT

14.1 Accounting on Final Completion

Following the issuance of the Final Completion Certificate in accordance with Section 24.3 TAKING OVER OF THE WORK of the General Specification, and final payment by the Purchaser in accordance with Section 24 FINAL PROGRESS STATEMENT of the Terms and Conditions of Payment below, the Parties will proceed to review and conduct a final accounting and reconciliation of all Actual Costs, Contractor's GA&O Percentage calculated on such Actual Costs and Contractor's Profit Percentage calculated in accordance with the Terms and Conditions of Payment and paid for the Work (the "Final Accounting") in order to confirm the total Contract Price under Section 9.5 TOTAL CONTRACT PRICE of these Terms and Conditions of Payment.

Subject to any amounts in dispute by the Purchaser or the Contractor, as part of this Final Accounting, the Parties shall make commercially reasonable efforts to agree to:

(a) make any supported adjustments to any calculations of Actual Costs, Contractor's GA&O Percentage calculated on such Actual Costs and Contractor's Profit Percentage calculated on Final Target Price;
(b) make any supported adjustments to the Adjusted Target Price or Final Target Price through the issuance of an Extra Work Order or Change Order;
(c) make any other supported adjustments to the financial accounting for the Work; and
(d) making any resulting adjustments to payments made or owing by one Party to the other,

all in accordance with the provisions of the Contract. If a Party is determined to owe any amount to the other Party as a result of the Final Accounting, the amount shall be considered a debt due and payable by such Party to the other Party and the paying Party shall make payment to the other Party for the outstanding amount, within 30 days of the final results of such Final Accounting being made available to both Parties.

In the event that the Parties are unable to agree upon one or more of the aforementioned issues, then Engineer will make a determination documented in an Extra Work Order which either Party is entitled to dispute in accordance with Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification.

14.2 Final Accounting at Conclusion of Warranty Period

Following the conclusion of the Warranty Period as determined in accordance with Section 25 WARRANTY of the General Specification, the Actual Costs certified by the Engineer to be payable to the Contractor for all warranty work will be accounted for in accordance with Section 14.1 ACCOUNTING ON FINAL COMPLETION of the Terms and Conditions of Payment and all resulting adjustments and payments shall be in accordance with the provisions of such Section.

14.3 Open Book Process

The pricing of and payment for the Work is based upon the principle of open book accounting between the Purchaser and the Contractor, so that the Purchaser will have full and open access to the books and records of the Contractor relating to the Work.

The Contractor shall adopt a system of open book accounting and shall at all times:

(a) maintain a full record of particulars of the cost of performing the Work, including all Actual Costs; and
(b) provide a monthly summary of any of the costs referred to in Section 14.1(a) ACCOUNTING ON FINAL COMPLETION of the Terms and Conditions of Payment, in such form and detail as the Purchaser may reasonably require,

together with explanations as required by the Purchaser, to monitor the performance by the Contractor of its obligations under the Contract; and

(c) provide such facilities as the Purchaser (or its representative) may reasonably require for its representatives to visit any other place where the records are held and examine the records maintained under this Section 14.3. In the event that no such location is available, then the books and records, together with the supporting or underlying documents and records, shall be made available for audit at a time and location during regular business hours and which is convenient for the Purchaser (or its representative).

14.4 Record Keeping

(a) Compliance with Section 14.3 OPEN BOOK PROCESS of these Terms and Conditions of Payment shall require the Contractor to keep books of accounts on an open book accounting system and in accordance with generally accepted accountancy practice with respect to the Contract and the Work. The financial information shall be laid out in a format as agreed between the Purchaser and the Contractor, but, at a minimum, shall include the following items:

i) Actual Costs;
ii) invoices from Subcontractors and records of payments to Subcontractors;
iii) capital expenditures and such revenue expenditures as not detailed above;
iv) such other available items relating to the Contractor's costs of performing the Work as the Purchaser may reasonably require; and
v) such other items as the Purchaser may reasonably require to conduct cost audits for verification of cost expenditure or estimated expenditure.

The Contractor shall have (and shall require that Subcontractors performing work on a cost reimbursable basis shall have) all books of account evidencing the items listed in this Section 14.4(a) available for inspection by the Purchaser, upon reasonable notice, during regular business hours, and shall present a report of these to the Purchaser as and when requested.

(b) The Contractor shall permit all records referred to in this Section and any other audited or unaudited financial statements in relation to the Contract or the Work to be examined and copied by the Purchaser or its representatives, at the Purchaser's cost.

(c) The records referred to in this Section shall be retained for a period of at least ten (10) years from the date of the Final Completion Certificate provided for in Section 24.3 TAKING OVER OF THE WORK of the General Specification.

(d) The Purchaser and Contractor agree that all such accounting or financial information provided by the Contractor as set out above shall be considered "Contractor's Confidential Information" and treated as such in accordance with Section 30.10 CONFIDENTIALITY of the General Specification.

14.5 Audit Rights

(a) The Purchaser (or its representative) may audit all of the Contractor's Records for the later of a period of ten (10) years after final payment and the period required by applicable Laws. The Contractor's Records shall be maintained and subject to audit to the extent necessary to adequately permit evaluation and verification of:

i) the Contractor's compliance with the requirements of the Contract; and
ii) compliance with provisions for Monthly Progress Statements submitted by the Contractor.

(b) The Purchaser's audit rights shall extend to all information, materials and data of every kind that may, in the Purchaser's reasonable judgment, have any bearing on or pertain to any matters, rights, duties or obligations under or covered by the Contract. Where the Contractor's Records have been generated from computerized data (whether mainframe, mini-computer, or personal computer based computer systems), the Contractor agrees to provide the Purchaser's representatives with extracts of data files in computer readable format on data disks or suitable alternative computer data exchange formats.

(c) The Contractor shall require all Subcontractors (excluding those entering into lump sum and/or unit price subcontracts or major material purchase orders), to comply with the provisions of this Section 14.5 by insertion of the requirements of this Section 14.5 in a written contract agreement between Contractor and each of its Subcontractors. Contractor will cause all Subcontractors to cooperate fully in furnishing or in making available to the Purchaser from time to time whenever requested in an expeditious manner any and all such information, materials and data required by this Section 14.5.

(d) The Purchaser's agent or its authorized representative shall have access to the Contractor's facilities, shall be allowed reasonable opportunity to interview all current or former employees to discuss matters pertinent to the performance of the Contract (to the extent the Contractor is able to provide such opportunity to conduct interviews using reasonable efforts), shall have access to all Records, and shall be provided adequate and appropriate work space, during regular business hours, in order to conduct audits in compliance with this Section 14.5.

(e) If an audit inspection or examination in accordance with this Section 14.5, discloses overpricing or overcharges (of any nature) by the Contractor to the Purchaser in excess of one and one half percent (1.5%) of the total Contract billings, in addition to repayment or credit for the overcharges, the reasonable actual cost of the Purchaser's audit shall be reimbursed to the Purchaser by the Contractor. Any adjustments and/or payments which must be made as a result of any such audit or inspection of the Contractor's invoices and/or records shall be made within a reasonable amount of time (not to exceed 30 days) from presentation of the Purchaser's findings to Contractor.

15. PERFORMANCE SECURITY

[NTD: The Purchaser is prepared to consider proposals in respect of the performance security provided that the combination of letter of credit/performance holdback held by the Purchaser conforms to the following amounts and timelines:

(a) $10,000,000, with a term commencing within 10 days of the signing of the Contract;
(b) Increasing to $50,000,000 on January 14, 2015;
(c) Increasing to $100,000,000 on August 19, 2015;
(d) Increasing to $150,000,000 on August 16, 2017;
(e) **Decreasing to $100,000,000 on the first working day of October in the year the 250,000th cubic meter of concrete is placed;**
(f) **Decreasing to $5,000,000 upon issuance of the Final Completion Certificate and to termination upon expiration of the final Warranty Period]**

The Contractor shall within ten (10) days of the signing of the Contract, deliver or cause to be delivered to the Purchaser an irrevocable letter of credit in the amounts and time frames as outlined below:

(g) $10,000,000, with a term commencing within 10 days of the signing of the Contract;
(h) Increasing to $50,000,000 on January 14, 2015;
(i) Increasing to $100,000,000 on August 19, 2015; and
(j) Decreasing to $50,000,000 on the first working day of October in the year the 250,000th cubic meter of concrete is placed which letter of credit shall terminate upon the issuance of the Final Completion Certificate.

All irrevocable letters of credit which the Contractor must deliver and maintain as required under the Contract, including any letter of credit delivered in lieu of part or all of the Performance Holdback pursuant to Section 16 PERFORMANCE HOLDBACK of the Terms and Conditions of Payment, shall be issued or confirmed by a Canadian Schedule I Bank or another bank approved in advance by the Purchaser, acting reasonably, all in accordance with and subject to the Uniform Customs and Practice for Documentary Credits (2007) International Chamber of Commerce - Publication 600.

Without prejudice to any other right or remedy provided or available in the Contract or at law including contract and tort or equitable relief), it at any time the Contractor fails to perform any of its covenants or obligations in or pursuant to the Contract, including without limitation failure by the Contractor to deliver, or cause to be delivered, to the Purchaser any irrevocable letter of credit (or amendment to a letter of credit increasing the amount of a letter of credit previously given) as required herein, the Purchaser shall be entitled to:

i) call upon, in any amount(s), any irrevocable letter of credit delivered to the Purchaser pursuant to the Contract, in accordance with its terms;
ii) to hold and retain such sums until such time as the Contractor has performed such covenants or obligations in accordance with the Contract;
iii) to hold and retain such sums as are proportional as continued security for the Contractor's performance of its covenants and obligations in and pursuant to the Contract; and
iv) withhold or deduct or set-off against such sums in accordance with the Contract.

Without limiting the above, if the Contractor fails no later than 45 days prior to the expiry of a letter of credit to obtain an extension of the expiry date of a letter of credit to a date that is at least 60 days after the latest expiry date required of the letter of credit under the Contract, the Purchaser may, after giving the Contractor 7 calendar days notice to extend the expiry date, immediately without liability to the Contractor call down on the letter of credit in full if the expiry date has not been extended during that 7 calendar day notice period. The Purchaser shall hold the funds obtained from a call on the letter of credit for the same period and for the same purposes as for which the letter of credit is required by the Contract to be provided to the Purchaser.

If the Contractor is in disagreement with any action taken by the Purchaser in accordance with the above, the Contractor shall be entitled to proceed to arbitration in accordance with Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification.

Any amounts called upon and held by the Purchaser pursuant to this Section 15 shall bear no interest and shall be so held until the breach is corrected or the dispute, if any, is resolved. The Purchaser shall indemnify and hold the Contractor harmless from and against all damages, losses and expenses, including reasonable legal fees and expenses but excluding all Indirect Damages, resulting from an irrevocable letter of credit being called upon by the Purchaser to the extent to which the Purchaser was not entitled to call upon such irrevocable letter of credit, based upon the provisions of the Contract, if so determined by the Arbitrator pursuant to Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification.

Notwithstanding the foregoing or any other provision in the Contract, any costs associated with obtaining and maintaining any and all letters of credit delivered by the Contractor under the Contract in excess of 2.5% per annum of the balance of such letters of credit shall be Ineligible Costs.

Upon their respective expiry, the Purchaser shall deliver to the Contractor such irrevocable letters of credit that have been previously provided pursuant to this Section 15.

16. PERFORMANCE HOLDBACK

A performance holdback in the amount of 7.5% will be deducted from each payment due by the Purchaser to the Contractor pursuant to these Terms and Conditions of Payment (the "Performance Holdback").

The Purchaser shall continue to deduct the Performance Holdback until such time as the dollar value of the total Performance Holdback is fifty million ($50,000,000) dollars. Contractor shall not be entitled to any interest on the Performance Holdback during the period under the Contract in which the Purchaser is entitled to deduct and retain the Performance Holdback. Notwithstanding the foregoing, the Contractor at its discretion may deliver or cause to be delivered an irrevocable letter of credit in substitution of a part or all of the Performance Holdback retained by the Purchaser.

The Purchaser may deduct, apply and retain amounts from the total accumulated Performance Holdback and/or draw on the letter of credit at any time in respect of any amounts determined to have been overpaid by the Purchaser to the Contractor for the Work including for Actual Costs, the Contractor's GA&O Percentage calculated on Actual Costs, Contractor's Profit Percentage calculated on the Adjusted Target Price, or for any other amount as permitted in accordance with the Contract. The Performance Holdback will not be replenished to replace any amounts deducted and retained from it by the Purchaser as provided for above.

Ninety percent (90%) of any remaining Performance Holdback will be released to the Contractor upon the issuance of the Final Completion Certificate for the balance of the Work as provided for in Section 15.3 TAKING OVER OF THE WORK of the General Specification. The remaining ten percent (10%) of the Performance Holdback will be released to the Contractor at the conclusion of the last Warranty Period provided for in Section 25 WARRANTY of the General Specification. In the event the Contractor opted to deliver a letter of credit in respect of a part or all of the Performance Holdback, and the Purchaser has not drawn on such letter of credit pursuant to this Section 16, the Purchaser shall return such letter of credit upon the issuance of the Final Completion Certificate provided that if the Purchaser is not holding an amount equal to $5,000,000 in respect of the Performance Holdback, the Contractor shall, as a condition precedent to the return of the original letter of credit provide a replacement letter of credit equal to the difference between $5,000,000 and the amount held by the Purchaser in respect of the Performance Holdback.

17. NO BUILDERS LIENS HOLDBACK

Section 3 of *The Builders Liens Act* (Manitoba), excludes contracts with Manitoba Hydro with respect to certain work performed in relation to hydro-electric generating stations from the application of that Act. Accordingly, the Purchaser will not retain a builder's lien holdback from payments made under the Contract.

The Contractor shall inform, in writing, all of its Subcontractors who are subcontracted to perform or supply any part of the Work that a builder's lien holdback will not be retained by the Purchaser in relation to any payments made to the Contractor pursuant to the Contract.

If anyone claiming under or through the Contractor asserts or files a claim of builders lien in respect of the Work against any lands or interest in lands, except where such lien is filed as a result of non-payment by the Purchaser, the Contractor shall promptly at its own cost, not part of the Actual Costs and without reimbursement from the Purchaser, promptly cause such lien to be discharged and removed from the title to lands, and shall indemnify and hold the Purchaser and Keeyask Hydropower Limited Partnership, and their respective directors, officers, employees and agents, harmless from all liabilities and damages they may incur resulting from such liens or assertion of lien rights.

18. MONTHLY PROGRESS STATEMENTS

Within the first fifteen (15) days of the month following the month in which elements of the Work were performed, the Contractor shall forward to the Engineer one copy of a Monthly Progress Statement in a form provided by the Purchaser, of the Actual Costs in respect of the Work undertaken as of the date of the statement. The Monthly Progress Statement shall have written evidence attached to substantiate the Actual Costs of the Work performed.

19. CERTIFICATION OF PAYMENT

The Engineer shall refuse to certify payment for any costs identified as Ineligible Costs in Section 11 ACTUAL COSTS of the Terms and Conditions of Payment.

Once properly incurred Actual Costs are certified, plus the Contractor's GA&O Percentage and the Contractor's Profit Percentage calculated on such Actual Costs (as such items are subject to adjustment as set forth elsewhere in the Contract), as evidenced by the signature of the Engineer or his delegate, the Engineer shall attach the signed certification to the applicable Monthly Progress Statement. Only Work that has been certified by the Engineer shall be processed for payment by the Purchaser. The Contractor is responsible for demonstrating to the Engineer's satisfaction that all amounts claimed in a Monthly Progress Statement have been incurred in the performance of the Work, including by providing such back up documentation as requested by the Engineer.

The Engineer will, no later than 20 days after the receipt of the Monthly Progress Statement by the Contractor submitted in accordance with these Terms and Conditions of Payment, either certify the entire Monthly Progress Statement or certify portions of the Monthly Progress Statement and give the Contractor reasons for non-certification of any other portion and request that the Contractor's re-submit with the required detail in respect of such non-certified portion.

The Engineer will issue to the Purchaser, no later than 20 days after receipt of a Monthly Progress Statement by the Contractor submitted in accordance with these Terms and Conditions of Payment and acceptable to the Engineer, a Certificate for payment in the amount applied for or in such other amount as the Engineer determines to be properly due.

A Certificate for payment shall not be construed as the Engineer's final verification of quantities or quality of the Work completed.

20. PROGRESS STATEMENT BREAKDOWN

Applications for payment for Materials delivered to the Site but not yet incorporated into the Work shall be supported by such evidence as the Engineer may reasonably require to establish the value and delivery of the Materials. Therefore, when invoicing the Purchaser, the Contractor shall apply and be entitled to payment for the Contractor's Profit Percentage and Contractor's GA&O Percentage, as provided for and subject to adjustment in these Terms and Conditions of Payment but shall not apply any additional amount or element of profit, overhead or administrative charge that would otherwise fall within the amount calculated using the Contractor's Profit Percentage or Contractor's GA&O Percentage on any Actual Costs. In the event this is determined to have occurred, through an audit pursuant to the Contract or otherwise, the Contractor shall repay such profit, overhead or administrative amounts to the Purchaser, within 30 days of the Purchaser's demand therefor, subject to the Contractor's right to dispute the payment of such amounts pursuant to Section 33.4 DISPUTE RESOLUTION AND ARBITRATION of the General Specification.

All discounts, rebates and refunds directly or indirectly received by the Contractor for any items purchased by the Contractor for the performance of the Work shall accrue to the benefit of the Purchaser. The Contractor shall give full credit to the Purchaser for such items in its invoices presented to the Engineer for certification.

[NTD: Subject to Section 16 and the Purchaser being satisfied by the Contractor's proposed Project cash flow, the Purchaser is prepared to advance funds such that the Contractor stays in a cash neutral position]

21. PAYMENT

Subject always to satisfactory performance of the Work by the Contractor in accordance with the Contract as certified by the Engineer, the Purchaser shall pay the Contractor, in Canadian currency, no later than 10 days after the certification of the Monthly Progress Statement by the Engineer, the amount certified by the Engineer less the Performance Holdback, if applicable, and less an amount equal to the aggregate of all previous payments made to the Contractor hereunder. Subject to Section 16 PERFORMANCE HOLDBACK in the event the Contractor delivers a letter of credit in respect of some or all of the Performance Holdback, seven and one half percent (7.5%) of the certified amount shown on each Monthly Progress Statement will be held back as the Performance

Holdback until such time as the Performance Holdback reaches fifty million dollars ($50,000,000) as provided for in Section 16 PERFORMANCE HOLDBACK and the Performance Holdback will be paid (or the letter of credit returned) to the Contractor in accordance with Section 16 PERFORMANCE HOLDBACK and Section 24 FINAL PROGRESS STATEMENT of the Terms and Conditions of Payment.

Notwithstanding any other provision in the Contract, any and all costs, losses, damages, credits, other liabilities or payments due or to become due from the Contractor to the Purchaser, may be set-off against any payment due or to become due from the Purchaser to the Contractor or deducted from the accumulated amount of the Performance Holdback or recovered by the Purchaser calling upon any letter of credit provided for in Section 15 PERFORMANCE SECURITY of the Terms and Conditions of Payment, and the Purchaser shall have a discretion in respect of selection of the time or times for effecting the set-off or recovery of part or all of any such amount, provided that a written accounting for each such deduction or set-off exercised is provided forthwith to the Contractor. Such set-offs need not be accumulated or delayed to completion of the Work.

22. NON-CONFORMING WORK

No payment by the Purchaser under the Contract nor partial or entire use or occupancy of the Work by the Purchaser shall constitute an acceptance of any portion of the Work which are not in accordance with the requirements of the Contract.

23. INTEREST ON OVERDUE PAYMENTS

Should either Party fail to make payments as they become due under the terms of the Contract or in an award by arbitration, interest at the prime rate on such unpaid amounts shall also become due and payable at the annual rate of interest equivalent to that charged to preferred borrowers by the Purchaser's bank ('prime lending rate') in Winnipeg.

Interest shall apply at the rate and in the manner prescribed above on the amount of any claim for which either Party is entitled to payment pursuant to the Contract upon resolution of any dispute, or otherwise, from the date the amount would have been due and payable under the Contract, had it not been in dispute, until the date it is paid.

24. FINAL PROGRESS STATEMENT

When the Contractor considers that the Work is completed, the Contractor shall submit a final Monthly Progress Statement.

The Engineer will, no later than 20 days after the receipt of the Contractor's final Monthly Progress Statement, either certify the final Monthly Progress Statement or give the Contractor reasons for non-certification and request that the Contractor's re-submit with the required detail.

Once the final Monthly Progress Statement is in a form and with detail satisfactory to the Engineer, and the Final Completion Certificate for the Work has been issued in accordance with Section 24.3 TAKING OVER OF THE WORK of the General Specification, subject to the exceptions noted below, the Engineer will promptly certify the Contractor's final Monthly Progress Statement in respect only of work completed since the previous Monthly Progress Payment.

Subject to:

(a) any deductions properly made by the Purchaser in accordance with the terms and conditions of the Contract;
(b) provision by the Contractor of a Statutory Declaration in a form acceptable to the Purchaser; and
(c) provision by the Contractor of a clearance certificate issued by the Worker's Compensation Board,

the Purchaser shall make payment of the amount certified by the Engineer to the Contractor together with all other amounts owing as determined pursuant to Section 14.1 ACCOUNTING ON FINAL COMPLETION of the General Specification, no later than 30 days after the determination of other amounts owing pursuant to Section 14.1 ACCOUNTING ON FINAL COMPLETION of the General Specification.

END OF TERMS AND CONDITIONS OF PAYMENT

TOR01: 5322705: v7

Terms and Conditions of Payment Schedule 'A'

CANADA)
)
PROVINCE OF MANITOBA)
)
TO WIT:

I, _____

of the _____ of _____ in the Province of Manitoba,

MAKE OATH AND SAY:

1. THAT I am the _____

of _____

and as such have personal knowledge of the facts and matters herein deposed to.

2. THAT by agreement in writing dated _____ 20__, undertook the following work for Manitoba Hydro, namely:

_____

_____

3. THAT all work or services required to be performed and all materials required to be furnished or placed, pursuant to said Agreement, have been performed, furnished or placed and that all wages, accounts, claims and demands in connection therewith, and in connection with any subcontract for the doing of work, provision of services and supply of materials, have been fully paid and satisfied, other than:

NAME	PARTICULARS	AMOUNT

4. THAT all assessments and levies by the Workers Compensation Board against _____ have been paid in full.

SWORN before me at the _____ of _____, in the Province of Manitoba, this _____ day of _____, 20__.

_____
A Commissioner for Oaths in and for the Province of Manitoba.
My Commission expires _____, 20__

Part 1 General

1.1. SECTION INCLUDES

1.1.1. The work to be performed under this section shall consist of supplying all labour, material, and plant and performing all Work necessary to complete the design, supply and installation, including acquisition of any required permits, for any indirect cost that are incurred on the project but are not attributable to any individual pay item:

1.1.1.1. Indirect Costs;

1.1.1.2. Contingency

1.2. RELATED SECTIONS

1.2.1.1. General Specification.

1.3. MEASUREMENT AND PAYMENT PROCEDURES

1.3.1. General

1.3.1.1. The requirements for determining the Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

1.3.1.2. The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate multiplied by the unit price set out therein for each Item as specified.

1.3.1.3. The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

1.3.2. Measurement

1.3.2.1. No separate measurement will be made for the following items:

1.3.2.1.1. 01 10 05 (a) - Indirects

1.3.2.1.2. 01 10 05 (b) - Contingency

1.3.3. Unit Price

1.3.3.1. The Estimated Cost for Item 01 10 05 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's submission shall be for supply, installation, transportation, unloading, handling, for all labour, supervision, equipment and materials for any indirect cost that are incurred but are not attributable to any one individual Item in the bill of quantities, unit prices, and target price estimate.

1.3.3.2. The Estimated Cost for Item 01 10 0 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's submission shall be for the Items of contingency to be held by the Contractor.

1.4. SUBMITTALS

1.4.1. Submissions shall be made in accordance with Section 21.7 Contractor's Documents of the General Specification.

1.5. QUALITY MANAGEMENT

1.5.1. Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

1.6. DELIVERY, STORAGE AND HANDLING

1.6.1. Delivery, storage and handling of all materials/plant associated with the work shall be in accordance with Section 7.24 Inspections of Deliveries to Site and Storage of the General Specification.

1.7. SITE CONDITIONS

1.7.1. Site conditions shall be as described in Section 4 Site Location and Access of the General Specification and this Specification.

Part 2 Products

Not Applicable

Part 3 Execution

3.1. INDIRECTS

3.1.1. In addition to the requirements described in Section 7 The Contractor and Section 8 Safety of the General Specification, the Contractor shall be responsible for the following:

3.1.1.1. Project Management

3.1.1.2. Safety (meetings, material, equipment, reporting)

3.1.1.3. Environment (equipment, subcontractors, materials, monitoring and reporting)

3.1.1.4. Staff (Engineering, Supervisory and Non-Supervisory Staff)

3.1.1.5. Training

3.1.1.6. Quality Control

3.1.1.7. Contractor's Plant including;

3.1.1.7.1. Operation and Maintenance of Shop/Warehouse/Office facilities

3.1.1.7.2. Rental/Purchase and operation/maintenance of Office/Lunch/Wash Trailers at the construction site

3.1.1.7.3. Temporary construction roads/ramps/laydown areas

3.1.1.7.4. Project Equipment (not attributable to any one ITEM)

3.1.1.7.5. Electrical/water/sewage/communication distribution from the points identified on the drawings

3.1.1.7.6. Fuel Depot and Explosive Magazine

3.1.1.7.7. Survey equipment and supplies

3.1.1.8. Site Administration and Overheads including:

3.1.1.8.1. Office Costs (including furnishings, hardware, software, IT support, stationary, phone, internet, radios, photos)

3.1.1.8.2. Travel (flights, taxi, hotel, meals, mileage)

3.1.1.8.3. Fixed Business Costs

3.1.1.8.4. Performance Security (all types)

3.1.1.8.5. Finance Expenses

3.1.1.9. Variable Costs including:

3.1.1.9.1. Professional Consulting Services

3.1.1.9.2. Licenses, permits and fees

3.1.1.9.3. Administration of Project Labour Agreement

3.1.1.9.4. Insurance

3.1.1.9.5. Taxes

3.2. CONTINGENCY

3.2.1. The Contractor shall be responsible for developing the risk matrix items that the Contractor will hold for the completion of the Work, the total cost of each risk item, the probability of occurrence of each risk item and the factored cost of each risk item.

3.2.2. The Contingency shall be set at the sum of the factor cost of all of the risk items identified in the matrix.

END OF SECTION

Part 1 General

1.1. SECTION INCLUDES

1.1.1. The work to be performed under this section shall consist of supplying all labour, material, and plant and performing all Work necessary as shown on the Drawings and as directed by the Engineer and as specified herein to complete the design, supply and installation, including acquisition of any required permits, of the following temporary utilities:

1.1.1.1. Temporary Construction Power;

1.1.1.2. Temporary Site Communications;

1.1.1.3. Temporary Water;

1.1.1.4. Temporary Sewer;

1.1.1.5. Temporary Heat.

1.2. RELATED SECTIONS

1.2.1.1. General Specification.

1.2.1.2. Section 03 30 00 - Cast-In-Place Concrete

1.2.1.3. Section 03 39 00 - Concrete Curing

1.2.1.4. Section 31 23 19 - Control of Water

1.2.1.5. Section 26 05 00 - Electrical General Requirements

1.2.1.6. Section 27 00 00 - Communications

1.2.1.7. Section 40 05 00 - Mechanical & Piping General Requirements

1.3. REFERENCES

1.3.1. The work shall be performed in accordance with the latest edition of the standards mentioned, except where specified otherwise.

1.3.2. The works shall conform to all regulations applicable to this type of work in effect at the time the work is performed.

1.3.3. At a minimum, the works shall be performed in accordance with:

1.3.3.1. Manitoba Electrical Code (current code at time of issue)

1.3.3.2. Freshwater Intake End of Pipe Screen Guidelines – Department of Fisheries and Oceans.

1.3.3.3. Keeyask Generating Station Project EIS.

1.3.3.4. Manitoba Hydro Customer Metering Standards (current at time of issue).

1.4. MEASUREMENT AND PAYMENT PROCEDURES

1.4.1. General

1.4.1.1. The requirements for determining the Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

1.4.1.2. The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate multiplied by the unit price set out therein for each Item as specified.

1.4.1.3. The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

1.4.2. Measurement

1.4.2.1. No separate measurement will be made for the following items:

01 51 00 (a) - Temporary Power
01 51 00 (b) - Temporary Heating

1.4.3. Unit Price

1.4.3.1. The Estimated Cost for Item 01 51 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transportation, unloading, handling and identification, for all labour, equipment and materials for the Temporary Power system(s), as follows:

Item 01 51 00 (a)i to iii – shall cover the Work associated with the temporary service points for use by the Purchaser.
Item 01 51 00 (a)iv to v – shall cover the Work associated with the temporary power supplies to the Permanent Works.

1.4.3.2. The Estimated Cost for Item 01 51 00 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transportation, unloading, handling and identification, for all labour, equipment and materials for the Temporary Heating system(s), as follows:

Item 01 51 00 (b)i to iv – shall cover the Work associated with the temporary heating of the enclosed Powerhouse Complex, during the years noted.

1.5. SUBMITTALS

1.5.1. Submissions shall be made in accordance with Section 21.7 Contractor's Documents of the General Specification.

1.5.2. The Contractor shall submit, for the Engineer's approval, their Construction Power Distribution Plan, including the single line(s) and other pertinent details, of their construction power facilities for the Site.

1.5.3. The Contractor shall submit, for the Engineer's approval, their proposed Concrete Batch Plant Water Utilization plan, as part of Phase I of the Work. It shall include details regarding the intake structure, sizing, location and routing of all piping, pumps and equipment required for the plant operation.

1.5.4. The Contractor shall submit, to the Purchaser, a copy of any permit applications being made, in addition to any judgments on said permits, made by the Authority Having Jurisdiction.

1.6. QUALITY MANAGEMENT

1.6.1. Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

1.7. DELIVERY, STORAGE AND HANDLING

1.7.1. Delivery, storage and handling of all materials/plant associated with the work shall be in accordance with Section 7.24 Inspections of Deliveries to Site and Storage of the General Specification.

1.8. SITE CONDITIONS

1.8.1. Site conditions shall be as described in Section 4 Site Location and Access of the General Specification and this Specification.

1.9. WARRANTY

1.9.1. The requirements shall be in accordance with Section 25 Warranty of the General Specification.

1.9.2. It is expected that all material/equipment required for use under this specification will be selected based upon a service life of the construction period (as a minimum) and to operate at the duty identified in the Contractor's plans.

Part 2 Products

2.1. TEMPORARY CONSTRUCTION POWER

2.1.1. As described in Section 7.29 Construction Power of the General Specification, electrical power will be made available by the Purchaser; this power will be provided at the following locations and capacities:

2.1.1.1. Work Area A: 1 - 2 MVA, at 347/600 Vac, 3 phase, 60 Hz, nominal. This is intended to service the Contractor's power requirements for Work Area A.

2.1.1.2. Work Area B: 1 - 500 kVA at 347/600 Vac, 3 phase, 60 Hz nominal. This is intended to be used to connect the Contractor's site office, in addition to a service for parking lot receptacles in the Work Area.

2.1.1.3. East of the North Access Road, near STA23+400: 2 - 4 MVA at 7.2/12.47 or 4.16/7.2 kVac, 3 phase, 60 Hz nominal (Voltage to be confirmed when Contractor's site construction power plan is submitted). This is intended to supply the Contractor's distribution system at the GS site.

2.1.2. Any service requirements outside of the above shall be outlined and requested in the Contractor's construction power distribution plan. Additional service points are subject to the review and approval of the Engineer.

2.2. TEMPORARY SITE COMMUNICATIONS

2.2.1. A fibre optic line will be supplied by the Purchaser to the Contractor's engineering building which is closest to the Purchaser's engineering building. The Purchaser will be responsible for the connection of this fibre optic line, within the engineering building.

2.2.2. The Purchaser will provide a wireless data system with up to 10Mbps available for use by the Contractor at the Site. Up to six (6) wireless antennas and radios for this system will be provided by the Purchaser with a port for a wired connection by the Contractor at buildings identified by the Contractor. The Contractor shall give the Purchaser a minimum of four (4) weeks notice for the installation of any wireless data system hardware.

2.3. TEMPORARY WATER

2.3.1. Water Service Provisions by the Purchaser

2.3.1.1. The following connections to the Purchaser's water supply will be made available for the Contractor's use:

Work Area A - 25mm water service connection/curb stop (qty. 4), located per the drawings.

Work Area B - 25mm water service connection/curb stop (qty. 1), located per the drawings.

2.3.2. Water Service for Concrete Batch Plant Use shall be taken from the Nelson River, subject to the Engineer's approval of the Concrete Batch Plant Water Utilisation plan.

2.3.2.1. The Purchaser's water supply shall not be used for the purpose of concrete batching.

2.4. TEMPORARY SEWER

2.4.1. Sewer water, generated during construction activities, is to be handled per the following:

2.4.1.1. Access to the Sewer Main will be available in Work Area B, per the drawings. This will include a 150mm connection to the main, to be used to connect the Contractor's Office Complex to the site waste water treatment system, located per the drawings.

2.4.1.2. For areas where access to the sewer main is unavailable, the Contractor will be required to utilize the Purchaser's sewage transfer station, in conjunction with a sewage transfer vehicle.

2.5. TEMPORARY HEATING

2.5.1. The Contractor shall provide, as necessary for performance of its works temporary heat for the proper installation of materials and the protection of the Work against injury from the cold.

2.5.2. In addition to the temporary heat required for performance of its own works, the Contractor shall provide and maintain, sufficient heating and hoarding to maintain an average daily temperature of at least 10° C, within the Powerhouse Complex, to the limits shown on the drawings and as outlined in these specifications.

Part 3 Execution

3.1. TEMPORARY CONSTRUCTION POWER

3.1.1. In addition to the requirements described in Section 7.29 Construction Power of the General Specification, the Contractor shall be responsible for the following:

3.1.1.1. The Contractor shall be responsible for all material and equipment supply, mobilization, erection, operation and demobilization of temporary construction facilities and services for the Contractor's own requirements.

3.1.1.2. The Contractor shall supply and install replacement fuses, as required, for the feeder switches used by the Contractor in the Purchaser's construction power switchboards and shall maintain a spare stock of fuses.

3.1.1.3. The Contractor shall maintain the construction power distribution equipment in good condition, free of grounds and short circuits. Frayed or damaged cables shall be removed from service immediately. All power circuits shall meet the requirements of the Manitoba Electrical Code.

3.1.1.4. Where power supplied by the Purchaser is to be utilised for operation of heavy equipment rated at 25 hp or larger, reduced voltage motor starting facilities shall be utilised to minimise disturbance to the Purchaser's electrical power supply. Similarly, suitable approved fault protection equipment shall be employed to clear equipment and lines from the Purchaser's electrical power supply in the event of faults.

3.1.1.5. The Contractor shall provide all additional material and labour where necessary to install temporary feeders to switchboard(s) other than the switchboard closest to its work or, alternatively, provide engine-powered generators or engine powered welders to meet its requirements, in the event that the switchboard closest to its work becomes overloaded.

3.1.1.6. Where the Contractor elects to utilise the Purchaser's electrical power supply for pumping or other services which cannot be subject to interruption, the Contractor shall have installed and immediately available for use, suitable standby facilities to the satisfaction of the Engineer.

3.1.2. The Contractor shall be responsible for the supply and maintenance of all construction power required to perform the works, from the points of service provided by the Purchaser, to the point of use.

3.1.3. The Contractor shall assess where temporary lighting is required for its work and shall supply and install temporary lighting to meet its requirements. All lighting systems shall meet the requirements of the Manitoba Electrical Code.

3.1.4. Additionally, the Contractor shall maintain said temporary lighting, within enclosed sections of the Powerhouse Complex until such time that the permanent lighting system can be put into operation.

3.1.5. In addition to the works required to provide its own construction power, the Contractor shall be responsible to supply and maintain the following services, for the Purchaser's use, at the locations noted:

3.1.5.1. 800A @ 347/600Vac, in the Service Bay Erection Area. This service shall be available starting one month after the completion of the first pour of the Service Bay Erection area elevation. It shall be removed upon completion of the plant AC Station Service System, or at the direction of the Engineer, whichever is earlier.

3.1.5.2. 400A @ 347/600Vac, in the Intake Hoist Housing. This service shall be available starting one month before the completion of Intake Upper Headblock pours in the first available unit. It shall be removed after the complete removal of the North Channel Stage I Cofferdam, or at the direction of the Engineer, whichever is earlier.

3.1.5.3. 800A @ 347/600Vac, near the Spillway Bridge Deck. This service shall be available starting one month after the completion of the concrete on the first available Spillway pier. It shall be removed after the complete removal of the Spillway Stage I Cofferdam, or at the direction of the Engineer, whichever is earlier.

3.1.5.4. The above supplies shall be installed to allow for isolation of the load side lugs and connection by the Purchaser or their delegate.

3.1.5.5. The final locations of these services shall be discussed and approved by the Engineer prior to installation. Any changes to the location of the above services shall be submitted to the Engineer for review, prior to the work being performed.

3.1.5.6. The services identified above shall not be secured to the permanent works, but shall be supported by independent means.

3.1.6. In addition to the previously identified supplies, the Contractor shall be responsible to provide the following temporary supplies, to the permanent works, until such time that the permanent power connections can be utilized:

3.1.6.1. 300A @ 347/600Vac for the Powerhouse Crane bus, to be available to connect one month after the start of the Powerhouse crane rail installation.

3.1.6.2. 100A @ 347/600Vac for the Draft Tube Crane bus, to be available to connect one month after the start of the Draft Tube crane rail installation.

3.1.7. All planned outages to the services identified in 3.1.5 and 3.1.6 shall be submitted in writing to the Engineer, 48 hours before the outage, for approval.

3.2. TEMPORARY SITE COMMUNICATIONS

3.2.1. In addition to the requirements described in Section 7.33 Communications of the General Specification, the Contractor shall be responsible for items described below.

3.2.2. The Contractor's shall extend the Purchaser supplied data service to the individual workstations within the identified buildings using equipment and labour supplied by the Contractor. All wiring within each such building is the Contractor's responsibility.

3.2.3. Telephone lines will be VoIP through equipment provided by the Contractor. Contractor is responsible for payment of VoIP services.

3.3. TEMPORARY WATER

3.3.1. In addition to the requirements described in Section 7.31 Water and Sewer Services of the General Specification, the Contractor shall be responsible for the items described below.

3.3.2. The Contractor shall be responsible for all labour, materials and plant required for connection to the Purchaser supplied connections, in addition to the associated piping distribution network required for the incorporation of this water supply into the works. This shall include any materials required to allow the system to function under any weather conditions anticipated.

3.3.3. The Contractor is responsible for all labour, materials and plant associated with the provision of all other water required for the performance of the Works.

3.3.4. The Contractor is responsible for the control of any water utilized from the above services, in accordance with the requirements of this specification.

3.4. TEMPORARY SEWER

3.4.1. In addition to the requirements described in Section 7.31 Water and Sewer Services of the General Specification, the Contractor shall be responsible for the items described below.

3.4.2. The Contractor will be responsible for the supply of all labour, material and plant associated with the connection of the Contractor’s site Office Complex, to the Purchaser’s sewer main.

3.4.3. The Contractor is responsible for the supply of all labour, material and plant associated with the installation, maintenance and removal of the temporary sewage infrastructure, for services not connected to the Purchaser’s sewer main.

3.4.4. The Purchaser’s sewer transfer station shall only be used to receive the Contractor’s washroom facility effluent.

3.5. TEMPORARY HEATING

3.5.1. The Contractor shall be responsible for all labour, material and plant associated with the provision of Temporary Heating, as outlined in Section 7.32 Temporary Heating and Hoarding of the General Specification and this Section.

3.5.2. Should the Contractor choose to generate heat by the use of electrical energy, it shall employ the most energy efficient methods reasonably available. If steam is generated and distributed, condensate return lines shall be incorporated into the distribution system.

3.5.3. The Contractor shall be responsible for providing temporary heating and hoarding in the areas outlined in the drawings and as follows:

3.5.3.1. The heating season for any year shall be defined as starting September 1st of that year and ending May 31st of the following year.

3.5.3.2. For years one through three of the Contract, the Contractor shall not be required to provide temporary heating outside of their own requirements.

3.5.3.3. For year four of the Contract, the Contractor shall be required to provide temporary heating within the Service Bay and Unit 1 of the Powerhouse.

3.5.3.4. For year five of the Contract, the Contractor shall be required to provide temporary heating within the Service Bay and Units 1-4 of the Powerhouse.

3.5.3.5. For years six and seven of the Contract, the Contractor shall be required to provide temporary heating within the entire Powerhouse Complex.

3.5.4. The Contractor's temporary heating and hoarding requirements shall include, if required, the installation of temporary end walls of sufficient construction to maintain the heated areas as outlined in this specification.

END OF SECTION

Part 1 General

1.1. SECTION INCLUDES

1.1.1. The work to be performed under this section shall consist of supplying all labour, material, and plant and performing all Work necessary as shown on the Purchaser's Drawings and as directed by the Engineer and as specified herein to complete the design, supply and installation, including acquisition of any required permits, of the following:

1.1.1.1. Contractor's Mobilization of Equipment

1.1.1.2. Contractor's Buildings and preparation of Work Areas;

1.1.1.3. Contractor's Demobilization of Equipment

1.1.1.4. Final Cleanup

1.2. RELATED SECTIONS

1.2.1.1. General Specification.

1.2.1.2. Section 01 51 00 – Temporary Utilities

1.3. REFERENCES

1.3.1. The work shall be performed in accordance with the latest edition of the standards mentioned, except where specified otherwise.

1.3.2. The works shall conform to all regulations applicable to this type of work in effect at the time the work is performed.

1.4. MEASUREMENT AND PAYMENT PROCEDURES

1.4.1. General

1.4.1.1. The requirements for determining the Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

1.4.1.2. The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate multiplied by the unit price set out therein for each Item as specified.

1.4.1.3. The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

1.4.2. Measurement

1.4.2.1. No separate measurement will be made for the following items:

01 52 00 (a) – Mobilization of Equipment

01 52 00 (b) – Other Mobilization and Site Preparation

01 52 00 (c) – Demobilization of Equipment

01 52 00 (d) – Final Clean-up

1.4.3. Unit Price

1.4.3.1. The Estimated Cost for Item 01 52 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's submission shall be for supply, installation, transportation, unloading, handling and identification, for all labour, equipment and materials for the mobilization of the Contractor's equipment to site.

1.4.3.2. The Estimated Cost for Item 01 52 00 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's submission shall be for supply, installation, transportation, unloading, handling and identification, for all labour, equipment and materials for the work related to the supply and set-up of the Contractor's site buildings and for the construction and site preparation of the Contractor's Work Area, including the supply of materials, for the Contractor's temporary roads in the Contractor's Work Area, parking area and storage areas.

1.4.3.3. The Estimated Cost for Item 01 52 00 (c) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's submission shall be for supply, installation, transportation, unloading, handling and identification, for all labour, equipment and materials for the demobilization of the Contractor's Equipment and any temporary infrastructure.

1.4.3.4. The Estimated Cost for Item 01 52 00 (d) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's submission shall be for supplying all labour, materials and plant, and performing all work necessary for cleanup and removal of plant, surplus materials and debris, as required before the issue of the Completion Certificate

1.5. SUBMITTALS

1.5.1. Submissions shall be made in accordance with Section 21.7 Contractor's Documents of the General Specification.

1.5.2. The Contractor shall submit, to the Purchaser, a copy of any permit applications being made, in addition to any judgments on said permits, made by the Authority Having Jurisdiction.

1.6. QUALITY MANAGEMENT

1.6.1. Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

1.7. SITE CONDITIONS

1.7.1. Site conditions shall be as described in Section 4 Site Location and Access and Section 21.17 Sources of Materials of the General Specification, unless otherwise noted in this Section.

1.7.1.1. The work areas located in Work Area A, B and C, will be provided with all trees/brush cleared from the site with no further improvements.

1.7.1.2. All remaining areas shall be assumed to be provided in the natural state of the site.

1.7.1.3. All temporary infrastructure must be located within the Project Footprint.

1.8. WARRANTY

1.8.1. The requirements shall be in accordance with Section 25 Warranty of the General Specification.

Part 2 Products

2.1. ACCESS ROADS

2.1.1. The Purchaser will construct the North Access Road, the South Access Road and the Work Area Access Road outlined on the Purchaser's Drawings. The Contractor will be required to construct all other access roads that may be required for the Contractor to complete the Work.

2.2. MAINTENANCE OF ROADS

2.2.1. The Purchaser will be responsible for the maintenance of the North Access Road, from STA 0+000 to 19+900, and the South Access Road, except while being used as a haul road.

2.2.2. The Contractor shall be responsible for the maintenance of any portions of the North Access Road or South Access Road being utilised by the Contractor for hauling rock, granular, impervious, or excavated materials.

2.2.3. The Contractor will be required to maintain the North Access Road, from STA 19+900 to 23+442 and any Work Area access roads.

2.3. CONTRACTOR WORK AREAS

2.3.1. The Contractor shall be provided with the work areas outlined on the Purchaser's Drawings.

2.3.2. The designated area in Work Area B (approximately 1,000 m^2), is intended to be used for the Contractor's Engineering Office.

Part 3 Execution

3.1. CONTRACTOR WORK AREAS & INFRASTRUCTURE

3.1.1. The Contractor shall be responsible for all labour, materials and plant required for construction of any infrastructure as required in Contractor Area 4, Contractor Area 5, Contractor Area 6, Contractor Area 7 and Contractor Area 15. Note that the Contractor is restricted by the overhead transmission right of way in Contractor Area 15.

3.1.2. The Contractor shall not have any buildings within 10 meters of another building. The Contractor shall not have any buildings within the division of Contractor Area 3 and Contractor Area 4.

3.1.3. Utility services to the above infrastructure shall be provided as outlined in Section 01 54 00 – Temporary Utilities.

3.2. HAUL/ACCESS ROADS

3.2.1. The Contractor shall be responsible for all labour, materials and plant required for construction of any infrastructure, as required to construct and maintain, temporary haul roads within the Project Footprint.

3.2.2. The Contractor shall be responsible for the maintenance of the roads as outlined above. Maintenance of roads includes the following activities:

3.2.2.1. Grading as required to achieve a smooth driving surface free of ruts, potholes and washboard and any repairs to roadways, shoulders, culverts, signs, and other safety devices

3.2.2.2. Application of calcium chloride or alternative treatment, as approved by the Engineer, for dust control

3.2.2.3. Operation of signs, barriers, flag persons, and other control devices to ensure the safe and orderly flow of traffic and the protection of life and property on roads and crossings of roads.

3.2.2.4. Sanding or graveling of slippery hills and icy surfaces, thawing of culverts and any other operations required to keep the road in a safe and useable condition.

3.2.2.5. Snow plowing to remove excessive snow from the surface of the road as required.

END OF SECTION

Part 1 General

1.1. SECTION INCLUDES

1.1.1. The work to be performed under this section shall consist of supplying all labour, material and performing all Work necessary and as directed by the Engineer and as specified herein to operate the Powerhouse crane, including acquisition of any required permits.

1.2. RELATED SECTIONS

1.2.1.1. General Specification.

1.2.1.2. Section 01 51 00 - Temporary Utilities

1.3. REFERENCES

1.3.1. The work shall be performed in accordance with the latest edition of the standards mentioned, except where specified otherwise.

1.3.2. The works shall conform to all Laws applicable to this type of work in effect at the time the work is performed.

1.3.3. At a minimum, the works shall be performed in accordance with:

1.3.3.1. Manitoba Workplace Safety and Health Regulation – 217/2006 Part 23 Cranes and Hoists

1.3.3.2. Contractor Safe Work Procedures

1.3.3.3. The Burntwood Nelson Agreement (BNA)

1.4. MEASUREMENT AND PAYMENT PROCEDURES

1.4.1. General

1.1.1.1. The requirements for determining the Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

1.1.1.2. The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate multiplied by the unit price set out therein for each Item as specified.

1.1.1.3. The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

1.4.2. Measurement

1.4.2.1. Measurement for Items 01 54 11 (a)i to iii inclusive will be in hours, as scheduled to work, based upon the Monthly Powerhouse Crane Operator Schedule.

1.4.3. Unit Price

1.4.3.1. The unit prices for the following Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply of the Items specified herein:

a. Item 01 54 00 (a)i – shall cover the straight-time (1.0x) labour hours associated with the operation of the Powerhouse crane(s).

b. Item 01 54 00 (a)ii – shall cover the time-and-one-half (1.5x) labour hours associated with the operation of the Powerhouse crane(s).

c. Item 01 54 00 (a)iii – shall cover the double-time (2.0x) labour hours associated with the operation of the Powerhouse crane(s).

1.5. SUBMITTALS

1.5.1. Submissions shall be made in accordance with Section 21.7 Contractor's Documents of the General Specification.

1.5.2. The Contractor shall submit, to the Engineer, the credentials of the crane operators.

1.5.3. The Contractor shall provide all engineered lift plans required, subject to the review of the Engineer for any lifts undertaken within the Contractor's scope. The Purchaser shall provide all engineered lift plans required for any lifts undertaken for work that is undertaken by others.

1.6. SITE CONDITIONS

1.6.1. Site conditions shall be as described in Section 4 Site Location and Access of the General Specification, unless otherwise noted in this Section.

Part 2 Products

2.1. POWERHOUSE CRANES SPECIFICATIONS

2.1.1. The Purchaser will furnish, free of charge, two (2) 205 Mg Powerhouse cranes, each with an auxiliary hoist of 25 Mg capacity, with the following specifications:

2.1.1.1. The Powerhouse cranes shall be of the double girder, electric overhead travelling type with wire-rope hoists.

2.1.1.2. The control cab shall have a console type chair and features for operator comfort and safety, variable frequency drives for all motions, jogging controls, load cells with relays and digital scoreboards, and complete capability to operate both main and auxiliary hoists with remote control.

2.1.2. The Purchaser will make available, for the Contractor's use, one or both Powerhouse cranes, as allowed by crane availability.

2.1.2.1. Typically, the Contractor can expect one crane to be reserved for the Purchaser's use, while one crane will be available for use by the Contractor.

2.1.2.2. The Contractor shall be responsible to declare, to the Engineer, its intended crane usage, on a monthly basis. This shall be submitted in writing, seven days before the Engineer determines the schedule discussed in 3.2.

2.2. POWERHOUSE CRANE OPERATOR

2.2.1. The supply of the Operator shall be in accordance with the General Specifications. The crane operators shall be available for equipment specific training provided by the Purchaser.

2.2.2. The Contractor shall ensure that there are sufficient, qualified staff available to operate the Powerhouse cranes, as set forth in 3.2.

Part 3 Execution

3.1. POWERHOUSE CRANE AVAILABILITY

3.1.1. The use of the Powerhouse crane will be scheduled by the Engineer and its use is subject to the following:

3.1.1.1. The Contractor will not have exclusive rights to the Powerhouse crane(s).

3.1.1.2. The Purchaser will furnish all slings, special hoisting equipment, small tools, jacks, braces and all materials, articles, supplies and things whatsoever necessary of proper for the performance and temporary support of its work.

3.1.1.3. The Contractor shall furnish all slings, special hoisting equipment, small tools, jacks, braces and all materials, articles, supplies and things whatsoever necessary of proper for the performance and temporary support of the Work where the Contractor is using the Powerhouse crane(s).

3.1.1.4. The Contractor shall provide radios for crane operator and rigger communications.

3.1.2. The crane made available to the Contractor will depend on both the needs of the Contractor and the needs of the Purchaser within the Powerhouse. In the case of a dispute over use of the cranes, the Engineer, considering the needs of all parties, shall implement a crane usage schedule that shall be followed by the Contractor.

3.1.3. The Purchaser shall not be responsible for any costs or delays to the Contractor associated with the implementation of this schedule.

3.1.4. Periodically, the Powerhouse crane(s) will be unavailable, due to outages.

3.1.4.1. These outages will include scheduled, monthly maintenance outages, as well as unplanned emergency outages, resulting from equipment malfunction or failure.

3.1.4.2. The Purchaser shall not be responsible for any costs or delays to the Contractor, associated with such outages, unless the outages extend beyond 48 hours in duration.

3.2. MONTHLY POWERHOUSE CRANE OPERATOR SCHEDULE

3.2.1. The Contractor shall be responsible for the supply of all labour for the operation of the two Powerhouse cranes, at the schedule set by the Engineer. This schedule will include shifts up to and including, operations of the crane(s) for 24 hours per day, 7 days a week, during the period of August 2017 to August 2020.

3.2.1.1. The Engineer will be responsible to set the Monthly Powerhouse Crane Operator Schedule, one month in advance, on the 1st of each month.

3.2.2. The Purchaser will require crane operators for the installation of the Turbine and Generator embedded and non-embedded parts from January 2018 to August 2020 at which time one or both of the cranes may be unavailable for other use.

3.2.2.1. During this period the Purchaser requires both cranes for multiple and tandem lifts. Periods when both cranes will be used by the Purchaser will be determined by the Engineer but will not exceed a duration of up to 20% of the available day shifts

END OF SECTION

General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary for the design, supply, fabrication, placement, structural supports and bracing, and stripping and removal of formwork to form concrete as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

Those Sections and Subsections of the General Specification set out below.

.1 Section 03 15 13 - Waterstops.

.2 Section 03 21 00 - Reinforcing Steel.

.3 Section 03 30 00 - Cast-In-Place Concrete.

.4 Section 03 35 00 - Concrete Finishing and Repair.

.5 Section 26 05 27 - Embedded Grounding.

.6 Section 40 05 00 - Mechanical and Piping General Requirements.

1.3 DEFINITIONS

.1 For the purpose of the Technical Specification, formwork shall be defined under the following classifications.

.1 Flat Form: Any form employed to produce a plane surface that may be vertical or inclined, excluding any such surface as may be included in Article 1.3.1.3 to 1.3.1.8 below.

.2 Lower Cone Form: Forms required for the exterior face of the lower cone for each powerhouse unit.

.3 Curved Form: Any form not comprised of plane surfaces and is not included in 1.3.1.4 to 1.3.1.8 below. The limit of the curved form shall not extend beyond the point of tangency or the intersection with a plane surface.

.4 Intake Structure Water Passage Roof Form: The form used to produce the surface of the intake water passage roof. The water passage roof shall extend downstream from the intake bulkhead gate check to the vertical construction joint connecting the intake to the powerhouse.

.5 Powerhouse Semi-Spiral Case Water Passage Roof Form: The form used to produce the surface of the powerhouse semi-spiral case water passage roof. The semi-spiral case water passage roof shall extend downstream from the vertical construction joint connecting the intake to the powerhouse. The roof shall also include the wetted concrete surface of the semi-spiral case upper cone.

.6 Powerhouse Draft Tube Water Passage Form: The form used to produce the surface in the draft tube water passage from the lower end of the check in the concrete for the steel draft tube liner to the construction joint between the powerhouse and tailrace structures.

.7 Soffit Forms: Any form for horizontal and inclined surfaces to 60 degrees from horizontal except those included in 1.3.1.3, 1.3.1.4, and 1.3.1.5 including all falsework required to support the vertical loads.

.8 Forms for Shear Keys: The flat surface forms for shear keys, comprised of the developed (actual) area of the surfaces of shear keys.

.9 Cantilevered Service Bay Formwork: The cantilevered formwork in the service bay, if required, shall be defined as the formwork required to support the service bay base slab cantilever adjacent to Unit 1 of the powerhouse. The need for said formwork will be determined following completion of the bedrock excavation for the powerhouse and service bay structures.

.10 Spillway Rollway Formwork: Forms and appurtenances required to form the face of the rollway.

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 Canadian Standards Association:

CSA A23.1 - Concrete Materials and Methods of Concrete Construction.

CSA A23.4 - Precast Concrete - Materials and Construction.

CSA O86 - Engineering Design in Wood.

CSA O121 - Douglas Fir Plywood.

CSA O141 - Softwood Lumber.

CSA O151 - Canadian Softwood Plywood.

CSA O153 - Poplar Plywood.

CSA S16 - Design of Steel Structures.

CSA S269.1 - Falsework for Construction Purposes.

CSA-S269.3 - Concrete Formwork.

.3 American Concrete Institute:

ACI 347 - Recommended Practice for Concrete Formwork.

ACI SP-4 - Formwork for Concrete.

ACI 117 - Specification for Tolerances for Concrete Construction.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specifications shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of

Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 03 11 00 (a) to 031100 (d) inclusive will be in square metres based on the neat lines of formwork in contact with concrete surfaces, as shown in the applicable Purchaser's Drawings and Contractor's Documents, and as directed by the Engineer, or as herein provided.

.2 Measurement will be made for contact surfaces only, except as herein provided. No deductions in area will be made for:

Embedments or openings less than 0.5 m^2 in area*.

Embedments and attachments 150 mm wide or less.

Embedments not designed to resist the pressure of wet concrete where specifically shown on the applicable Purchaser's Drawings and Contractor's Documents.

* Deductions shall be made for formwork that extends across openings larger than 0.5 m^2 in area.

.3 Measurement for formwork on sloping top surfaces of concrete shall be limited to surface areas inclined at more than 20 degrees to the horizontal.

.4 No separate measurement will be made for handling, installing, or removing stoplogs, unwatering and dewatering required for the construction of the spillway rollways.

.5 No separate measurement will be made for the supply, installation, and removal of shoring for the support of formwork.

.3 Unit Price

.1 The unit prices for Items 03 11 00 (a) to 03 11 00 (d) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be used to calculate the Target Prices for the Items for designing, supplying, placing and stripping of forms as specified herein and as follows:

Items 03 11 00 (a)i to 03 11 00 (a)vi shall cover flat forms.

Items 03 11 00 (b)i to 03 11 00 (b)iv shall cover curved forms.

Items 03 11 00 (c)i to 03 11 00 (c)v shall cover soffit forms.

Item 03 11 00 (c)vi shall cover soffit forms for the Intake water passage roof.

Item 03 11 00 (c)vii shall cover soffit forms for the Powerhouse Semi-Spiral Case water passage roof.

Item 031 1 00 (d)i shall cover forms for the Powerhouse Draft Tube water passage.

Item 03 11 00 (d)ii shall cover forms for the Spillway rollways.

Item 03 11 00 (d)iii shall cover forms cantilevered from bedrock for the Service Bay.

.2 The supply, installation, and removal of shoring to support formwork is considered incidental to the Work. Include costs for such Work in the unit prices proposed for the Items to which this Work applies.

.3 The handling of stoplogs and the unwatering and dewatering of the Spillway Bays for the construction of the rollways is considered incidental to the Work. Include costs for such Work in the unit prices proposed for the Items to which this Work applies.

1.6 SUBMITTALS

.1 General Submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification manufacturer's literature for any plywood sheathing employed in the formwork, 2 months prior to fabrication of formwork.

.3 The Contractor shall submit 2 weeks prior to erection, shop drawings showing the sizes and specifications of the formwork and falsework, including the types and grades of all materials to be used in the construction, design loads on falsework supports, horizontal forces imposed on the falsework and used for design purposes, and details of splices and connections.

.4 The Contractor shall indicate method and schedule of construction, materials, arrangement of joints, ties, shores, liners, and locations of temporary embedded parts on shop drawings. The Contractor shall comply with CSA S269.1 for shop drawings for falsework and comply with CAN/CSA-S269.3 and ACI 347 for shop drawings for formwork.

.5 The Contractor shall indicate sequence of erection and removal of formwork/falsework on shop drawings.

.6 Each shop drawing submission shall bear the stamp and signature of a qualified Professional Engineer registered or licensed to practice in the Province of Manitoba, Canada.

.7 All shop drawings for formwork and falsework shall meet the requirements of the applicable laws, regulations, guidelines, and codes.

.8 The Contractor shall submit to the Engineer, upon request, design calculations for formwork/falsework 2 weeks prior to erection.

1.7 DELIVERY, STORAGE AND HANDLING

The requirements shall be in accordance with Section 7.24 Delivery, Storage and Handling of the General Specification.

.1 Forming materials and accessories shall be stored in neat supported piles to prevent warping, twisting, and other damage.

Part 2 Products

2.1 DESIGN

.1 The Contractor shall be solely responsible for the supply, design, construction and maintenance of any and all formwork and falsework required during the course of the

Work. A Professional Engineer registered or licensed to practice in the Province of Manitoba shall verify the design of all formwork and falsework and shall sign and seal all the formwork/falsework shop drawings.

.2 Formwork shall be designed, fabricated and erected in accordance with the latest revisions of the applicable provisions governing formwork contained in The Workplace Safety and Health Act (Manitoba) and in accordance with the applicable CSA Standards.

.3 Formwork and falsework shall be designed, constructed, supported and braced to withstand safely and without distortion, all loads likely to be applied to it before, during and after the placing of concrete.

.4 All designs shall be accompanied by detailed shop drawings and calculations showing the size and specification of the falsework, including type and grade of all materials used in the construction; design loads on falsework supports; horizontal forces imposed on the falsework and used for design purposes; and details of splices and connections, including the number, size and spacing of nails, spikes and other fasteners. If mechanical equipment such as concrete buggies, screeding machines, etc, is to be used, this information shall be shown on the shop drawings.

.5 The Contractor shall construct the falsework in strict accordance with the reviewed falsework shop drawings, one set of which shall be kept at the Site at all times.

.6 Changes to falsework shop drawings shall require further review and authorization by the Engineer prior to proceeding with the changes in the field.

.7 Forms shall be designed to permit the concrete to be deposited as nearly as practicable directly in its final position, and shall be such as to allow inspection, checking and cleanup of the surface of the preceding concrete placement to be completed without delay.

.8 Where falsework is used, sufficient diagonal bracing shall be provided in the vertical and horizontal planes to prevent lateral movement of the formwork and buckling of the falsework members.

.9 Where falsework is more than one tier in height, the junction of each tier shall be braced to prevent any lateral movement.

.10 Fittings for falsework shall be sound, rigid and capable of carrying the maximum loads without settlement or deformation.

2.2 MATERIALS

.1 Forms shall be of straight lumber, shiplap, tongue and groove lumber, plywood or steel. All materials used in formwork shall be of a type and of sufficient strength to withstand the fluid pressures due to concrete, any equipment that may be placed on them, personnel that may be working on them or other construction/design loads. The deflections under said loads shall be within the tolerances specified.

.2 Formwork or suspended concrete slabs shall conform to CSA Standard S269.1 and formwork for special architectural finishes shall also meet the requirements of Section 8.3 of CSA Standard A23.1 and the relevant clauses of CSA Standard A23.4.

.3 All materials used in the fabrication and erection of formwork shall be of adequate strength and quality (grade) for their intended purpose in accordance with the applicable CSA Standards, and prior to being authorized for use, shall be subject to the review of the Engineer.

.4 Where lumber is used, it shall be sound, straight, and free of warping, loose knots and decay. Except as specified herein, it shall be dressed smooth and sized to the appropriate width and thickness.

.5 Where plywood is used, it shall be non-warping, non-wrinkling and manufactured with special waterproof glues. Insofar as is practicable, plywood sheets shall be of uniform width and length.

.6 Where steel forms or steel-lined forms are used, the surfaces shall be smooth and free of dents, buckled areas or other surface irregularities.

.7 Forms to be used in water passages, and for concrete that will be exposed to view, shall be faced with plywood or steel and free of all defects which may produce blemishes on the finished concrete surfaces.

.8 Reuse of forms and form lumber will be permitted provided they are thoroughly cleaned and repaired and remain capable of producing the concrete finishes specified herein. Metal patches will not be permitted for surfaces permanently exposed to view.

.9 Internal ties shall consist of bolts and rods and they shall be straight and arranged such that when the forms are removed no metal shall be left closer than 50 mm to any formed surface for all finishes. Welding and securing of form ties to reinforcing steel or embedded items will not be permitted. The use of tie wires will not be permitted. Other types of form tie shall be used only when authorized by the Engineer.

.10 All form surfaces shall be thoroughly cleaned before erection and shall be coated with a non-staining mineral oil or lacquer, or form release agent, as authorized by the Engineer. All excess oil/coating shall be wiped off prior to concreting and no oil/coating shall be permitted on the reinforcing steel or other embedded Items. The Contractor shall provide proof of compatibility between the form oil product and the concrete and shall perform any required subsequent treatment that the formed surface is to receive. All form oil or coatings shall prevent ingress of wood resins into the concrete surface.

Part 3 Execution

3.1 QUALITY MANAGEMENT

Shall be in accordance with Section 7.13 Project Quality Management of the General Specification.

.1 Designers and tradesmen skilled in the design and construction of formwork/falsework in relation to the surface finish requirements and safety aspects of the erection shall be employed.

.2 Formwork shall produce surfaces that are smooth in appearance and of top quality.

.3 This aspect of the Work shall be coordinated with other trades working at the Site.

3.2 EXAMINATION

.1 Prior to commencing installation, the Contractor shall thoroughly examine other aspects of the Work upon which the Work pursuant to this Section is dependent. The Contractor shall report deficiencies discovered and propose adjustments to the Engineer and obtain written authorization before proceeding. Commencement of the Work pursuant to this Section shall imply acceptance of the existing conditions.

.2 Lines, levels and centerlines shall be verified before proceeding with the formwork. The Contractor shall ensure that the dimensions agree with the Purchaser's Drawings and Contractor's Documents and that the supplied equipment, hardware and cast-in items fit the concrete dimensions.

3.3 PLACING AND PREPARATION OF FORMS

.1 The construction of formwork and falsework shall adhere to the Contractor's reviewed design. The use of contraction joint (CTJ) key ways to facilitate waterstop installation will not be allowed. Split formwork or some other method shall be used to place waterstops at CTJs.

.2 The formwork shall be fabricated, erected and supported in accordance with CSA S269.1, CAN/CSA-S269.3 and ACI 347 to produce finished concrete conforming to shape, dimensions, locations and levels indicated on the Purchaser's Drawings and Contractor's Documents, and within the tolerances specified.

.3 The Contractor shall obtain the Engineer's authorization prior to the use of earth forms.

.4 The Contractor shall align form joints and make them watertight. Form joints shall be kept to a minimum. For concrete surfaces permanently exposed to view, the joints in form panels shall be arranged to provide a pleasing appearance, placed so that the joint marks on concrete surfaces will be in alignment both horizontally and vertically, and the joints between surfaces shall be smooth. Where forms for continuous surfaces are placed in successive pours/lifts, care shall be taken to fit the forms over the completed surface to obtain accurate alignment of the surfaces and to prevent leakage of mortar.

.5 The Contractor shall form chases, slots, openings, drips, recesses, and all joints as indicated on the Purchaser's Drawings and the Contractor's Document. The Contractor shall obtain the Engineer's authorization before adding any openings that are not indicated on the Purchaser's Drawings and Contractor's Documents.

.6 The Contractor shall modify formwork to form pipe checks where embedded piping is indicated on the applicable Purchaser's Drawings and Contractor's Documents.

.7 Moulding strips shall be placed in the corners of forms so as to produce beveled (chamfered) edges in permanently exposed exterior concrete corners. Interior corners shall be beveled where shown on the applicable Purchaser's Drawings and Contractor's Documents or as directed by the Engineer. Unless otherwise indicated on the applicable Purchaser's Drawings and Contractor's Documents, all chamfers shall be 20 mm.

.8 Before depositing concrete, all forms shall be rigid and tight and shall be thoroughly cleaned. The forms shall be surface treated with form oil of a type acceptable to the Engineer. The form oil shall be applied before the reinforcing is placed. Forms, which have dried out as a result of being left in place too long, shall be re-oiled.

.9 Openings shall be provided in forms as necessary to permit inspection and cleaning, placing and compaction of concrete and the forming and processing of construction joints. Temporary openings shall be framed neatly, with provision for keys as directed. Provision shall be made to keep forms tightly in contact with hardened concrete at construction joints to prevent the mortar of the fresh concrete from leaking past the joint and to prevent any offset at the joint. Rough lumber may be used for formed construction joints.

.10 Where internal tie rods remain embedded, they shall terminate not less than 50 mm back from the formed face for concrete. Removable embedded fasteners on the ends of the rods shall be such as to leave holes of regular shape with a diameter not greater than

25 mm. These holes shall be reamed with a suitable toothed reamer, and, after being cleaned, shall be neatly and solidly filled with dry patching mortar of a matching colour to the surrounding concrete.

3.4 TOLERANCES

Formwork and falsework shall be designed, constructed, located, supported and braced in such a manner that variations in alignment, grade, position and dimensions of finished surfaces of concrete structures from the established alignment shown on the construction drawings will be within the tolerances shown in CAN/CSA A23.1, ACI-117, where indicated in Table 1, as indicated on the Purchaser's Drawings and Contractor's Documents, and to satisfy the requirements of Section 03 35 00 Concrete Finishing and Repair.

Table 1: Construction Tolerances for Reinforced Concrete Construction

Variation from plumb:		
(a) General.	In any 3 m span	5 mm
(b) In the lines and surfaces of columns, piers, walls, and other rises.	In any storey/lift, or 6 m span max In 12 m span or more	10 mm 15 mm
(c) For exposed corner columns, control joint grooves, other conspicuous lines and water passage faces.	In any 6 m length In 12 m span or more	5 mm 12 mm
(d) Block out for guides receiving secondary concrete.		± 5 mm
(e) Guides embedded in primary concrete.	See requirements given in Section 35 20 17 Embedded Guides of the Technical Specification or as required by the gate manufacturer	
Variation in the sizes or locations of sleeves, floor openings, and wall openings.		5 mm
Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls.	Minus Plus	5 mm 12 mm

Permitted variations by the Engineer to the above tolerances in one part of the construction or in one section of the Technical Specification shall not be construed as permitting variation of the more stringent requirements for any other parts of the construction or in any other sections of the Technical Specification.

3.5 REMOVAL OF FORMWORK

.1 Forms shall not be removed until the concrete has hardened and is of sufficient strength to carry its own weight safely and without distortion, together with construction loads imposed upon it. Forms shall be removed only with the prior authorization of the Engineer, and in general, once the minimum concrete compressive strength at the various structural elements, noted as follows, has been achieved (confirmed by testing or other methods authorized by the Engineer):

.1 Semi-spiral case roof, intake roof and draft tube roof - 25 MPa.

.2 Arches, beams and deck slabs - 20 MPa.

.3 Columns and walls - 15 MPa.

.4 Mass concrete - 10 MPa.

.2 Formwork removal times, as related to concrete strength gain, may be adjusted with the authorization of the Engineer, on the basis of the information provided by ACI SP-4.

.3 For individual pours, upon consideration of weather conditions and type of pour, the Engineer will specify the minimum strength requirement before formwork can be removed.

.4 Forms shall be removed so as to avoid cracking, spalling, peeling or breaking of edges or surfaces; or other damage to the concrete. If it is necessary to wedge the forms loose from the concrete, only wooden wedges shall be used against the concrete. The re-use of formwork and falsework is subject to the requirements of CSA A23.1.

.5 Formwork shall be removed in accordance with the principles of hot and cold weather concreting given by CSA A23.1 in order to minimize the exposure of concrete to sudden variations in temperature.

.6 Forms for the powerhouse semi-spiral case roof shall remain in place until all lifts of the semi-spiral case concrete roof are completed and have reached the minimum strength specified above.

END OF SECTION

General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary for supplying, transporting, storing, handling and placing Types A (WSA) and B (WSB) polyvinylchloride waterstops, Type C (WSC) hydrophilic waterstops, injection hose waterstops, and injecting microfine cement as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 11 00 - Concrete Formwork.

.3 Section 03 21 00 - Reinforcing Steel.

.4 Section 03 30 00 - Cast-In-Place Concrete.

1.3 DEFINITIONS

For the purpose of this section of the Technical Specification, the following definitions shall apply:

.1 Construction Joints (CJ): joints in concrete surfaces on or against which new concrete is to be placed and to adhere to the initial concrete surface, which has become so rigid that the new concrete cannot be incorporated integrally within that previously placed.

.2 Contraction Joints (CTJ): joints whose primary function is to allow relative movements of adjacent, independent structures or concrete units, as a result of thermal expansion/contraction, shrinkage or differential settlement.

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 American Society for Testing Materials (ASTM):

ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.

ASTM D570 - Standard Test Method for Water Absorption of Plastics.

ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.

ASTM D638 - Standard Test Method for Tensile Properties of Plastics.

ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.

ASTM D747 - Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam.

ASTM D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

ASTM D2240 - Standard Test Method for Rubber Property – Durometer Hardness.

.3 Canadian Standards Association (CSA):

A23.1 - Concrete Materials and Methods of Concrete Construction.

A23.2 - Methods of Test for Concrete.

A3000 - Cementitious Materials Compendium.

.4 Corps of Engineers:

CRD-C 572 - Corps of Engineers Specifications for Polyvinylchloride Waterstops.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

.2 Measurement

.1 Measurement for Items 03 15 13 (a) to 03 15 13 (d) inclusive will be in metres based on the straight line length of waterstop as shown in the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, or as herein provided.

.2 Measurement for Item 03 15 13 (e) will be in litres and shall be based on the actual amount of microfine grout injected in the field as specified herein and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 03 15 13 (a) to 03 15 13 (d) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for, supplying, storing, handling and installation of waterstop materials for use in contraction joints and horizontal and vertical construction joints as specified herein and as follows;

Item 03 15 13 (a) shall cover Type A (WSA) polyvinylchloride (PVC) waterstop.

Item 03 15 13 (b) shall cover Type B (WSB) polyvinylchloride (PVC) waterstop.

Item 03 15 13 (c) shall cover Type C (WSC) hydrophilic waterstop.

Item 03 15 13 (d) shall cover injection hose waterstop.

.2 The unit price proposed for Item 03 15 13 (e) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply, mixing, injecting and cleanup of microfine grout for use with the injection hose waterstop as specified herein and as directed by the Engineer. The price shall include all necessary equipment, testing, and submittal of grouting results associated with this Work.

1.6 SUBMITTALS

General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.1 The Contractor shall provide documentation to the Engineer demonstrating that the manufacturer has five years (minimum) continuous, successful experience in the production of waterstops.

.2 The Contractor shall supply, for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, all applicable Contractor's Documents showing compliance with standards and testing above for all waterstop products. Waterstops shall not be ordered without the Engineer's authorization.

.3 Product data sheets for materials provided for Work of this Section shall be provided in advance of Work.

.4 The Contractor shall submit for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification the grouting procedure.

.5 Grouting records shall be submitted for the Engineer' review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Annex G in CSA A23.1 provides a sample grouting record.

1.7 QUALITY MANAGEMENT

.1 The requirements shall be in accordance with Section 7.13 Project Quality Management of the General Specification.

.2 Materials and workmanship not conforming to the above standards may be rejected by the Engineer.

1.8 DELIVERY, STORAGE AND HANDLING

.1 The requirements shall be in accordance with Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The Contractor shall protect waterstops from oil, dirt, and sunlight while in storage on Site prior to use.

.3 All vendor-supplied products shall be handled in accordance with the manufacturer's recommendations. Care shall be taken to ensure requirements relating to shelf life, storage temperature and protection from moisture are met.

Part 2 Products

2.1 PVC WATERSTOPS

.1 The waterstop shall be extruded from a high grade elastomeric plastic compound, of which the basic resin is prime virgin polyvinylchloride (PVC). The material shall contain additional resins, plasticizers, stabilizers, inhibiters and other additives such that when compounded, will meet the specified performance requirements. The material shall also be homogeneous, free from porosity or other imperfections, and shall not contain any scrapped or reclaimed material or pigments. Damaged waterstops shall not be used in the Work. The waterstops shall conform to the shapes and sizes shown on the Purchaser's Drawings and Contractor's Documents.

.2 Accepted waterstops shall be as follows:

.1 WSA waterstops shall be Greenstreak, Profile Style Number 735 PVC waterstop or Engineer's approved equivalent, a 228.6 mm wide waterstop with a ribbed web (9.5 mm minimum thickness) and center bulb section (12.7 mm ID and 25.4 mm OD).

.2 WSB waterstops shall be Greenstreak Profile Style Number 646, or Engineer's approved equivalent, a 228.6 mm wide waterstop with a ribbed web (9.5 mm minimum thickness).

The waterstops shall be "Arctic Grade", be capable of resisting a head pressure of 45 m, remain workable throughout a temperature range of -50°C to +80°C. WSA waterstop shall be capable of accommodating a movement of 20 mm across the centre bulb. All waterstops for contraction (WSA) and construction (WSB) joints shall be located and detailed as shown on the Purchaser's Drawings and Contractor's Documents.

.3 For installation purposes, the waterstop shall come complete with hog rings or grommets spaced at 300 mm along the length of the waterstop.

.4 PVC waterstop shall meet the following requirements.

Requirement	**Method of Test**
Tensile strength using die "C": not less than 13.78 MPa	ASTM D412
Water Absorption: 0.15% max.	ASTM D570
Tear Resistance: not less than 35 kN/m	ASTM D624
Ultimate elongation: not less than 350%	ASTM D638
Low Temperature Brittleness: No failure at -50°C	ASTM D746
Stiffness in flexure: not less than 4.1 MPa	ASTM D747
Specific gravity: not less than 1.20; 1.45 max	ASTM D792
Tensile strength after accelerated extraction: 11.0 MPa	CRD C-572
Elongation after accelerated extraction: 300% min.	CRD C-572

2.2 HYDROPHILIC WATERSTOPS

.1 Hydrophilic waterstops, Type C (WSC), Hydrotite - Type CJ-0725, by Multiurethanes Ltd., or Engineer's approved equivalent, at selected locations, as noted on the applicable Purchaser's Drawings, Contractor's Documents and as authorized by the Engineer.

.2 The hydrophilic waterstop material to be used for waterproofing poured concrete construction joints shall be of rectangular profile measuring 7 mm thick x 25 mm wide

and incorporating hollow longitudinal compression openings; shall be comprised of synthetic chloroprene rubber; manufactured of co-extruded of hydrophilic and non-hydrophilic composition; complete with delay-action coating.

.3 Hydrophilic waterstops shall meet the following requirements:

Requirement	**Method of Test**
Tensile strength using die "C": not less than 2.5 MPa	ASTM D-412
Ultimate elongation: not less than 600%	ASTM D-638
Hardness, Shore A not less than 50	ASTM D-2240
Volume Expansion Capability, 3 to 1	Volumetric Change - Distilled water at 20^{o}C
Tear Resistance, not less than 895 kg/m	ASTM D-624

.4 A hydrophilic caulking shall be used to seal and smooth rough concrete surfaces prior to installation of Hydrotite hydrophilic waterstop profiles as directed by the Engineer and in accordance to the manufacturer's recommendations. The hydrophilic caulking shall be a single component, gun grade sealant, capable of swelling up to 2 times in volume following contact with water, compatible with Hydrotite rubber profiles, have an elongation exceeding 500% and a tensile strength exceeding 3 MPa. The applied thickness of hydrophilic caulking shall not exceed 15 mm. An acceptable product is Leakmaster, by Multiurethanes Ltd.

2.3 INJECTION HOSE WATERSTOP

.1 Permeable injection hose FUKO Type 2 by Greenstreak, or Engineer's approved equivalent.

.2 Microfine grout shall be Lafarge Microcem 900 Microfine Portland Cement or Spinor A12 Ultrafine Blast Furnace Slag Cement, or Engineer's approved equivalent.

.3 Water used for grouting shall be as specified in Section 03 30 00 Cast-In-Place Concrete.

.4 The equipment for pressure grouting shall include the use of a colloidal mixer, capable of mixing and stirring the grout and injecting it continuously and without interruption. The equipment shall be so arranged as to provide a continuous circulation of the grout through the system and permit accurate pressure control, regardless of the volume of flow. A reliable pressure gauge shall be connected to the system at the grout connection to indicate grout injection pressure.

Part 3 Execution

3.1 INSTALLATION

.1 The Contractor shall furnish all Materials, Plant, and Tools for cutting and end butt splicing waterstops. All waterstop intersections or changes in direction such as tees, 90º angles, Y-pieces, crosses, transitions or special interconnections shall be factory fabricated off Site by the supplier of the waterstop and as authorized by the Engineer, such that only butt joint splices are required in the field. The Contractor shall make necessary cuts and end butt splices in the waterstops by means of a suitable accepted portable teflon coated thermostatically controlled waterstop splicing iron, or by another

generally recognized method, provided the equipment and procedure is in strict accordance with the manufacturer's specifications. Lapping of waterstop, use of adhesives or solvents, shall not be allowed.

.2 The Contractor shall take suitable precautions and provide means to support and protect waterstops during the progress of this aspect of the Work and shall repair or replace any damaged waterstops. The Contractor shall supply all necessary supports and ties required for placing the waterstops, the cost of which shall be included in the unit prices tendered for waterstops.

.3 Waterstops located at contraction joints shall be installed as shown/detailed on the applicable Purchaser's Drawings and Contractor's Documents and shall be installed such that the bulb is centred across the contraction joint. Waterstops shall not be installed in formed keys that are offset from the face of the form/ contraction joint.

.4 Waterstops shall be installed at all construction joints that could be subjected to hydrostatic pressure, as shown on the applicable Purchaser's Drawings, Contractor's Documents and as directed by the Engineer. Waterstops shall also be installed at all intermediate joints not shown on the applicable Purchaser's Drawings and Contractor's Documents, those that have been caused by the setting of underlying concrete, as described in Section 03 30 00 Cast-In-Place Concrete and Article 3.3 Preparation of Surfaces for Concrete Placement. Waterstops shall be installed at joints between the foundation working slab and concrete pours above where seepage cut-off is required.

.5 Waterstops shall be installed with equal widths of the material embedded in the concrete on each side of the joint and shall be held rigidly in place. The concrete shall be carefully placed and vibrated around waterstops to ensure complete filling of the forms in the areas around waterstops and a complete bond between the concrete and all embedded areas of the waterstops. Concrete shall not be deposited directly onto the waterstops.

.6 Waterstops to be sealed against rock shall extend 300 mm into the rock in a drilled slot or similar neat excavation, as authorized by the Engineer, and the space around the waterstops in the slot shall be filled with flowable non-shrink grout as shown on the Purchaser's Drawings and Contractor's Documents. Drilling and grouting of waterstops into rock shall be included in the unit prices tendered for waterstop installation.

.7 Wherever waterstops project from completed sections and complete embedment is to be delayed, such waterstops shall be adequately protected by timber enclosures, or by other means as authorized by the Engineer.

.8 The hydrophilic waterstop shall be bonded to concrete surfaces that have been cleaned of all dust, oil, laitance, etc, using Leakmaster adhesive and concrete nails, in strict accordance with the manufacturer's instructions.

.9 All splicing, bending, sealing and joining to PVC waterstops shall also be as directed by the manufacturer, and as authorized by the Engineer.

3.2 TUBE INSTALLATION

.1 All installation, inspection, injection, and vacuuming operations shall be in strict accordance with the reinjectable hose system manufacturer's instructions and shall be done by an experienced applicator of the reinjectable hose system.

.2 The Contractor shall cut the injectable tubing into an appropriate number of lengths with the maximum length of each section not to exceed 5 m. For joint lengths exceeding 5 m the Contractor shall overlap additional sections.

.3 An appropriate length of colored extension tubing shall be placed on each end of each section of cut tubing.

.4 The Contractor shall use special care to avoid crimping or damaging the injectable tubing during installation.

.5 The colored extension tubing shall be cut to an appropriate length and extended with extension tubes visible and accessible to allow for future injection.

.6 Protect all reinjectable hoses from flame, sparks, oil, dirt, concrete splatter and damage prior to concrete pour.

.7 Concrete surfaces where reinjectable hoses are to be installed are to be clean, dry, smooth, and free from dirt and debris.

.8 Hoses must be located with at least 4 inches of concrete cover. Install as close as possible to centerline of wall or slab, with only the vent ends crossing over the reinjectable hose. Only vent ends should leave the joint.

.9 Do not fasten reinjectable hoses to reinforcing steel.

.10 Visible honeycombs at the surface should be patched directly after dismantling formwork to avoid loss of injection material during the injection operation.

3.3 GROUT MIXING AND INJECTION

.1 The injectable tubing shall be injected with microfine cementitious grout a minimum of 28 days after pouring concrete.

.2 Microfine cement grout shall be prepared in strict accordance with the manufacturer's instructions.

.3 Microfine cement grout shall be injected in accordance with FUKO tube suppliers, grout manufacturers and injection equipment manufacturers.

.4 Tubes shall be cleaned and emptied as per the manufacturer's instructions to allow for future injection of microfine cement.

3.4 FIELD QUALITY CONTROL

The requirements shall be in accordance with Section 7.13 Project Quality Management of the General Specification.

.1 Waterstop splicing defects which are unacceptable include, but are not limited to the following:

.1 Tensile strength less than 80% of parent section.

.2 Misalignment of center bulb, ribs, and end bulbs greater than 1.5 mm.

.3 Bond failure at joint deeper than 1.5 mm or 15% of material thickness.

.4 Misalignment that reduces waterstop cross section more than 15%.

.5 Visible porosity in the weld.

.6 Bubbles or inadequate bonding.

.7 Visible signs of splice separation when cooled splice is bent by hand at a sharp angle.

.8 Charred or burnt material.

.2 Grouting records approved by the Engineer shall be kept. Annex G in CSA A23.1 provides a sample grouting record. Particular attention shall be paid to the volume of grout injected into each tube.

END OF SECTION

General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, materials, Plant, and Tools except as herein provided, and performing all Work necessary for supplying, transporting, storing, handling, assembling and installing in place all anchors and inserts for permanent material and equipment, to be embedded in concrete, as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein.

.2 Anchors and inserts to be supplied (except as herein provided) and installed shall include, but shall not be limited to the following:

- .1 Anchors and anchor bolt assemblies for stoplog or bulkhead guides, lintels and sill beams for the intake trashracks and bulkhead gates, draft tube bulkhead gates and the spillway stoplogs.
- .2 Anchors and anchor bolt assemblies for intake and spillway gate guides, lintels and sill beams (install only).
- .3 Anchors for turbine and generator embedded parts, such the draft tube steel liners, stator and generator components (install only).
- .4 Anchors for structural steel columns including high strength post-tensioned anchors for the superstructure, complete with sleeves.
- .5 Anchors and/or anchor plates for crane rails, handrails, ladders, stairs, platforms, hatches, contraction joint embedments, davit arm sleeves and other items of similar nature.
- .6 Anchors for mechanical and electrical equipment, intake gate hoists, communication tower and other purchaser supplied equipment (install only).
- .7 Anchors for mechanical and electrical equipment supplied by the Contractor.
- .8 Anchors for roadway guardrails.
- .9 Channel concrete inserts for supporting items such as pipe hangers and cable trays.
- .10 Bull rings and ladder rungs.
- .11 Anchors for spillway hoist housing towers (install only).
- .12 Anchors for spillway precast panels.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 30 00 - Cast-in-Place Concrete.

.3 Section 05 12 23 - Structural Steel.

.4 Section 05 50 00 - Miscellaneous Metal.

.5 Section 09 90 00 - Painting and Coating.

.6 Section 35 20 13 - Bulkhead Gates, Stoplogs and Trashracks.

.7 Section 35 20 17 - Embedded Guides.

.8 Section 41 22 13 - Crane Rails.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all regulations applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.2 CSA G40.20 - General Requirements for Rolled or Welded Structural Quality Steel.

.3 CSA G40.21 - Structural Quality Steel.

.4 CSA S16 - Design of Steel Structures.

.5 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.

.6 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.7 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.8 ASTM A 36/A 36M - Carbon Structural Steel.

.9 ASTM A 108 - Steel Bars, Carbon and Alloy, Cold Finished.

.10 ASTM A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.

.11 ASTM A722 - Uncoated High Strength Steel Bars for Prestressing Concrete.

.12 ASTM F1554 - Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

.13 CMAA #70 - Specifications for Electrical Overhead Traveling Cranes.

.14 CMAA #74 - Specification for Top Running and Under Running Single Girder Electric Overhead Traveling Cranes.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 03 15 19 (a) to 03 15 19 (h) shall be in kilograms based on the weights shown on the Purchaser's Drawings and Contractor's Documents drawings, and as authorized by the Engineer.

.2 Measurement for Items 03 15 19 (i) and 03 15 19 (j) shall be based on the number of Items as shown on the Purchaser's Drawings and as authorized by the Engineer.

.3 No separate measurement will be made for embedded anchors for crane rails, handrails, ladders, stairs, platforms, hatches, contraction joint embedments, mechanical and electrical equipment supplied by the Contractor, and structural steel not requiring pipe sleeves.

.3 Unit Price

.1 The unit prices proposed for Items 03 15 19 (a) to 03 15 19 (f) inclusive, in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, loading, transporting, unloading, handling and installing embedded anchor assemblies, including nuts, washers, plates and pipe sleeves, threaded inserts, and nelson studs as specified herein and as follows:

Item 03 15 19 (a) shall cover anchor bolts supplied with pipe sleeves for the Powerhouse Complex.

Item 03 15 19 (b) shall cover anchors embedded in primary concrete for assemblies for gate guides, sill beams, and lintel beams supplied by the Contractor.

Item 03 15 19 (c) shall cover roadway guardrail anchors (c/w bolts and washers).

Item 03 15 19 (d) shall cover channel concrete inserts.

Item 03 15 19 (e) shall cover bull rings and ladder rungs.

Item 03 15 19 (f) shall cover high strength anchors required for spillway rollway precast panels.

.2 The unit price proposed for Items 03 15 19 (g) to 03 15 19 (j) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for handling and installing embedded anchor assemblies (supplied by others) as specified herein and as follows:

Item 03 15 19 (g) shall cover anchors embedded in primary concrete for assemblies for the Intake and spillway gate guides, lintels and sill beams.

Item 03 15 19 (h) shall cover anchor assemblies for various electrical and mechanical equipment supplied by the Purchaser.

Item 03 15 19 (i) shall cover anchor assemblies for the turbine and generator equipment and assemblies.

Item 03 15 19 (j) shall cover anchor bolts for the spillway hoist housing towers.

.3 The supply and installation of embedded anchors for crane rails, handrails, ladders, stairs, platforms, hatches, contraction joint embedments, mechanical and electrical equipment supplied by the Contractor and structural steel, not requiring pipe sleeves is considered incidental to the Work. Include costs for such Work in the unit prices proposed for the Items to which this Work applies.

.4 The post-tensioning of Item 03 15 19 (a), 03 15 19 (f) and 03 15 19 (j) shall be considered incidental to the Work of superstructure steel, precast beams, and

spillway hoist housing Work. Include costs for such Work in the unit price proposed for the Items to which this Work applies.

1.5 SUBMITTALS

General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.1 Indicate materials, finishes, connections, joints, method of anchorage, number of anchors, weight, supports, reinforcement, details and accessories shall be indicated on the Contractor's Documents.

.2 Certified copies of all mill test reports for post-tensioned anchors, showing physical and chemical analysis, shall be submitted to the Engineer.

.3 Provide dimensional check records of anchor positioning and concrete block-out dimensions shall be indicated on the Contractor's Documents.

1.6 DELIVERY, STORAGE AND HANDLING

Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.1 Anchors, anchor plates, anchor rods, threaded inserts and channel inserts, hereinafter referred to as anchors, shall be handled and stored in such a manner as to prevent damage to the rods, bolts, threads, or attachments.

.2 Any materials supplied by the Engineer that are damaged or lost by the Contractor shall be repaired or replaced by the Contractor to the satisfaction of the Engineer at no additional cost to the Purchaser.

1.7 QUALITY MANAGEMENT

Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.1 Contractors must be certified under the requirements of CSA W47.1.

.2 Welding shall be in accordance with CSA W59 and W186 for welding of structural steel and reinforcing bars respectively, using welding operators who are qualified under CSA W47.1.

Part 2 Products

2.1 MATERIALS

.1 Welded reinforcing steel: Weldable carbon steel Grade 400W deformed bars to CSA G30.18.

.2 Structural steel: CSA G40.20/G40.21 Grade 350W (except HSS Grade 350W, Class C), unless shown otherwise on the applicable Purchaser's Drawings and Contractor's Documents.

.3 Anchor bolts: ASTM F1554 Grade 36, unless shown otherwise on the applicable Purchaser's Drawings or Contractor's Documents.

.4 Shear studs: “Nelson Studs”, or Engineer’s approved equivalent to ASTM A108 (Grades 1010 through 1020).

.5 Guardrail anchors: Type DGR-2 by NCA, or Engineer’s approved equivalent.

.6 Channel inserts: “Power-Strut”, or Engineer’s approved equivalent.

.7 Threaded Inserts: Dayton Superior F-42 - Loop Ferrule Insert, or Engineer’s approved equivalent.

.8 Post-tensioned Anchors: Hot rolled Threadbars produced by cold stretched and stress relieved method in conformance with ASTM A722.

Part 3 Execution

.1 All anchors shall be carefully assembled and set to conform to the dimensions shown on the applicable Purchaser’s Drawings and Contractor’s Documents, and shall be held rigidly in place utilizing wood or steel templates or other means, as authorized by the Engineer.

.2 Anchor bolts shall be installed within the following tolerances unless otherwise shown on the applicable Purchaser’s Drawings and Contractor’s Documents. The requirement for Crane Supporting Structure:

.1 Variation from alignment (center-to-center distance between any two bolts within a bolt group) - As per CSA A23.1.

.2 Variation from bolt projection (center-to-center distance between adjacent bolt groups) - As per CSA A23.1.

.3 Variation from bolt projection (center-to-center distance between adjacent bolt groups) for crane runway beam supporting columns - As per CSA A23.1, CMAA #70 and CMAA #74 whichever is more stringent. (6.3 mm Max).

.3 Should anchors become displaced during concrete operations, the Contractor shall correct the displacement accordingly. A displacement of anchors under this clause is considered to be any movement of the anchors in any direction which displaces the anchors from the locations shown on the applicable Purchaser’s Drawings and Contractor’s Documents by more than the tolerances specified above, whether caused by movement of the anchors relative to the forms, or by shifting of the forms, or otherwise.

.4 When pipe sleeves are provided with the anchors, the Contractor shall align the sleeves according to the details shown on the applicable Purchaser’s Drawings and Contractor’s Documents with the pipe sleeve set concentrically and positioned to suit the tolerances stated above. Accepted means shall be used to secure the sleeve in concentricity with the anchor bolt and to prevent concrete or other foreign material from entering the space between the bolt and the sleeve. After embedment, the Contractor shall clean the threads, utilizing a thread chaser, grease the bolts and replace the nuts. Where anchors in pipe sleeves are required to be left exposed to the elements during winter, the sleeves shall be filled with antifreeze.

.5 The Contractor shall protect all threads of anchors and couplings from concrete splatter during concreting operations and from any possible damage due to the elements or construction activities after such anchors and couplings have been embedded.

.6 The Contractor shall provide a survey of the anchor locations and concrete blockout dimensions to the Engineer for all gates, stoplogs, and bulkheads.

.7 Post-tensioning of the powerhouse complex superstructure column anchors shall be completed as specified in Section 05 12 23 Structural Steel.

END OF SECTION

General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, materials, Plant, and Tools and performing all Work necessary for the placing of reinforcing steel and anchor dowels (where required) for concrete structures, including reinforcing steel dowels used as anchors, as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein. This aspect of the Work shall include supply, transporting, off-loading at the Site, handling, storing, cutting, on-Site and off-Site bending, cleaning, placing and fastening in position of reinforcing steel and welded wire fabric, drilling and grouting of anchor dowels, and the performance of all other Work and supply of all other labour, materials, Plant, and Tools connected therewith.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 11 00 - Concrete Formwork.

.3 Section 03 15 31 - Waterstops.

.4 Section 03 30 00 - Cast-in-Place Concrete.

.5 Section 03 40 00 - Precast Concrete.

.6 Section 03 41 33 - Precast Concrete Beams and Girders.

.7 Section 03 45 13 - Precast Wall Panels.

.8 Section 04 22 00 - Concrete Unit Masonry.

.9 Section 26 05 27 - Embedded Grounding.

.10 Section 31 68 00 - Post-Tensioned Foundation Anchors.

.11 Section 31 81 00 - Foundation Grouting.

.12 Section 40 05 00 - Mechanical and Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 Canadian Standards Association (CSA):

CSA A23.1 - Concrete Materials and Methods of Concrete Construction.

CSA A23.3 - Design of Concrete Structures.

CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.

CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.3 American Society for Testing Materials (ASTM):

ASTM A185 - Steel Welded Wire Reinforcement - Plain - for Concrete.

ASTM A497 - Steel Welded Wire Reinforcement - Deformed - for Concrete.

ASTM A767/A767M - Zinc-coated (Galvanized) Steel Bards for Concrete Reinforcement.

ASTM C1107/C1107M - Packaged Dry, Hydraulic-Cement Grout (Non-Shrink).

.4 American National Standards Institute/American Concrete Institute:

ACI SP-66 - ACI Detailing Manual.

.5 Reinforcing Steel Institute of Canada:

Reinforcing Steel - Manual of Standard Practice.

.6 Concrete Reinforcing Steel Institute (CRSI).

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price proposed for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

.2 Measurement

.1 Measurement for Items 03 21 00 (a) to 03 21 00 (i) inclusive and Item 03 21 00 (m) will be in kilograms based on the weights provided in the accepted reinforcement bar lists, and as directed by the Engineer, or as herein provided.

.2 Measurement for Items 03 21 00 (a) to 03 12 00 (i) inclusive will be computed from the unit weights in the table below.

Bar Designation	**Mass/Length (kg/*m*)**
10M	0.785
15M	1.570
20M	2.355
25M	3.925
30M	5.495

35M	7.850
45M	11.775
55M	19.625

.3 Measurement for Item 03 21 00 (m) will be computed from tables for common styles of welded wire fabric as published by the Concrete Reinforcing Steel Institute (CRSI).

.4 Measurement for Items 03 21 00 (j), 03 21 00 (k), 03 21 00 (l), and 03 21 00 (n) shall be the number of Items as shown on the applicable Purchaser's Drawings, Contractor's Documents and as directed by the Engineer.

.5 No separate measurement will be made for supply and installation of steel supports, chairs, or ties used to support the reinforcing steel before or during the placing of concrete.

.3 Unit Price

.1 The unit prices proposed for Items 03 21 00 (a) to 03 21 00 (i) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, off-loading, loading, transporting, unloading, handling, cutting, cleaning, bending, and placing Grade 400 reinforcement as follows:

Item 03 21 00 (a) shall cover reinforcing steel for the Spillway Structure.

Item 03 21 00 (b) shall cover reinforcing steel for the Spillway Transition Structures.

Item 03 21 00 (c) shall cover reinforcing steel for Walls A to D inclusive.

Item 03 21 00 (d) shall cover reinforcing steel for the Intake Structure.

Item 03 21 00 (e) shall cover reinforcing steel for the Powerhouse Structure.

Item 03 21 00 (f) shall cover reinforcing steel for the Tailrace Structure.

Item 03 21 00 (g) shall cover reinforcing steel for the Service Bay Structure.

Item 03 21 00 (h) shall cover reinforcing steel for the Powerhouse Transitions Structures.

Item 03 21 00 (i) shall cover reinforcing steel for Walls E and F.

.2 The unit prices proposed for Items 03 21 00 (j) to 03 21 00 (l) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, off-loading, loading, transporting, unloading, handling, installing and testing mechanical reinforcement splices as follows:

Item 03 21 00 (j) shall cover splices for 35M bars.

Item 03 21 00 (k) shall cover splices for 45M bars.

Item 03 21 00 (l) shall cover splices for 55M bars.

.3 The unit price proposed for Item 03 21 00 (m) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, off-loading, loading, transporting, unloading, handling, cutting, cleaning, and placing welded steel wire fabric.

.4 The unit price propose for Item 03 21 00 (n) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply, offloading, loading, transporting, unloading, handling, and installation of the anchor dowels embedded 3 m into rock, including the drilling and cleaning of the anchor dowel holes and the grouting of the anchor dowels.

.5 The supply and installation of steel supports, chairs, or ties used to support the reinforcing steel is considered incidental to the Work. Include the cost for such Work in the unit prices proposed for the Items to which this Work applies.

1.5 SUBMITTALS

General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.1 Certified copies of all mill test reports of reinforcing steel, showing physical and chemical analysis, shall be submitted to the Engineer prior to commencement of reinforcing steel Work.

.2 Upon request, the Contractor shall inform the Engineer of the proposed source of material to be supplied. All reinforcing steel shall be from one manufacturer.

.3 All Contractor Documents for placing shall be prepared in the system of units corresponding to the Purchaser's Drawings and submitted at least 21 days prior to installation.

.4 Contractor's Documents for placing shall reference the detailed reinforcing (bar bending) schedules produced by the Engineer and shall indicate sizes, spacings, locations and quantities of reinforcement and mechanical splices, with identifying code marks, to permit correct placement without reference to the drawings. The shop drawings for placing shall also indicate sizes, spacings and locations of chairs, spacers and hangers. The Contractor shall prepare drawings for reinforcement in accordance with Reinforcing Steel - Manual of Standard Practice by Reinforcing Steel Institute of Canada.

.5 Lap lengths and bar development lengths shall be detailed to CSA A23.3, Class B, unless otherwise indicated.

1.6 DELIVERY, STORAGE AND HANDLING

Shall be in accordance with Section 7.24 Delivery, Storage, and Handling of the General Specification.

.1 The bars should be stored and handled in accordance with the requirements of the CSA A23.1 standard.

.2 Bars shall be delivered to the Site bundled by size or identified code mark (for straight or bent bars), with each bundle clearly tagged for easy identification.

.3 Bundles shall be stored on racks or other similar supports that will allow easy access and will prevent contamination from deleterious materials.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 All reinforcing steel, including steel for anchor dowels, shall be supplied by the Contractor and shall be Grade 400 deformed steel bars, except that plain bars may be used for spirals or helical ties. Bars with size designations 10 M to 45 M inclusive, shall

conform to the requirements of the Canadian Standards Association Specification, CSA G30.18, "Carbon Steel Bars for Concrete Reinforcement", Grade 400.

.2 Galvanized reinforcement shall not be used unless specifically indicated on the applicable Purchaser's Drawings and Contractor's Documents. If indicated, it shall be in conformance to ASTM A767/A767M standard.

.3 For the purpose of the Technical Specification, welded wire fabric shall be classed as reinforcing steel, and shall conform to the requirements of the American Society for Testing Materials, ASTM A185, "Steel Welded Wire Reinforcement - Plain - for Concrete" and ASTM A497, "Steel Welded Wire Reinforcement - Deformed - for Concrete".

.4 Wire for tying reinforcement shall be black annealed wire, with a diameter of not less than 1.6 mm.

.5 Metal or concrete chairs, metal spacers, metal hangers or other accepted supports and ties shall be used where required for proper support and spacing of the reinforcement and shall be supplied by the Contractor. All supports shall be in accordance with CSA A23.1. Steel supports and chairs shall have a rust resistant surface.

.6 Mechanical splices shall be subject to the authorization of the Engineer.

.7 Grout for anchor dowels, if required, shall be Target 1118 non-shrink grout for vertical installations and AMBEX anchoring capsules for horizontal installations, or Purchaser's approved equivalent.

2.2 FABRICATION

.1 Except as otherwise stated herein, the Contractor shall cut and bend all reinforcing steel in accordance with reinforcement bar schedules in the Purchaser's Drawings. Cutting, bending, placing and cleaning shall conform to the requirements of the CSA A23.1 "Concrete Materials and Methods of Concrete Construction". Bent reinforcing steel shall not be straightened or re-bent in a manner that will alter the material properties.

.2 Reinforcement shall be cut and bent to conform to the standard bending details shown on the applicable Purchaser's Drawings and Contractor's Documents or as required to suit Site conditions. The dimensions indicated on the bar bending schedules shall conform to the concrete lift heights and construction joints shown on the Purchaser's Drawings.

.3 The Contractor shall have cutting and bending equipment on Site for the field fabrication of reinforcement as required. Up to 5% of the total quantity of reinforcement may require field fabrication to suit Site conditions.

.4 Partially embedded reinforcing bars shall not be straightened or re-bent without the authorization of the Engineer.

.5 When field bending is authorized, bending of reinforcing steel shall be carried out without heat, applying a slow and steady pressure. The Contractor shall replace all reinforcing bars or anchor dowels that develop cracks or splits.

.6 All dimensions on the Contractor's Documents shall be verified by the Engineer prior to commencing fabrication.

.7 Joints or splices in reinforcing bars or welded wire fabric shall be made at the positions shown on the applicable Purchaser's Drawings and Contractor's Documents. Additional joints or splices will be permitted at positions other than those shown on the applicable Purchaser's Drawings and Contractor's Documents, subject to prior authorization by the

Engineer, and provided that the joints and splices in adjacent bars are staggered, if so directed. All additional joints and/or splices shall conform to the requirements of CSA A23.3.

.8 Mechanical splices, if required and authorized by the Engineer, must be capable of obtaining the joint strength of at least 1.25 times the yield strength of the smaller reinforcing bar being coupled.

.9 Mechanical splices, if required and authorized by the Engineer, will be randomly tested, at the discretion of the Engineer, to ensure the integrity of the splicing equipment, and that the splices meet the minimum strength requirement. Calibration gauges or other such device shall be provided on all splicing equipment such that the compression range specified by the equipment manufacturer can be verified throughout the course of the Work.

.10 The ends of reinforcing bars that are to be mechanically spliced shall be cut by shearing methods and not flame cut.

.11 Where continuous lengths of vertical reinforcement are required, reinforcing steel bars shown on the applicable Purchaser's Drawings and Contractor's Documents will generally not be less than 6 m long, plus the required length for lapping. Lap lengths shall be as indicated on the Purchaser's Drawings and Contractor's Documents. Where the Contractor uses bars shorter than directed, with the authorization of the Engineer, the Contractor shall provide the required lap or mechanical splices as the case may be. Unless otherwise directed by the Engineer, welding will not be permitted for lap splices or for holding reinforcing steel in position during installation.

Part 3 Execution

3.1 PREPARATION

.1 Prior to placement of reinforcing steel, the surfaces of the bars and the metal bar supports shall be cleaned of heavy rust, loose mill-scale, dirt, mud, oil, grease, and other objectionable or deleterious foreign substances.

3.2 PLACEMENT

.1 Reinforcing steel shall be placed as indicated on the applicable Purchaser's Drawings and Contractor's Documents for placing and in accordance with CSA A23.1. It shall be placed within standard tolerances and supported adequately against displacement during concrete placement and subject to authorization by the Engineer. Care should be taken to avoid contact of the reinforcing steel with form oil.

.2 After placement, reinforcing steel or welded wire mesh shall be maintained in a clean condition until completion of embedment in concrete.

.3 Reinforcing steel will be inspected by the Engineer for compliance with the requirements to size, shape, length, splice locations, and position. Prior to placing concrete, the Contractor shall obtain the Engineer's authorization of the placed reinforcement. Concrete placement shall not commence until the in-place reinforcement has been authorized by the Engineer.

.4 The Contractor shall ensure that installation of all piping, sleeves, ducts, anchors and other Items to be embedded in concrete that may interfere with the placing of concrete reinforcement is coordinated and timed to ensure efficient execution of the Work.

.5 Reinforcing steel and wire mesh shall be accurately placed and secured in position, such that they will not be displaced during the concrete placement operation. The Contractor shall ensure that no disturbance occurs to reinforcing steel or wire mesh that has already been placed.

.6 The placement of anchor dowels shall include drilling of the anchor dowel holes, cleaning, flushing and grouting of the anchor dowels, as shown on the applicable Purchaser's Drawings, Contractor's Documents and according to manufacturer's procedures. Drilling equipment shall be according to Article 2.2 of Section 31 81 00 Foundation Grouting and grouting according to Section 31 68 00 Post-Tensioned Foundation Anchors.

.7 Reinforcing steel shall be placed in such a manner that a minimum clear distance of 30 mm, or as otherwise directed by the Engineer, shall be maintained between the reinforcement and any anchor bolts or other embedded metalwork placement.

.8 Unless otherwise indicated on the applicable Purchaser's Drawings and Contractor's Documents, the minimum clear protective cover from the face of the concrete to the reinforcing steel shall conform to the requirements of CSA A23.1 and CSA A23.3, and as modified below.

Location	Minimum Cover (mm)
Concrete in contact with flowing water	100
Road deck surfaces subject to salt/chlorides	100
Concrete placed against rock or excavated surfaces	80
All components exposed to weather only	60
All faces of interior beams, girders and columns	40
Interior concrete slabs	40

.9 In no case shall the cover be less than 1.5 times the nominal maximum size of the aggregates.

END OF SECTION

General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, except as provided herein, and performing all Work necessary for the supplying, transporting, storing and handling of cement, fly ash, aggregates, concrete admixtures and water, batching, mixing, transporting, placing, monitoring temperature rise, curing, finishing, cooling, heating and hoarding of concrete and cleaning and preparing surfaces for concrete placement as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer or and as specified herein. It shall also include the placing of secondary concrete under, behind, and around embedded parts, whether these parts are installed by the Contractor or by the Engineer. The Contractor shall do any necessary Work and supply any necessary material as may be required by the Engineer, in order to obtain satisfactory concrete, complete in every respect. Also included in this Section of the Technical Specification is a CSA certified concrete testing.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 11 00 - Concrete Formwork.

.3 Section 03 15 13 - Waterstops.

.4 Section 03 15 19 - Embedded Anchors.

.5 Section 03 21 00 - Reinforcing Steel.

.6 Section 03 35 00 - Concrete Finishing and Repair.

.7 Section 03 39 00 - Concrete Curing.

.8 Section 03 53 00 - Concrete Floor Toppings.

.9 Section 05 50 00 - Miscellaneous Metal.

.10 Section 26 05 27 - Embedded Grounding.

.11 Section 35 20 17 - Embedded Guides.

.12 Section 40 05 00 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 National Building Code of Canada,

.2 National Fire Code of Canada.

.3 Canadian Standards Association:

CSA A23.1 - Concrete Materials and Methods of Concrete Construction.

CSA A23.1 Annex B - Alkali-Aggregate Reaction.

CSA A23.2 - Test Methods and Standard Practices for Concrete.

CSA A23.3 - Design of Concrete Structures.

CSA A23.4 - Precast Concrete - Materials and Construction.

CSA A3000 - Cementitious Materials Compendium (which consists of A3001, A3002, A3003, A3004 and A3005).

CSA A283 - Qualification Code for Concrete Testing Laboratories.

.4 Reinforcing Steel Institute of Ontario (RSI0):

Reinforcing Steel - Manual of Standard Practice.

.5 American Society of Testing and Materials:

ASTM C31/C31M - Making and Curing Concrete Test Specimens in the Field.

ASTM C33/C33M - Standard Specification for Concrete Aggregates.

ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

ASTM C40/C40M - Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.

ASTM C70 - Standard Test Method for Surface Moisture in Fine Aggregate.

ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete.

ASTM C127 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Coarse Aggregate.

ASTM C128 - Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate.

ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.

ASTM C150/C150M - Standard Specification for Portland Cement.

ASTM C192/192M - Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.

ASTM C260/260M - Standard Specification for Air-Entraining Admixtures for Concrete.

ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

ASTM C451 - Standard Test Method for Early Stiffening of Hydraulic Cement (Paste Method).

ASTM C457/C457M - Standard Test Method for Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete.

ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete.

ASTM C666/C666M - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.

ASTM C1017/C1017M - Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.

.6 Cement Association of Canada:

Design and Control of Concrete Mixtures.

.7 American Concrete Institute:

ACI 207.1R - Guide to Mass Concrete.

ACI 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.

ACI 214R - Guide to Evaluation of Strength Test Results of Concrete.

ACI 301M - Specifications for Structural Concrete.

ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.

ACI 305R - Guide to Hot Weather Concreting.

ACI 306R - Guide to Cold Weather Concreting.

ACI 308R - Guide to Curing Concrete.

ACI309R - Guide for Consolidation of Concrete.

ACI 318M - Building Code Requirements for Structural Concrete.

1.4 DEFINITIONS

.1 **Mass Concrete** - Any volume of concrete with dimensions large enough to require that measures be taken to cope with generation of heat from hydration of the cement and attendant volume change to minimize cracking.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 03 30 00 (a) to 03 30 00 (d) inclusive, will be in cubic metres to the neat lines shown on the applicable Purchaser's Drawings, Contractor's Documents and as directed by the Engineer.

.2 For the purpose of measurement, voids in concrete, created by embedded piping 150 mm in diameter and greater, and recesses and blockouts of any dimension, shall be deducted from concrete volumes in accordance with the dimensions shown.

.3 No separate measurement shall be made for overbreaks.

.4 No separate measurement will be made for handling, installing, or removing stoplogs, unwatering and dewatering required for the construction of the spillway rollways.

.3 Unit Price

.1 The unit prices for Items 03 30 00 (a) to 03 30 00 (d) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying and handling of cement, fly ash, aggregates, admixtures and water; batching, mixing, transporting, placing, curing of concrete; cooling, heating and hoarding of concrete; cleaning preparation of surfaces for concrete placement and testing as specified herein, as shown on the Purchaser's Drawings, Contractor's Documents and as follows:

Items 03 30 00 (a)i to 03 30 00 (a)vii shall cover concrete Work associated with the spillway structure, spillway transitions, and Walls A to D.

Items 03 30 00 (b)i and 03 30 00 (b)ii shall cover concrete Work associated with the service bay structure.

Items 03 30 00 (c)i to 03 30 00 (c)xiv shall cover concrete Work associated with the powerhouse structure, powerhouse transitions, and Walls E to F.

Item 03 30 00 (d)i shall cover secondary concrete placed in areas blocked out of primary concrete to embed sill and lintel beams, gate guides, and turbine components as per the Technical Specification.

Item 03 30 00 (d)ii shall cover concrete poured on sheet metal decking or "Q-deck", such as for equipment hatch covers, elevator machine room floors, battery room roofs, spillway gate hoist housing floor, control building floors above el 152.1, circuit breaker platforms, etc.

Item 03 30 00 (d)iii shall cover dental concrete for dyke and dam foundations and in areas directed by the Engineer.

Item 03 30 00 (d)iv shall be for supply of concrete at the batch plant.

.2 Supply and placement of concrete necessary to correct for overbreak during bedrock excavation is considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices set out for Items to which this Work applies.

.3 Handling, installing, and removing of stoplogs, unwatering and dewatering required for the construction of the spillway rollways are considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices set out for Items to which the Work applies.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit copies of test reports covering physical and chemical testing in compliance with CSA A3000, by the manufacturer for each consignment of cement and fly ash used in the Work performed pursuant to this Section of the Technical Specification.

.3 At least 2 months prior to concrete placement, submit concrete placement procedure documents for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Indicate construction joints, pour sequence, concrete placement method, conveyance plan, measures to control temperature rise of concrete, measures of protecting concrete from thermal shock, embedded Items, finishing and curing.

.4 At least 2 months prior to installation, provide a detailed layout of the batch plant for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.5 The Contractor shall submit certificates confirming that each formula mix chosen will produce concrete having the qualities and performance prescribed in this Section of the Technical Specification and meeting the requirements of the CSA A23.1 and A23.3 standards. The Contractor shall submit the proposed mix designs for all concrete Work to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification at least 2 months prior to the commencement of any concrete placement. As a minimum, the Contractor shall provide information on aggregate quality, quantity of cementitious material used per cubic meter, and proposed admixtures. The Contractor shall also submit independent test data certifying all of the admixtures are compatible and comply with the requirements of the applicable CSA and ASTM standards.

.6 One copy of concrete delivery ticket shall be submitted to the Engineer on Site at time of concrete delivery.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 The Contractor shall furnish at site a CSA Certified Laboratory for testing concrete and performing mix design tests Category 1 Certification, complying with the requirements of CSA A283 - Qualification Code for Concrete Testing Laboratories. Frequency of testing of aggregates and concrete shall meet the requirements of CSA A23.1. Tests that the laboratory will be required to complete are in addition to the Category 1 tests are:

.1 A23.2-2C - Making Concrete Mixes in the Laboratory.

.3 The Laboratory building shall be a dual use facility and of adequate size to house both Contractor Quality Control (QC) and Engineer or Quality Assurance (QA) testing. Facility shall be available for use at least 90 days prior to batching of the first concrete from the central batch plant and shall be to the acceptance of the Engineer. The Engineer shall have full access to the laboratory. See Paragraph 2.2.2 Concrete Testing Laboratory in this Section of the Technical Specification for building laboratory requirements.

.4 All personnel shall be appropriately trained and CSA certified for performing concrete sampling and testing Work.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The Contractor shall be solely responsible for the supply, unloading, storing, and handling of the cement and fly ash to the Site in accordance with CSA A23.1, and in such

a manner as to protect it at all times from the weather and from moisture or other forms of contamination. Cement and fly ash shall be stored immediately upon arrival at the Site. All storage facilities shall be subject to the acceptance of the Engineer. Cement and fly ash shall be used in the chronological order in which it is delivered to the Site.

.3 Cement and fly ash shall be kept in weather tight and moisture proof silos that will be emptied for cleaning at regular intervals not exceeding 12 months, or as otherwise directed by the Engineer. Cement or fly ash that is contaminated or deteriorated in any way shall be retested when directed by the Engineer. Cement shall not contain lumps or any other evidence of deterioration at the moment of use. The use of deteriorated or contaminated cement which does not meet the requirements of CSA A3000 will not be permitted. If, in the opinion of the Engineer, the cement has become unusable, it shall be promptly removed from the Site by the Contractor.

.4 Cement of different types and fly ash shall be stored in separate silos.

.5 The Contractor shall be responsible for all aspects of the ordering of cement and fly ash.

.6 The Contractor shall supply an accurate measuring device on the cement and fly ash silos for performing regular inventories of the cementing materials.

.7 Cement or cementitious materials used for the purposes of grouting and installation of geotechnical instrumentation shall be supplied in sacks. Cement in sacks shall be delivered in strong, well-constructed paper containers, factory-sealed and undamaged. Individual sacks that vary by more than 5% from the nominal weight will be rejected.

.8 The Engineer or reserves the right to sample and test the cement and fly ash to check compliance with the requirements of this specification. The Contractor shall provide safe and simple access to its cement storage facilities to allow inspection, sampling and inventory measurement, by the Engineer, of stored cement and fly ash.

.9 The Contractor shall provide separate silo storage capacity at the batching plant for a minimum amount of cement and equivalent fly ash that is adequate to meet its production capabilities. The Contractor must submit their plan to manage storage and production, particularly during periods of peak production.

.10 Storage of aggregates and water shall be so arranged that these materials can be heated during cold weather concreting operations, and cooled during warm weather concreting operations.

.11 Fine aggregate and each of the nominal sizes of coarse aggregate shall be stockpiled separately. The method of handling and stockpiling shall be such as to prevent segregation and the inclusion of dirt or foreign matter. Tracked equipment shall not be utilized within coarse aggregate stockpile areas. Partitioning shall be employed to prevent intermixing of aggregate piles.

.12 Water storage facilities and/or an alternate water supply, shall be provided to ensure that concreting operations will not be hindered by a temporary breakdown in the Contractor's main supply line. The Contractor shall also arrange for cooling of water during warm weather and for heating of water during cold weather.

.13 Suitable waterproof, frost-free and heated (during cold weather) storage shall be provided by the Contractor for the concrete admixtures.

Part 2 Products

2.1 MATERIALS

.1 Cement

.1 All cement shall be Type GU General Use Portland Cement conforming in all respects to the requirements of CSA A3001, "Cementitious Materials for Use in Concrete", unless otherwise specified. The cement used in a given section of the Work shall be from the same manufacturer, unless otherwise accepted by the Engineer. The cement shall be made available at all times for testing and inspection by the Engineer. The total alkali content contributed by the Cement shall be less than 0.6% Na_2O.

.2 Fly Ash

.1 All fly ash shall be classified "Fly Ash Class CI or F", conforming to CSA A3000 and as further described in Clause 2.2.1, Concrete Mixes. The total alkali content of the fly ash shall be limited to 4.5% maximum. The fly ash shall be obtained from one manufacturing source to ensure consistent quality and compatibility with the concrete materials.

.3 Admixtures

.1 Only approved admixtures shall be used in the concrete. Each admixture shall be batched in its own batcher and added to the mixing water separately before discharge into the mixer. Admixtures shall be delivered in suitably labelled containers to enable identification.

.2 The Contractor shall supply, store, handle and incorporate in all concrete mixes, an air-entraining agent and a water-reducing, set retarding chemical admixture.

.3 The air-entraining agent shall conform to the requirements of CSA A23.1 and ASTM C260/C260M. The agent shall be dispensed separately into the concrete mixture in an amount required to attain the specified quantity of air in the concrete as placed. The agent shall be used in strict accordance with the manufacturer's directions. The quality of the admixture shall be sufficient to produce an air void system meeting the requirements of Clause 4.3.3.3 of CSA A23.1.

.4 Chemical admixtures shall meet the requirements as specified in CSA A23.1 and ASTM C494/C494M and C1017/C1017M. The admixtures shall be dispensed separately into the concrete mix using the average dosage rate recommended by the manufacturer and shall be used in strict accordance with the manufacturer's directions, and shall at all times be subject to the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.5 The Contractor shall provide the Engineer with independent test data certifying that all admixtures are compatible and comply with the requirements of the applicable CSA and ASTM Standards specified in this Section of the Technical Specification.

.6 The Contractor shall have the ability to incorporate a superplasticizing agent into concrete mixtures. This admixture will meet requirements of a chemical admixture as specified in ASTM C494/C494M. Any such superplasticizing agent will be supplied by the Contractor and shall be incorporated into the mix in accordance with industry standards and the manufacturer's recommendations.

.7 The use of calcium chloride is not permitted.

.4 Water

.1 Water used for mixing and curing concrete and for processing concrete aggregates shall meet the requirements of CSA A23.1 and shall be clean and free from oil, salt, acid, alkali, silt, organic matter, clay, mud, and other deleterious substances. The nature of its source, its quality, and the general arrangements for its supply shall be to the satisfaction of the Engineer. It shall be the responsibility of the Contractor to supply all mixing water, curing water and water for use in the processing of aggregates.

.2 If water from local natural sources should contain, at certain times, quantities of impurities in excess of the above requirements, the Contractor shall take whatever measure may be necessary for ensuring its purity before use.

.3 The water content of the aggregates, in excess of saturated surface dry condition, as determined using test method CSA A23.2-11A or other proven and accepted method, shall also be considered as part of the mixing water.

.5 Fine Aggregate

.1 Fine aggregate shall be a natural sand from an approved local borrow source(s) and shall meet the requirements specified in CSA A23.1. The sand shall be washed by the Contractor, and any pit blending, screening, classifying or other processing required for the sand to meet the requirements specified in CSA A23.1 shall be performed by the Contractor.

.2 The term “fine aggregate” is used to designate aggregate in which the maximum nominal particle size is 5 mm. Fine aggregate for concrete, grout and mortar shall be processed sand or Purchaser’s approved equivalent.

.3 Fine aggregate shall consist of clean, hard, dense, durable uncoated rock fragments and shall be free from injurious amounts of dust, clay, soft or flaky particles, shale, alkali, organic material, loam, and other deleterious substances. Sampling of fine aggregate shall conform to CSA Test Method A23.2-1A, unless otherwise specified, and shall conform to the applicable test methods listed in Table 1 -“Test Methods for Normal Density Coarse and Fine Aggregate”. The sum of all deleterious substances, as delivered to the mixer, shall not exceed 3% by weight. The percentage of deleterious substances for fine aggregate, when tested in accordance with the methods contained in CSA A23.2, shall not exceed the limits listed in Table 12 - “Limits for Deleterious Substances and Physical Properties of Aggregate” in CSA A23.1.

.4 Fine aggregate shall meet the requirements of CSA A23.1 when tested in accordance with Test Method A23.2-7A and shall have a fineness modulus greater than 2.30 but less than 3.10 for natural sand. The fine aggregate shall be well graded and blended and shall conform to the limits indicated for fine aggregate FA1 in Table 10 “Grading Limits for Fine Aggregates” of CSA A23.1.

.5 Control tests and analyses of the sand at various stages of production and handling shall be made by the Contractor in accordance with test procedures contained in CSA A23.2, Test Methods and Standard Practices for Concrete and as further listed in Table 1 “Test Methods for Normal Density Coarse and Fine Aggregate”. The Contractor shall provide such facilities, at its own cost, as the Engineer may consider necessary for the ready procurement of representative test samples.

Table 1: Test Methods for Normal Density Coarse and Fine Aggregate

CSA A23.2 - 1A	Sampling Aggregate for Use in Concrete
CSA A23.2 - 2A	Sieve Analysis of Fine and Coarse Aggregate
CSA A32.2 - 3A	Clay Lumps in Natural Aggregate
CSA A23.2 - 4A	Low Density Material in Aggregate
CSA A23.2 - 5A	Amount of Granular Material Finer than .08 mm in Aggregate
CSA A23.2 - 6A	Relative Density and Absorption of Fine Aggregate
CSA A23.2 - 7A	Test for Organic Impurities in Fine Aggregates for Concrete
CSA A23.2 - 8A*	Measuring Mortar-Strength Properties of Fine Aggregate
CSA A23.2 - 9A*	Soundness of Aggregate by Use of Magnesium Sulphate
CSA A23.2 - 10A	Bulk Density of Aggregate
CSA A23.2 - 11A	Surface Moisture in Fine Aggregate
CSA A23.2 - 12A	Relative Density and Absorption of Coarse Aggregate
CSA A23.2 - 13A	Flat and Elongated Particles in Coarse Aggregate
CSA A23.2 0 - 14A*	Potential Expansivity of Cement-Aggregate Combinations (Concrete Prism Expansion Method)
CSA A23.2 - 15A*	Petrographic Examination of Aggregates
CSA A23.2 - 16A*	Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
CSA A23.2 - 17A*	Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
CSA A23.2 - 25A*	Test Method for Detection of Alkali Silica Reactive Aggregate by Accelerated Expansion of Mortar Bars
* (Tests marked with an asterisk may not be within the capability of the Site lab).	

.6 Coarse Aggregate

.1 Coarse aggregate shall be manufactured from sound rock obtained from the structures excavation area or from an approved quarry site. Type and capacities of equipment used to produce coarse aggregate shall be submitted for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Any crushing, screening, blending, washing or other processing required for the aggregate to meet these specifications shall be performed by the Contractor.

.2 The rock in the structures area and approved quarry sites is known to have potential alkali aggregate reactivity. The level of reactivity is identified on the Purchaser's Drawings and Contractor's Documents.

.3 The term "coarse aggregate" is used to designate aggregate in which the minimum nominal size is 5 mm and which is reasonably well-graded from 5 mm to the largest size required in the Work in which the material is to be used. Sampling for coarse aggregate shall conform to CSA Test Method A23.2-1A, except as specified otherwise, and shall meet the requirements of CSA A23.1 when tested in accordance with the applicable test methods listed in Table 1 "Test Methods for Normal Density Coarse and Fine Aggregate".

.4 Coarse aggregate shall consist of clean, hard, fresh, well shaped, dense, durable, uncoated rock fragments, free from injurious amounts of deleterious substances (maximum amount as noted in Table 12 of CSA A23.1) and shall be separated into nominal sizes of 5 mm to 20 mm, 20 mm to 40 mm, and 40 mm to 80 mm meeting the grading requirements (limits) in Table 11 of CSA A23.1. The aggregate shall not exceed 20% by mass of flat and elongated particles, as indicated in Table 12 of CSA A23.1 and as measured by Procedure A of CSA Test Method A23.2-13A.

.5 Coarse aggregate may be rejected if losses, when subjected to 5 cycles of the magnesium sulphate test for soundness (CSA Test Method A23.2-9A), are more than 10% by weight.

.6 The processed aggregate shall meet the requirements specified in CSA Standard CSA A23.1, except as noted herein. The percentage of deleterious substances in any nominal size of coarse aggregate, when tested in accordance with the methods contained in CSA A23.2, shall not exceed the limits listed in Table 12 of CSA A23.1.

.7 Tracked equipment shall not be used on the coarse aggregate stockpiles.

.8 Routine control tests and analyses of the coarse aggregate at various stages in the processing operations shall be made by the Contractor. The coarse aggregate gradation shall be in compliance with Table 11 of CSA A23.1 at the point of manufacture.

.9 Just prior to entering the batch plant the coarse aggregate shall be washed and any excess water shall be removed. Provision shall be made for bypassing the fine aggregate around the washing screens.

2.2 DESIGN

.1 Concrete Mixes

.1 Design and supply concrete mix proportioned to produce concrete specified in Table 3 “Concrete Mixes”. Ensure that the constituent materials will not segregate and excessive bleeding will not occur and temperature rise is minimized.

.2 The concrete shall be composed of Portland cement, fly ash, water, fine and coarse aggregates, and admixtures, as specified herein. The concrete shall be supplied using the “performance” method for specifying concrete, as defined in Table 3 and the meet the requirements of CSA A23.1. The concrete mix proportions will be determined by the Contractor to produce a workable, compactable, and durable concrete which meets the strength and durability requirements for each structure.

.3 The actual amount of water used in the production of the various mixes shall be the minimum necessary to provide concrete of the proper consistency and shall be regulated/monitored for required adjustment for any variation in the moisture content or grading of the aggregates as they enter the mixer. The addition of water to overcome stiffening of the concrete before placement will not be permitted. Uniformity in concrete consistency from batch to batch is required.

.4 Fly ash shall be considered a beneficial material as partial replacement for the cement in the concrete. The quantity of fly ash for the various mixes will be the maximum amount of supplementary cementing material practical for

construction, as determined by the Contractor. Minimum 15% up to a maximum of 40% replacement of cement with fly ash will be considered.

.5 The various concrete mixes used on the Project will range from mass concrete having an 80 mm maximum size aggregate to heavily reinforced concrete sections having 20 mm maximum size aggregate. The locations, in which the various sized aggregate concretes are to be placed, shall be as specified by the Engineer. In general, the nominal size of aggregate used in concrete shall be in accordance with Table 2 - "Maximum Size of Aggregate".

Table 2: Maximum Size of Aggregate

	Maximum Size of Aggregate (mm)	
Minimum Dimension of Section (mm)	**Lightly Reinforced (<100 kg/m^3) Sections**	**Heavily Reinforced (>100 kg/m^3) Sections**
Less than 300	40 to 20	20
300 to 1000	40 to 20	40 to 20
1000 to 3000	40	40 to 20
Greater than 3000	80	40 to 20

.6 Target slumps for typical concrete pours shall be determined by the Contractor in advance of pour authorization for placement and quality assurance requirements. The Contractor must determine plastic concrete properties for proper placement, and relay these to the Engineer.

.7 The Engineer will determine and direct which type or types of concrete are to be placed in the various parts of the structures. In some placement units, two or more different types may be required. A change in aggregate size shall not be considered a type change. The Contractor shall provide whatever facilities are necessary to enable the Engineer to identify the various mixes arriving at the placement unit. The procedures and equipment used to accomplish this shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.8 Development of mix-designs shall ensure that the criteria in CSA 23.2-27A and CSA 23.2-28A are satisfied.

Table 3: Concrete Mixes

Type	**Description**	**Exposure Class**	**Cement Type***	**Compressive Strength at 28 days**
A	Structurally reinforced concrete exposed to chlorides with or without freezing and thawing conditions	C-1	GU	35 MPa
B	Structurally reinforced concrete exposed to freezing and thawing in a saturated condition but not to chlorides	F-1	GU	30 MPa
D	Concrete in unsaturated condition exposed to freezing and thawing but not to chlorides (exterior walls and columns)	F-2	GU	25 MPa
E	Secondary concrete for gate guides and stoplog guides	F-1	GU	35MPa
G	All interior reinforced concrete	N	GU	30 MPa

H	Dental Concrete	N	GU	15 MPa
J	Mass Concrete Sections	N	LH/GU	25MPa (at 56 days)
Note 1:	Concrete shall be low shrinkage concrete with low heat of hydration designed based on the principles of ACI 207.1R and CSA A23.1. This requirement applies to all concrete Work where heat of hydration would be of concern.			
Note 2:	Mix design of concrete shall be, modified accordingly for interior slabs that require a trowel finish (i.e., reduction of air entrainment).			

.2 Concrete Testing Laboratory

.1 The concrete testing laboratory building shall meet the design requirements of the National Building Code of Canada, the National Fire Code of Canada, CSA A23.3 - Design of Concrete Structures, CSA S16 - Design of Steel Structures, and shall be designed for the appropriate environmental loads for Thompson, Manitoba. Foundations shall be designed for an allowable soil bearing pressure of 100 kPa.

.2 The concrete testing laboratory building shall be approximately 8.0 m x 10.0 m in plan area (and include an exterior 2.5 m x 6.0 m concrete apron slab). It shall be heated, air conditioned and ventilated to allow a temperature of 23°C, +/-2°C, to be maintained, shall be insulated and free of vibration and shock and shall be located near the central batch plant, adjacent to the concrete sampling area. The building shall minimally have the following features/design requirements:

Fog Room and Receiving Area.

Insulated 2,750 mm x 2,750 mm overhead door along with appropriate sized man-door.

Floor design service load of 24 kPa or AASHTO HS20 Truck loading for receiving area and apron slab.

Serviced with running water, 110 V electrical outlets, and shall be fully serviceable/usable “year round”.

Contain a concrete floor, floor/drainage sump, workbenches and sinks with provision for grey water disposal.

Hose reel c/w nozzle, capable of hot/cold water mix.

Scale, oven, platform balance, end grinder for concrete cylinders, cart, forney compression machine (2), water bath for cylinder densities, storage racks, and assorted hand tools and small equipment as required to satisfactorily perform the Work.

The interior wall surfaces of the testing area shall be comprised of pre-finished metal liner panels. Mechanical rooms shall be 1 hour fire rated. The fog room shall be boarded with Type ‘X’ Gypsum wallboard, covered (on fog room side) with FRP panel, and adequately sealed with elastomeric sealant.

.3 The Contractor shall include with the concrete testing laboratory all platforms, tools and equipment for obtaining representative samples of fresh concrete from the mixers and for transporting the material to the concrete testing laboratory. The sampling location and procedures shall meet the requirements of Test Method A23.2-1C contained in CSA A23.2, and shall be subject to Engineer’s review in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification.

Part 3 Execution

3.1 BATCHING AND MIXING

.1 The Contractor shall provide at the Site, a modern and dependable automatically controlled batching and mixing plant. The plant shall contain certain facilities for programming and automatically selecting a minimum of 15 separate concrete mixes and shall include not less than two concrete mixers, each with a separate power or drive system and separate hopper and chute for holding and delivery to concrete trucks, to allow the plant to produce two different mixes simultaneously.

.2 The Contractor shall provide such means and equipment as are required to automatically control the actual batched amounts of each of the various materials, including water, cement, fly ash, admixtures and each size of fine and coarse aggregate. All measuring devices shall be constructed so as to permit rapid adjustments in the mix proportions to compensate for variation in the moisture content of the aggregate. Gates, valves and closing devices shall be positive in action and so constructed that they will prevent leakage of materials when in the closed position.

.3 All materials used in the concrete mix shall be mechanically measured by weight, except for admixtures which may be batched by volume.

.4 Water, cement, fly ash, and each size of fine and coarse aggregate shall be weighed separately and not cumulatively. The accuracy of the weighing devices shall be maintained so that the indicated mass does not vary by more than 0.4% of scale capacity from true mass throughout their range of use. The equipment shall be capable of being operated to control the delivery of materials so that the combined inaccuracies in feeding and measuring do not exceed the following limits.

Material	**Percentages**
Cement and fly ash (combined)	±1 (by mass)
Water	±1 (by mass)
Aggregate	±2 (by mass)
Admixtures	±3 (by mass or by volume)

.5 The Contractor shall provide standard certified test weights to a minimum of 50% of the largest scale capacity and any other auxiliary equipment required for checking the operating performance of each scale or other measuring device. Unless otherwise directed by the Engineer, the Contractor shall undertake check tests of equipment used for measuring water, cement, fly ash, and the admixtures, at intervals not exceeding 1 month and check tests of equipment used for measuring fine and coarse aggregate at intervals not exceeding two months. The tests shall be made in the presence of the Engineer and the Contractor shall make such adjustments, recalibrations, repairs or replacements as the Engineer may deem necessary to secure satisfactory performance before further use of the measuring device will be allowed.

.6 The measuring and weighing equipment shall comply with the following requirements.

.1 Each weighing unit shall register in kilograms, the scale load at any stage of the weighing operation. Scales shall be of the springless dial type. Other methods of measuring may be accepted if they meet the foregoing requirement, and the requirement for accuracy set out in this Section of the Technical Specification. Scales shall be compatible with mixer size and shall operate in the 75% range for the maximum mixer batch size. Plant scales shall be within ±3 scale gradations before discharge or recycle of the batch system can occur.

.2 The plant shall be equipped with a batching recorder which shall print the mass for each material in each batch, identify the concrete mix being batched, the size of each batch in cubic metres, the location the batch is cast at, and the time and date of batching. The records for all plant produced and manual batches shall be submitted to the Engineer, on a daily basis, and shall become the property of the Engineer.

.3 A suitable means shall be provided to allow the plant operator to observe the weighing equipment and material discharge at the bin gates and material discharge into the mixers.

.4 The batching equipment shall be so constructed and arranged that the sequence and timing of the batcher discharge gates can be controlled to produce an intermixing of the aggregate, water and cement as the materials pass through the charging hopper into the mixer. The batching controls shall be so interlocked that a new batching cycle cannot be started until all the weighing hoppers are completely empty.

.5 Suitable facilities shall be provided for obtaining representative test samples of aggregates from each of the weighing hoppers.

.6 The devices for adding admixtures shall be interlocked with the batching and discharging operation of the plant.

.7 The mixers shall be equipped with torque meters or similar devices to monitor mixer performance.

.7 The mixing equipment shall combine aggregate, cement, fly ash, water and admixtures within the time specified hereinafter into a thoroughly mixed and uniform mass and shall discharge the mixture without segregation.

.8 The mixers shall be charged so that some water will enter in advance of cement and aggregate and all materials shall continue to flow in as rapidly as possible. Loss of materials shall be prevented.

.9 The mixers shall not be charged beyond their rated capacities and the entire contents of the mixers shall be discharged before recharging.

.10 Unless otherwise directed by the Engineer, the mixing of each batch shall continue for a period of not less than 2 minutes (and in accordance with CSA A23.1) after all materials, except the full amount of water, are in the mixer. The minimum mixing period specified above is predicated on proper control of the speed of rotation of the mixer and of the introduction of the material, including water, into the mixer. The mixing time shall be increased when charging and mixing operations fail to produce a uniform concrete meeting the requirements of CSA A23.1.

.11 Each mixer shall be equipped with a mechanically or electrically operated timing and signalling device for indicating and assuring the completion of the required mixing period and for counting the batches.

.12 The retempering of partially set concrete, with or without additional cement, supplementary cementing materials, aggregate, or water, will not be permitted.

.13 The mixers shall be inspected regularly and cleaned of any hardened materials which have built up on the insides. Should a mixer at any time produce unsatisfactory results, in the opinion of the Engineer, its use shall be discontinued until it is repaired or replaced.

.14 Copies (hard copy and electronic) of all testing results shall be provided to the Engineer. If unsatisfactory trends become evident in the test results, the Contractor shall take immediate action to correct the deficiency by adjusting the mix design.

.15 Sampling for the purpose of testing concrete shall be performed at the batch plant. The Contractor shall provide equipment for obtaining concrete samples after 10% and before 90% of a batch has been discharged from the mixer. Tests to determine if the properties of the fresh and hardened concrete are in accordance with that specified herein shall be performed by the Contractor in accordance with test procedures contained within CSA A23.2, Test Methods and Standard Practices for Concrete. As minimum, tests to determine slump, air content, wet-density, and temperature of the fresh concrete shall generally be performed at the central batch plant once for every 50 to 150 m^3 of concrete batched. One set of four 150 x 300 mm cylinders shall generally be made for each mix batched on a given day and an additional set of cylinders shall be made when the batched volume for any given mix exceeds 200 m^3 per day and for each additional 200 m^3 on that day.

.16 The Contractor shall moist cure and test one cylinder at seven days, two cylinders at 28 days, and one cylinder at 56 days. Additional test cylinders shall be taken to check on the adequacy of curing and/or hot or cold weather protection. No field-cured cylinders will be used for quality control of concrete.

3.2 CONVEYING

.1 Concrete shall be conveyed from the mixer to the place of final deposit without segregation, loss of ingredients or damage from exposure to the elements. Equipment such as buckets, trucks, belt conveyors and pumping units which are used for conveying concrete, shall be of such size, design and condition as to exceed the production capacity of the batch plant and ensure an even supply of concrete to the pours in progress.

.2 If a conveyor system is used, conveyors shall be sufficiently wide enough to avoid overflow. The conveyor operation rate and belt speed shall be dependent on the proper placement and consolidation of the concrete with the belt inclination such that no segregation occurs from any sliding or roll-back of the concrete. All conveying equipment shall be supported independently of the forms. All methods used shall be subject to the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.3 The use of chutes to convey concrete will not be permitted, except that short lengths of chutes less than 5 m in total length may be used immediately adjacent to, or in the forms. Where chutes are used, they shall be so constructed and arranged as to permit continuous flow of the concrete without separation of the ingredients. Under no condition shall the required consistency of the concrete be changed to facilitate "chuting" of the concrete.

.4 Concrete shall be confined in a suitable vertical drop pipe whenever the free-fall distance exceeds 2 m. Where it is necessary to drop concrete more than 15 m, it shall fall into a hopper with a capacity of 1 m^3 more than the volume of the full drop pipe.

.5 For pumping operations, information regarding the type of equipment, lines or ducts carrying the concrete shall be submitted for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification prior to use. Aluminum pipe or aluminum alloy pipe shall not be used. Pumping operations shall provide a continuous stream of concrete without air pockets. Pumping equipment shall be positioned to prevent disturbance of fresh concrete. Maximum aggregate size shall not

be modified to facilitate pumping operations. Temperature rise of fresh concrete due to conveyance/pumping shall be minimized.

3.3 PREPARATION

.1 Concrete placing methods and equipment shall be such that the specified concrete mix is conveyed and deposited without segregation, and without changing or affecting the quality of the concrete. All concrete placing methods and equipment shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Concrete shall not be placed in any part of the Work until foundations, formwork, reinforcing steel, and Items to be embedded in that area have been inspected by the Engineer and permission given by the Engineer for concrete placing to proceed. The Contractor shall give weekly pour schedules to the Engineer prior to the start of each week and a minimum of 2 hours notice of placing concrete at each approved pour location.

.3 Overbreak areas shall be filled with concrete of the same class as the overlying or abutting concrete unless authorized otherwise by the Engineer.

.4 Before placing new concrete on concrete that has set, or against rock or earth surfaces, the surfaces shall be prepared as follows:

.1 All surfaces upon which, or against which, concrete is to be placed, shall be thoroughly cleaned of dirt, mud, debris, snow, frost, ice, grease, oil, dried mortar or grout, loose particles, or other deleterious matter.

.2 When placing new concrete on rock or on hardened concrete, the first layer shall be 150 mm thick and contain 20 mm maximum size aggregate. The concrete shall be of the same mix type as specified for the remainder of the pour. The concrete shall be vibrated thoroughly into all irregularities of the surface.

.3 All construction joint surfaces against which new concrete is to be placed shall be kept saturated for at least 24 hours before concreting and at the time of placing, the surfaces shall be saturated and free from pools of water.

.4 Disturbance of surface concrete at a construction joint during the early stages of hardening shall be avoided, and traffic on the concrete will not be permitted until the concrete has hardened sufficiently, as determined by the Engineer.

.5 Rock surfaces against which any concrete, including dental concrete, is to be placed shall be thoroughly cleaned by the use of high-velocity air-water jets, 105 MPa (15,000 psi) water jets, stiff wire brooms, picks, or other effective means satisfactory to the Engineer. If necessary, the surface shall then be washed to remove all loose material. All pools of water shall be removed from depressions in order to ensure proper bonding of the fresh concrete with the rock surfaces. Riser pipes, headers, sand drains or other installations necessary to produce a foundation free of running or standing water shall be installed by the Contractor and so welded or otherwise securely fastened in place as to prevent their being jarred loose by concrete placement.

.6 Concrete shall not be placed against mud or dry porous earth, or upon fills which have not been subjected to approved rolling or tamping, until required compaction has been obtained.

.7 Horizontal construction joints shall be formed as shown on the applicable Purchaser's Drawings and Contractor's Documents and also at intermediate

levels, where, in the opinion of the Engineer, concrete in an active pour has set such that fresh concrete cannot be integrally incorporated with it. The joints shall be flattened to remove all footprints and other depressions immediately after concrete placing has been completed. The joints shall be struck off and float finished for about 75 mm back from the face of the form and sloped down slightly towards the form. Where exposed to view, the edge of the joint shall be straight and horizontal.

.8 Preparation of horizontal joints and initial cleanup shall be commenced as soon as concrete has reached the proper stage of hardness. The initial cleanup of a lift shall be made by brushing with stiff wire brooms, or air-water jets just before the concrete has taken its final set, or by blasting the surface with high pressure (15,000 psi) water jet, so that all laitance is removed, exposing but not disturbing or undercutting the coarse aggregate. Waterstops and all other embedded Items shall be adequately protected from any damage that could result from the high pressure water blasting. Operators of the 15,000 psi water jets shall be properly trained. The materials dislodged by the brooming or jetting action shall be completely removed from the surface of the lift. Vertical and horizontal surfaces of blockouts for secondary concrete placement shall also be prepared in this manner (i.e., at gate sill beams). During surface preparation, care shall be taken to prevent damage to waterstops or other embedded materials.

.9 When the initial cleanup has not been done at the proper time, and when the cleanup has not been satisfactory, the deleterious layer shall be removed by chipping, high pressure (15,000 psi) water jet, or Purchaser's approved equivalent method.

.10 The surface of vertical contraction or construction joints shall be thoroughly cleaned of accretions of concrete or other foreign materials by scraping, chipping or Purchaser's approved equivalent.

.11 Concrete surfaces in which concrete floor toppings shall be applied, shall be prepared as directed in Section 03 53 00.

.12 All formed blockouts that are to receive secondary concrete placement, such as the gate sill beams, stator and main bearing bracket anchorages, and the like, shall be prepared by roughening all horizontal and vertical surfaces with the use of a scrabbler or high pressure (15,000 psi) washer jet to a profile similar to that specified for floor toppings (CSP 5 profile).

.5 If required for concrete placement, the Contractor may create temporary openings in the reinforcement. The reinforcement spacing must be re-established once the placement opening is no longer required. Cutting reinforcement for placing concrete shall require Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification and shall require appropriate splice bars to be placed prior to covering with concrete.

3.4 PLACING

.1 Concrete shall be placed in accordance with CSA A23.1.

.2 The concrete shall be deposited in horizontal layers, the thickness of which shall not exceed 500 mm, in a stepped fashion to minimize the amount of exposed surface area of fresh concrete. If, in the opinion of the Engineer, 500 mm layers of concrete cannot be placed satisfactorily, the Engineer may require layers of lesser depth. When bottom dump buckets are being used in areas of mass concrete, the full capacity of a bucket may be deposited in one operation when, in the opinion of the Engineer, this procedure will have no objectionable effect on the placement of concrete; otherwise, the discharge shall be controlled so that concrete may be effectively compacted in horizontal layers not exceeding 500 mm in thickness, to ensure a minimum of lateral movement and tendency for segregation.

.3 Concreting shall be done as a continuous operation, as far as practicable, until placing in the lift, section, panel, or monolith is completed. The Contractor shall provide equipment adequate for handling and placing low slump concrete mixes containing the largest permissible size of aggregate. Concrete shall be deposited as close as possible to its position in the forms so that flow within the mass does not exceed 2 m and consequent segregation is reduced to a minimum. The concrete shall be compacted and worked in a manner acceptable to the Engineer into all corners and angles of the forms, and around reinforcement and embedded Items without permitting the component materials to segregate.

.4 When different classes of concrete are used in the same monolith, they shall be placed as nearly simultaneously as plant operations will permit so that the different mixtures will unite in their plastic state to form an integral mass. In placing mass concrete in each lift of the structures, the Contractor shall maintain the exposed area of fresh concrete at the practical minimum. The slope formed by the unconfined edge of the successive layers of concrete shall be regulated to minimize segregation and secure adequate compaction without enlarging unnecessarily, the area of exposure of the fresh concrete. Each layer of concrete within a lift must be covered with fresh concrete within a period of 45 minutes to 1 hour, depending on the prevailing climatic temperature and humidity.

.5 The Contractor shall provide whatever facilities are necessary to enable identification to be made of the various mixes arriving at a placement area. These facilities, including the identification method, shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Concrete trucks and placement crews shall be equipped with two-way radios and shall maintain radio contact with the batch plant.

.6 Care shall be taken that no segregation occurs due to placing concrete through reinforcing steel mats or grids. All surfaces of reinforcing bars, forms and embedded steel which have become encrusted with dried mortar or grout from concrete placed previously shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is poured.

.7 The temperature of concrete during the placing operation shall be within the limits specified in Cl. 3.7 - "Requirements for Cold and Hot Weather Concreting".

.8 Concrete shall not be placed during rain without adequate protection for the Work. The Contractor shall supply evaporation protection and shelter from rain for deck and other concrete that is required to be near horizontal finished surface pours.

.9 Measures shall be taken to minimize temperature rise in concrete pours. Thermocouples shall be placed to record the temperature rise in concrete pours.

.10 For concrete placed abutting or around mechanical and electrical apparatus or any part thereof, the Contractor shall place the reinforcement and concrete with special care to ensure that no damage occurs to the equipment, and that all voids are properly filled with concrete. The Contractor shall cooperate with the Engineer and the manufacturer installing the apparatus in such a manner that there will be no delay in placing the concrete after the apparatus or any part thereof has been placed in position.

.11 Secondary concrete under, around, above and behind, as the case may be, gate guides, turbine stay rings, draft tube liners and the like, shall be placed at a maximum rate of 1000 mm thickness per hour or as per manufacturer's guidelines and the basis of the form design when considering the forces from the liquid head of the concrete. The unbalanced loading due to concrete pressure heads shall not exceed 300 mm when casting these Items.

.12 In general, concreting shall be done in accordance with the alternate block principle.

.13 The height of horizontal concrete lifts will be as shown on the applicable Purchaser's Drawings and Contractor's Documents or as otherwise agreed upon by the Engineer and the Contractor. Horizontal lifts will in general not exceed 3 m in thickness. Shallow concrete lifts will be required in all non-reinforced concrete in the following cases, unless otherwise shown on the applicable Purchaser's Drawings and Contractor's Documents, or as directed by the Engineer.

.1 750 mm thick lifts shall be placed at the base of each block of a particular structure until at least 2/3 of the surface area of the rock is covered, but in any case, a minimum of two such lifts shall be placed. These two, or more, 750 mm lifts shall be then followed by one lift not thicker than 1,500 mm. The time interval between these lifts shall not be more than 14 days.

.2 When fresh concrete is placed on previously placed concrete between 15 and 30 days old, the first two lifts shall not be greater than 1,500 mm in thickness. The time interval between these lifts shall not be more than 14 days.

.3 When fresh concrete is placed on previously placed concrete which is more than 30 days old, two 750 mm thick lifts shall be placed followed by one lift not thicker than 1,500 mm. The time interval between these lifts shall not be more than 14 days.

.14 Unless otherwise directed by the Engineer or shown on the applicable Purchaser's Drawings and Contractor's Documents, the time between successive lifts, especially for mass concrete, shall generally not be less than 3 days after placing a 750 mm lift, 5 days after placing a 1,500 mm lift and seven days after placing a lift greater than 1,500 mm.

.15 Construction lift drawings are not yet available at the time of tender; the tender drawings included in the Technical Specification are intended to illustrate, in general, the degree and pattern of jointing which will be required.

.16 For any unreinforced face that will be left open for an extended period of time, a layer of temperature reinforcing shall be provided to prevent thermal cracking and shall be taken into consideration for undertaking the pour.

.17 The temperature of the intake headblock concrete shall be protected from falling below 5°C at any time until a minimum of two lifts have been placed and cured in accordance with these specifications. This is essential for crack control and is subject to Engineer's

review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.18 The semi-spiral case roof block and walls shall be cast in a manner that no two adjacent pours are performed simultaneously.

.19 The loading due to concrete pressures shall be balanced when casting concrete around the turbine pit liners. No direct loading from the upper cone concreting shall be placed on the turbine pit liner.

3.5 COMPACTION

.1 Concrete compaction shall be completed in accordance with CSA A23.1 and ACI 309R.

.2 Each layer or bucket of concrete shall be vibrated, rammed, tamped, or worked with suitable appliances until the concrete has been compacted to the maximum practicable density, is free of pockets, and is in complete contact with the forms, reinforcement and other materials embedded in the concrete.

.3 Normally, compaction shall be accomplished by the use of heavy-duty internal vibrators. The vibrators shall be sized as shown below with respect to the diameter of vibrator head.

.1 150 mm to 100 mm diameter for mass concrete.

.2 100 mm to 75 mm diameter for structural concrete (more than 1 m in width).

.3 75 mm to 50 mm diameter for structural concrete (less than 1 m in width).

.4 37 mm to 25 mm diameter for secondary concrete, such as at gate guides, etc.

.4 Vibrators with flexible operating handles shall be used for heavily reinforced concretes and for concrete in restricted forms. Extreme care shall be taken to ensure that the vibrators do not touch or disturb the reinforcement, embedded Items or forms.

.5 The speed of the vibrators shall not be less than 6,000 cycles per minute when immersed in concrete. The vibrators shall be operated in a near vertical position and the vibrating head shall be allowed to penetrate under the action of its own weight. In consolidating each layer of concrete, the vibrating head, shall be allowed to penetrate and revibrate the newly placed concrete into the upper portion of the underlying layers. The vibrating equipment shall at all times be adequate in number of units and power to properly consolidate all concrete as it is being placed, and shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.6 The vibrators shall be used systematically and at such intervals that the zones of influence overlap. A vibrator shall be operated at any point only until the concrete is properly compacted. Over-vibration, causing segregation or tending to bring an excessive amount of water to the surface, shall be avoided. Use of the vibrators to move the fresh concrete will not be permitted.

3.6 CONCRETE TEMPERATURE

.1 For mass concrete, the concrete temperature at the time of placing shall be as low as possible but not less than 5°C and shall not exceed 15°C under any condition and shall be measured at the pour. In no case shall the concrete temperature be greater than the limits given in CSA A23.1. The Contractor shall employ all necessary pre-cooling and/or post-cooling methods to ensure that the temperature limits are met. Adequate facilities shall be installed at the batching plant to control the temperature of the concrete as batched, to ensure that these limits are not exceeded. The Contractor shall not be entitled to additional compensation due to the foregoing requirements.

.2 Mix design, placement methods and curing requirements shall be suitably designed to limit temperature differentials to within 20°C as per CSA A23.1 requirements.

.3 The concrete temperature during placing shall be determined by placing a thermometer in the concrete immediately after sampling at the placement site. The temperature at the batch plant shall be adjusted as required to ensure that the specified concrete temperature is obtained at placement.

.4 Concrete shall be heated as necessary, but shall not be heated to a temperature higher than that necessary to keep the temperature of the concrete from falling below the specified minimum temperature. Methods of heating concrete shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.5 Temperature monitoring devices will be supplied, installed and monitored by the Contractor for quality control, and by the Engineer for quality assurance, during the placing operations to monitor the temperature of the concrete. Care shall be taken by the Contractor at all times to prevent damage to the monitoring device leads. All monitoring devices or leads damaged by the Contractor shall be replaced. A minimum of four temperature sensors per pour (2 near the centre of the pour and 2 near the edge of the pour) shall be placed in the pour at locations authorized by the Engineer. Additional sensors shall be provided as requested by the Engineer. The cost of the sensors shall be incidental to the Work set out in this Section of the Technical Specification.

.6 Maximum temperature of mass concrete shall be 50°C.

3.7 REQUIREMENTS FOR COLD AND HOT WEATHER CONCRETING

.1 The Contractor shall conform to CSA A23.1 for cold weather concreting when the air temperature is below 5°C or if the air temperature is likely to fall below 5°C during or immediately following the placement period. In cold weather, the Contractor shall provide suitable means for heating of mixing water and aggregates, install temporary enclosures for protection of concrete placing areas and provide all necessary insulation and/or heat to ensure against any possibility of damage to the concrete from freezing. The Contractor shall maintain the concrete in a moist condition for a minimum period of 7 days after the time of placement or to the strength required as deemed applicable by the Engineer . The curing period may have to be increased depending on the fly ash content and as per the requirements of the concrete mix designer. For a minimum of 3 days, or as required by the concrete mix designer, all concrete surfaces shall be maintained at a temperature of between 5°C and 25°C. Subsequently, the temperature of the moist concrete shall be maintained at a temperature above freezing for the remaining days of the curing period. Thereafter, the temperature of the air surrounding the concrete shall be allowed to fall at a rate of not more than 10°C every 24 hours until the surface temperature of the concrete equals to atmospheric temperature. The adequacy of the Contractor's methods in providing protection against winter/cold weather conditions shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Before depositing concrete in any form or on any concrete or rock surface, heat shall be applied in such a manner that snow or ice is completely removed and the air temperature immediately adjacent to the forms and/or concrete or rock faces is at or above 5°C.

.3 Where heat is employed, particularly in the case of forced hot air, special care shall be taken to ensure that hot air is not directed so as to cause rapid drying of the concrete. Combustion gases shall be vented to the outside of the heated area. Fuelling of fossil fuel

heaters used at temporary heating facilities for cold weather operations shall be performed outside of the pour locations. Suitable fire protection equipment shall be located, as required, at all heater locations. The Contractor shall adhere to the rules and regulations prescribed in the applicable Fire and Safety Standards and Clauses of the National Building Code and the National Fire Code.

.4 Salt, chemicals or other foreign materials shall not be mixed with the concrete for the purpose of preventing freezing. Salt or other chemicals shall not be applied to the finished surfaces to prevent the formation of ice.

.5 To avoid the possibility of premature stiffening of the fresh concrete when either the water or the aggregates are heated to a temperature in excess of 40°C, the water and aggregates shall come together first in the mixer in such a way that the temperature of the combination is reduced to below 40°C before the cement is added. Aggregates shall not be heated above 80°C and all lumps of frozen aggregates shall be excluded from the mix.

.6 Frozen concrete shall be replaced at contractor's expense to the satisfaction of the Engineer.

.7 In hot weather, the Contractor shall perform concreting operations in accordance with the CSA A23.1 and be prepared to adopt the following or any other effective means to ensure that the temperature of the concrete at the time of placing does not exceed 15°C.

.1 Coarse aggregate shall be cooled with water that has been cooled by refrigeration.

.2 Cooled coarse aggregate shall not be exposed to air temperature greater than 20°C on route to the batching plant and within the batching plant.

.3 Mixing water shall be effectively cooled by refrigeration.

.4 Flaked or crushed ice shall be substituted in whole or in part in place of the mix water.

.5 Mixing time and the time required to convey the concrete to the point of placement shall be kept to a minimum.

.6 Freshly placed concrete shall be protected from exposure to hot and/or dry weather conditions.

.8 The Contractor's heating and cooling equipment shall be adequately sized so that the temperature requirements can be met during all production periods. The Contractor's methods of producing and placing concretes that meet the temperature requirements set out in this Section of the Technical Specification shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.9 Equipment types and methods to be employed for all cold and hot weather concreting operations shall be submitted for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Heating and cooling systems for concrete production shall be ready for use on September 1 and June 1 respectively, for each construction season. The size of the refrigeration plants and boilers shall be compatible with the batch plant production.

3.8 ANCHORS AND EMBEDDED PARTS IN CONCRETE

.1 Anchors, anchor bolts, embedded parts, embedded pipe, embedded conduit, embedded grounding, structural shapes, plates, injectable tubing, and bearings required in connection with the installation of gates, gate hoists, valves, operating machinery, and other apparatus, shall be installed in the concrete by the Contractor as specified under the

applicable Sections of the Technical Specification and as shown on the applicable Purchaser's Drawings, Contractor's Documents and as directed by the Engineer. Wherever practicable, and as determined by the Engineer, anchors shall be installed before the concrete is placed. Except as specified, drilling into the concrete after the concrete is placed for the purpose of installing anchors will not be allowed unless permitted by the Engineer. Before being placed in position, all anchors and embedded parts shall be thoroughly cleaned of rust, grease, paint, splashed concrete, or other coatings that will reduce bond. Where the installation of the anchors before the concrete is placed is not practicable, as determined by the Engineer, formed openings shall be provided and the anchors shall be grouted into the openings at a later time and in a manner satisfactory to the Engineer.

.2 Stressing of post-tension bars, where required, shall not take place until concrete or grout has attained a minimum compressive strength of 25 MPa.

3.9 TOLERANCES

.1 Tolerances shall be according to Section 03 11 00 Concrete Formwork.

3.10 COMPLETION OF WORK

.1 All associated concrete Work, such as removal of forms and repair and finishing of concrete shall be completed as soon as practicable after the concrete is placed.

END OF SECTION

General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools except as provided herein, and performing all Work necessary for the finishing as well as patching and repair of concrete Work.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 21 00 - Reinforcing Steel.

.3 Section 03 30 00 - Cast-in-Place Concrete.

.4 Section 03 39 00 - Concrete Curing.

.5 Section 03 53 00 - Concrete Floor Toppings.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 Canadian Standards Association (CSA):

A23.1 - Concrete Materials and Methods of Concrete Construction.

.3 International Concrete Repair Institute (ICRI):

320.1 - Guideline for Selecting Application Methods for the Repair of Concrete Surfaces.

320.2 - Guide for Selecting and Specifying Materials for Repair of Concrete Surfaces.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding

unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 No separate measurement will be made for the Formed Finish Types F1 and F2 as defined in Paragraphs 3.2.2.1 and 3.2.2.2 of this Section.

.2 No separate measurement will be made for the Unformed Finish Types U1 and U2 as defined in Paragraphs 3.2.3.1 and 3.2.3.2 of this Section.

.3 Measurement for Items 03 35 00 (a) to 03 35 00 (d) shall be made in square metres made to the neat lines shown in the applicable Purchaser's Drawings, Contractor's Documents and as directed by the Engineer.

.4 No separate measurement or target price will be made for chamfering, patching and repair Work that is to be undertaken as specified herein and as directed by the Engineer.

.3 Unit Price

.1 The unit prices for Items 03 35 00 (a) to 03 35 00 (d) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for preparation, equipment, handling, finishing, curing and cleaning as specified herein, as shown on the Purchaser's Drawings and as follows;.

Item 03 35 00 (a) shall cover Type F3 finishing.

Item 03 35 00 (b) shall cover Type F4 finishing.

Item 03 35 00 (c) shall cover Type U3 finishing.

Item 03 35 00 (d) shall cover Type U4 finishing.

.2 Formed Finish Types F1 and F2 are considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices proposed for the Items to which this Work applies.

.3 Unformed Finish Types U1 and U2 are considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices proposed for the Items to which this Work applies.

1.5 SUBMITTALS

General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.1 Patching and Repair Procedure in accordance with Article 3.3 of Section 03 35 00 Concrete Finishing and Repair.

.2 Technical Data Sheets for any pre-packaged vendor supplied products shall be submitted to the Engineer for review prior to use.

.3 The Contractor shall submit a patching and repair procedure for review by the Engineer. This procedure shall identify the preparation, products, methodology and tolerances for patching and repair Work. The patching and repair procedure shall be in general compliance with good practice, CSA A23.1, ICRI 320.1 and 320.2, as well as the requirements in Article 3.3 of this Section.

1.6 DELIVERY, STORAGE AND HANDLING

Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage) of the General Specification.

.1 All vendor pre-packaged products shall be handled in strict accordance with the manufacturer's recommendations. Care shall be taken to ensure requirements relating to shelf life, storage temperature and protection from moisture are met.

.2 All non-vendor pre-packaged products shall be stored in accordance with CSA A23.1. The requirements shall be as specified in Section 03 30 00 Cast-In-Place Concrete. This includes storage on elevated platforms, under cover, and in a dry location. Cementitious materials which have become damp shall not be used.

.3 Aggregates shall be stored where grading and other required characteristics can be maintained and contamination avoided.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Cement, water and fine aggregate/sand shall be as per Section 03 30 00 Cast-In-Place Concrete.

.2 Vendor supplied pre-packaged products may be used, subject to the authorization of the Engineer.

2.2 MIXES

.1 Formed Finish Type F3 Sack Rub Mortar shall be as follows:

.1 The mortar shall consist of one part (by volume) of cement to two parts (by volume) of clean sand passing a 630 µm sieve, and enough water so that the mixed mortar shall have a consistency of thick paint. The mortar shall be pre-shrunk by mixing at least 1 hour before it is used and then remixed without the addition of water prior to use.

.2 The sand and cement shall be the same materials as those used in the concrete, except that it may be necessary to blend a white cement with the job cement to obtain a colour that will match the surrounding concrete surface.

.3 The mortar shall be mixed in a drum mixer when used in large quantities and a drill and paddle mixer when used in small quantities.

Part 3 Execution

3.1 PREPARATION

.1 Concrete surfaces in which concrete floor toppings shall be applied, shall be prepared as directed in Section 03 53 00 Concrete Floor Toppings.

.2 Where required, concrete surfaces shall be saturated with water as detailed herein.

3.2 CONCRETE FINISHING

.1 General

.1 The finishing of concrete surfaces shall be in accordance with CSA A23.1, and as detailed herein.

.2 During the course of construction, the Engineer will inform the Contractor, in writing, or on the applicable Purchaser's Drawings and Contractor's Document, what type of finish will be required in specific areas.

.3 Finishing shall only be performed by experienced and capable concrete finishers, capable of achieving the specified finish.

.4 Final finishing of unformed concrete surfaces shall commence after bleed water has disappeared and concrete is sufficiently stiff, in accordance with CSA A23.1.

.5 All external corners, where indicated by the Engineer, shall be chamfered by the use of moulding strips or finishing tools. All such chamfers shall be of the sizes shown on the Purchaser's Drawings and Contractor's Documents, or as authorized by the Engineer.

.6 Monolithically placed concrete floors shall be screeded and finished to such slopes as required on the Purchaser's Drawings and Contractor's Documents or as will provide floor surfaces which will properly drain to the nearest floor drain, as authorized by the Engineer.

.7 Before final approval of this aspect of the Work by the Engineer, the Contractor shall clean all exposed concrete surfaces of all encrustations of cement, mortar, or grout and shall remove unsightly stains. Concrete shall not be considered finished until all required repair Work and finishing has been completed.

.2 Formed Finishes

.1 Type F1: The finish shall apply to formed surfaces which are not exposed to view and where roughness is not objectionable, such as surfaces below ground or against which fill material, grout or concrete is to be placed, but not including surfaces to which damp-proofing is to be applied. Form tie rod ends on surfaces which will be in contact with fill material shall be protected from moisture if they will be below the water table or water line. Protection shall consist of recessing the tie rod ends and filling the recesses with dry pack or other accepted material. Form tie rod ends on surfaces which will be in contact with concrete or form tie rod ends on surfaces which will be in contact with fill material but will be above the maximum water table elevation may be cut off flush with the formed surfaces or may be recessed without filling.

Areas requiring this finish shall include the following and other areas as directed by the Engineer:

Tailrace - walls of the oil water seperator, walls of the tailrace piers not exposed to view.

Service bay - walls of the bulkhead gate storage slot in the service bay.

.2 Type F2: This finish shall apply to surfaces to which damp-proofing is to be applied and to all permanently exposed formed surfaces for which Type F3 or Type F4 finishes are not specified. The surfaces shall be smooth and dense, free from offsets, abrupt irregularities and other prominent surface blemishes. Surfaces shall be rubbed with carborundum brick or other abrasive until uniform texture is produced.

Areas requiring this finish shall include the following and other areas as directed by the Engineer:

Intake structure – Upstream face of the headblock, upstream faces of the intake hoist housing above elevation 161.5m, south transition and service bay end faces of the housing, downstream face of the intake structure exposed to the powerhouse generator floor.

Water passage faces of the intake structure only.

Powerhouse structure – Interior walls of the generator pit from the headcover to the steel enclosures, exterior walls of the generator pit, and upstream governor wall areas, south end wall (Unit 7) of the powerhouse, walls of the dewatering and drainage galleries.

Tailrace structure – Walls of the electrical and mechanical service and exposed interior faces of the draft tube gate gallery, downstream exterior face of the tailrace wall, exterior faces of the transformer deck and containment walls.

Service bay – Upstream, downstream face and other exterior exposed faces of the service bay gravity structure, all interior walls except for the lunch rooms and office rooms.

Transitions and walls – All exposed faces

All guides for gates, trashracks, bulkhead and stoplogs, including all pier noses.

All exposed columns, beams, and slab soffits.

.3 Type F3: This finish shall apply to formed surfaces prominently exposed to view and where an attractive appearance is paramount. Special care shall be taken to ensure that all forms are carefully erected and that form sheathing is so placed that joint marks on the concrete surface will be in alignment both horizontally and vertically and conform to a standard pattern. Finish tolerances shall be as contained in Paragraph 3.2.4 of this Technical Specification - Finish Tolerances. Following all required patching, cleaning and correction of major imperfections, the surfaces shall be sack-rubbed to fill all pits and voids in accordance with the following procedure:

Finishing mortar shall be as described in Article 2.2 of this Section - Mixes.

The concrete surfaces shall be thoroughly saturated with water and maintained wet for at least one hour before finishing operations are begun. All free water shall be removed prior to application of the finishing mortar.

The mortar shall be rubbed thoroughly over the prepared surfaces with clean burlap pads or other accepted methods so that all surface voids are filled. While the mortar is still plastic, the surfaces shall be sack-rubbed using a mixture of mortar of the same proportions as previously specified, except that no mixing water shall be used. The final rubbing shall be performed in such a manner that the filled voids are left flush with the surface of the surrounding concrete.

The finished surface shall be continuously moist cured for a minimum of 48 hours.

Areas requiring this finish shall be as noted in Paragraph 3.2.3 above and include the following and other areas as directed by the Engineer.

- Service bay - lunch room and locker rooms

.4 Type F4: This finish shall apply to formed surfaces where accurate alignment, density and evenness of surface are of vital importance for the prevention of the destructive effects of water action. Surfaces shall be rubbed smooth with carborundum brick or other abrasive as required. Poor joint areas and areas containing an excessive number of pits and air voids shall be sack-rubbed

following the procedure described in Paragraphs 3.2.3.1 to 3.2.3.4 above. Finish tolerances shall be as contained in Paragraph 3.2.4 of this Technical Specification - Finish Tolerances.

Areas requiring this finish shall be as noted in Paragraph 3.2.4 above and include the following and other areas as directed by the Engineer.

- Powerhouse and tailrace - water passage faces of the scrollcases, cones, draft tubes and tailrace extension that are exposed to flowing water.
- Spillway – Walls and pier noses of the spillway, and formed surfaces of the rollway.

.3 Unformed Finishes

.1 Type U1 (Screeded Finish): This finish shall apply to unformed surfaces that will be covered by fill material. Finish U1 is also used as the first stage of Finishes U2, U3 and U3. Finishing operations shall consist of sufficient levelling and screeding to produce even, uniform surfaces.

.2 Type U2 (Floated Finish): This finish shall apply to unformed surfaces not required to receive Finishes U3 and U4. Finish U2 shall be used as the second stage of Finishes U3 and U4. Floating may be performed by use of hand or power-driven equipment. Floating shall be started as soon as the screeded surface has stiffened sufficiently, and shall be the minimum necessary to produce a surface that is free from screed marks and uniform in texture. If Finish U3 or U4 is to be applied, floating shall be continued until a small amount of mortar without excess water is brought to the surface, so as to permit effective trowelling or brooming.

Areas requiring this finish shall include the following and other areas as directed by the Engineer.

- Curbs, trenches, elevator pits.

.3 Type U3 (Trowelled Finish): This finish shall be applied to unformed surfaces where accurate alignment and evenness of surface are required for prevention of the destructive effects of water action. Metal trowelling shall be started after bleed water has disappeared and the floated surface has hardened sufficiently to prevent excess fine material being drawn to the surface. Metal trowelling shall be performed to produce a dense, uniform surface, free from blemishes and trowel marks. The requirements for metal trowelling shall be considered by the concrete mix design. Finish tolerances shall be as contained in Paragraph 3.2.4 of this Technical Specification - Finish Tolerances.

Areas requiring this finish shall include the following and other areas as directed by the Engineer.

- Intake gate hoist housing.
- Electrical and mechanical service gallery, dewatering and drainage gallery.
- All floors of the service bay and control building, unless noted otherwise.
- Floor of the water passage in the intake, powerhouse and tailrace sections.
- Floors of the spillway.

.4 Type U4 (Broomed Finish): This finish shall apply to exterior slabs and other areas where a non-slip surface finish is required. This finish shall consist of Type U2 finish followed by brooming the surface, perpendicular to the direction of traffic, with a stiff bristled broom to obtain a uniform non-slip finish. Finish

tolerances shall be as contained in Paragraph 3.2.4 of this Section - Finish Tolerances.

Areas requiring this finish shall be as noted above and include the following and other areas as directed by the Engineer.

- Air entrained concrete slabs such as roadway decks, sidewalk, apron slabs.
- Scrollcase access area intake gate maintenance chamber, oil water seperator, tailrace deck, sump pits, and transformer containment chamber.
- Draft-tube gate gallery.
- Floor of the oil room.

.4 Finish Tolerances

.1 The surface of the spillway base slab and piers, the water surfaces of the draft tubes, and the surfaces of the semi-spiral case upper and lower cones, shall be chipped, ground and thoroughly cleaned where necessary, to provide smooth boundaries within the following limits:

Local protuberances or roughness of a height greater than 2 mm shall be reduced to 2 mm or less, without causing a gouge or hole.

All steps or abrupt changes in the surface, if not parallel to the direction of the flow, shall be completely reduced to a bevel of 1 to 25 ratio of height to length. If parallel to the direction of flow, only the excess over 5 mm need be removed to this bevel.

Gradual irregularities, such as bulges due to the bending of forms shall be reduced to 15 mm over a distance of 400 mm in the direction of flow.

.2 The surfaces of the water passages through the intakes and the floor, roof and walls of the semi-spiral cases shall be chipped, ground and thoroughly cleaned, where necessary, to provide smooth boundaries within the following limits:

Local protuberances or roughness of a height greater than 5 mm shall be reduced to 5 mm or less without causing a gouge or hole.

Steps or abrupt changes in the surface greater than 5 mm, if not parallel to the direction of the flow, shall have the excess over 5 mm reduced to a bevel of 1 to 12 ratio of the height to length. If parallel to the direction of flow, only the excess over 10 mm need be removed to this bevel.

.3 Type F3 Finish Tolerances surface irregularities shall not exceed 3 mm for abrupt irregularities and 15 mm for gradual irregularities.

.4 Floor finish tolerances shall meet the requirements of Table 22 Class B in CSA A23.1, unless noted otherwise on the applicable Purchaser's Drawings and Contractor's Documents or as authorized by the Engineer. Requirements for level may be waived as appropriate on floors which are sloped for drainage.

3.3 PATCHING AND REPAIRS

.1 In general, the following requirements shall be met:

.1 All holes left by the removal of ends of form rods, holes left by anchors or supports employed by the Contractor for its purposes, and all other holes shall be neatly filled with a patching product approved by the Engineer.

.2 All patches shall be neat and smooth and shall be as near as possible to the same colour and texture as the adjoining concrete. The patches shall be sound and free from shrinkage cracks and drummy sounding areas.

.3 All honeycombed areas and damaged concrete surfaces shall have concrete removed to sound concrete. The chipped openings shall be saw cut and keyed to dimensions authorized by the Engineer, and shall be filled to the required lines with fresh concrete or a patching product approved by the Engineer.

.4 Where concrete is used for filling, the chipped openings shall be not less than 75 mm in depth and the fresh concrete shall be reinforced and dowelled to the in-place concrete, or bonded with an accepted bonding compound.

.5 The patching material shall be prepared and placed in strict accordance with CSA A23.1, or the manufacturer's recommendations.

END OF SECTION

General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary for supplying, transporting, handling and applying floor hardener and/or concrete sealer, in or on concrete finished floors or concrete surfaces of the powerhouse, service bay, spillway and transitions as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 03 35 00 - Concrete Finishing and Repair.

.4 Section 03 53 00 - Concrete Floor Toppings.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Items 03 35 05 (a) and 03 35 05 (b) will be in square metres based on the area of floor to receive floor hardener or surface sealer, as shown on the Purchaser's Drawings, Contractor's Documents, as directed by the Engineer, or as herein provided.

.3 Unit Price

.1 The unit price proposed for Item 03 35 05 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for preparation of surface, supplying, transporting, handling, applying and curing of floor hardener as specified herein.

.2 The unit price proposed for Item 03 35 05 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for preparation, supplying, transporting, handling and applying of surface sealer as specified herein.

1.5 SUBMITTALS

General submittal requirements shall be in accordance with Section 21.7 Contractor's Document of the General Specification.

.1 Technical Data Sheets shall be submitted for all products to be used for Work pursuant to this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

Shall be in accordance the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.1 All materials shall be transported and stored in accordance with the manufacturer's instructions. Attention shall be paid to product shelf life, storage temperature and protection from moisture.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 The floor hardener shall be a premixed, natural emery aggregate surface hardener, such as EmeriCrete SH manufactured by Sika Canada Inc., or Purchaser's approved equivalent. The product shall be reviewed in conjunction with the concrete mix design and modifications, and if required, shall be brought to the attention of the Engineer for review.

.2 The liquid concrete acrylic emulsion, curing and sealing compound shall be Florseal WB 25 manufactured by Sika Canada Inc., or Purchaser's approved equivalent.

Part 3 Execution

3.1 PREPARATION

.1 All surfaces shall be prepared in accordance with the manufacturer's instructions.

3.2 APPLICATION

.1 All products shall be applied to the full extent of the areas identified in the Purchaser's Drawings and Contractor's Documents.

.2 EmeriCrete SH shall be applied for Heavy Duty use as detailed in the product manufacturer's instructions. EmeriCrete SH shall be applied in three shakes, the first application being 50% of the total and 25% in each of the subsequent applications. Each application shall be applied perpendicular to the previous application direction.

.3 The floor hardener and the curing and sealing compound shall be installed and cured in strict accordance with the product manufacturer's instructions and recommendations.

END OF SECTION

General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools except as provided herein, and performing all Work necessary for the curing of concrete as detailed in this Section.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 21 00 - Reinforcing Steel.

.3 Section 03 30 00 - Cast-In-Place Concrete.

.4 Section 03 53 00 - Concrete Floor Toppings.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all regulations applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 Canadian Standards Association (CSA):

A23.1 - Concrete Materials and Methods of Concrete Construction.

.3 American Society for Testing and Materials (ASTM):

ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete.

ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 The Work of this Section is considered incidental and no separate measurement or calculation of Target Prices shall be made. Include costs for the Work of this Section in the unit prices proposed for Items to which this Work applies.

1.5 SUBMITTALS

General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.1 The Contractor shall submit a procedure to the Engineer for curing concrete in accordance with the requirements of this Section.

.2 The Contactor shall submit the product data sheets to the Engineer for any products to be used in the curing process.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 All materials for use in curing shall meet the requirements of this specification.

.2 Type 1-D (with fugitive dye) non yellowing liquid membrane forming water-based curing compounds conforming to ASTM C309 and containing less than 20% solvents will be permitted on vertical finished surfaces where bond is not required for additional coverings or coatings.

.3 Curing materials shall meet the requirements of ASTM C171 or C309, as appropriate.

Part 3 Execution

3.1 CURING

.1 Curing shall be in accordance with CSA A23.1, except as modified herein or shown on the applicable Purchaser's Drawings and Contractor's Documents.

.2 Curing shall start as soon as possible following concrete placement without causing damage to the surface finish.

.3 All concrete and mortar surfaces shall be cured in accordance with:

.1 Mass concrete: Curing Type 3 - Extended Wet Curing as detailed in CSA A23.1.

.2 All other concrete: Curing Type 2 - Additional Curing as detailed in CSA A23.1.

.4 Exposed finished surfaces of concrete shall be protected from the direct rays of the sun for a minimum of 72 hours after the termination of concrete finishing.

.5 Temperature control of concrete during curing shall meet the requirements of CSA A23.1. Particular attention shall be paid to temperature differential between concrete surface temperature and ambient surface temperature as detailed in CSA A23.1. Care shall be taken to avoid thermal shock when introducing concrete elements to ambient temperatures at the termination of the curing process.

.6 Additional curing requirements may be necessary depending on the concrete mix, as directed by the concrete mix designers.

.7 All horizontal construction joints shall be kept continuously moist until they are covered with concrete. If it becomes necessary to delay the placement of new concrete upon or against a construction joint for an extended period, moist curing of the surface of the joint may be discontinued at the expiration of the regular prescribed curing period. If the moist curing is so discontinued, it shall be resumed not later than 24 hours prior to the placement of new concrete against the joint.

.8 Where chipped openings in concrete are not made until after the expiration of the regular prescribed curing period, the openings shall be kept continuously moist for at least 4 hours immediately prior to filling.

.9 Water curing shall be accomplished by continuously sprinkling or spraying with water, as may be necessary to keep the concrete from drying, or any other method authorized by the Engineer.

.10 Water curing shall be performed so as to prevent the formation of unsightly stains on concrete surfaces which will be permanently exposed.

.11 Where practicable, the use of suitable burlap for covering unformed finished concrete to act as a moisture retaining agent will be acceptable, provided that the burlap is maintained in a damp condition and will protect the concrete from drying during the prescribed curing period. The use of damp sand as a method of curing concrete will not be permitted.

.12 Requirements for hot and cold weather concreting, as well as control of heat of hydration, are detailed in Section 03 30 00 Cast-In-Place Concrete.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, materials, Plant, and Tools and performing all Work necessary, except as herein provided, for fabricating, supplying and installing precast Work as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, or as specified herein.

.2 This aspect of the Work shall include supplying all formwork, concrete and reinforcing steel necessary to cast the units, as well as loading, transporting, unloading, handling, installing and grouting the members and associated components. The Contractor shall also supply and install lifting lugs, shims, joint fillers, joint sealers and grout as required.

.3 The Contractor shall supply and install all metalwork and anchorage and related hardware required for fabrication of the precast concrete Work.

.4 Certain precast elements may be produced in the field, subject to prior authorization by the Engineer. In these instances, individual requirements for production of the elements, as detailed below, may be waived on a case by case basis subject to authorization by the Engineer.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 11 00 - Concrete Formwork.

.3 Section 03 15 19 - Embedded Anchors.

.4 Section 03 21 00 - Reinforcing Steel.

.5 Section 03 30 00 - Cast-In-Place Concrete.

.6 Section 03 35 00 - Concrete Finishing and Repair.

.7 Section 03 39 00 - Concrete Curing.

.8 Section 05 50 00 - Miscellaneous Metal.

.9 Section 07 91 26 - Joint Fillers.

.10 Section 07 92 00 - Joint Sealants.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 Canadian Standards Association (CSA):

.1 A23.1 - Concrete Materials and Methods of Concrete Construction.

.2 A23.2 - Test Methods and Standard Practices for Concrete.

.3 A23.3 - Design of Concrete Structures.

.4 A23.4 - Precast Concrete - Materials and Construction, including Appendices A and B.

.5 A3000 - Cementitious Materials Compendium.

.6 G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.7 G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.8 S6 - Canadian Highway Bridge Design Code.

.9 S16 - Design of Steel Structures.

.10 W47.1 - Certification of Companies for Fusion Welding of Steel.

.11 W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.12 W59 - Welded Steel Construction (Metal Arc Welding).

.13 W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.3 Canadian Precast/Prestressed Concrete Institute (CPCI):

.1 CPCI Design Manual.

.4 American Society for Testing and Materials (ASTM):

.1 A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.5 Precast Concrete Institute (PCI):

.1 MNL-116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

.2 MNL-117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be in accordance with the General Specification and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate multiplied corresponding by the unit price proposed for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section of the Technical Specifications shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Items 03 40 00 (a) to 03 40 00 (d) inclusive shall be made of the volume of concrete in precast work in cubic metres measured to the neat lines

as shown in the Purchaser's Drawings, Contractor's Documents and as directed by the Engineer.

.2 Measurement for Items 03 40 00 (e) to 03 40 00 (g) shall be the number shown on the Purchaser's Drawings, Contractor's Documents, and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 03 40 00 (a) to 03 40 00 (f) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for all formwork, concrete, reinforcing steel, embedded parts, grout, lifting lugs, shims, joint filler and joint sealer supplied, and all labour, materials and plant for casting, loading, transporting, unloading, handling, installing, post-tensioning precast concrete beams, traffic barriers, curbs and catch basins as specified herein and as follows:

.1 Item 03 40 00 (a) shall cover precast concrete beams in the Intake roof.

.2 Item 03 40 00 (b) shall cover precast concrete beams in the Draft Tube roof.

.3 Item 03 40 00 (c) shall cover precast concrete beams at the base of the downstream Tailrace wall.

.4 Item 03 40 00 (d) shall cover the precast concrete panels for Spillway Rollway blockout complete with post-tensioning.

.5 Item 03 40 00 (e) shall cover the precast concrete traffic barriers.

.6 Item 03 40 00 (f) shall cover the precast concrete curbs.

.7 Item 03 40 00 (g) shall cover the precast concrete catch basins.

1.5 CERTIFICATIONS

.1 Manufacturer of precast units shall be certified by the CPCI Certification Program, and a member in good standing of the CPCI.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 3.8 Submittals of the General Specification.

.2 The Contractor shall supply the Engineer with:

.1 Erection drawings for all precast units detailing unit location, as well as all information required to ensure the proper installation of the precast units. Information on location and extents of grouting, connection details and bearing pad details shall be clearly indicated as applicable. Drawings shall be sealed by a Professional Engineer registered in Manitoba.

.2 Shop drawings of all precast units which clearly identify member dimensions, as well as the location of all reinforcement, anchors, blockouts and other hardware and embedded items. Shop drawings shall be sealed by a Professional Engineer registered in Manitoba.

.3 Shop drawings showing the fabrication details for all reinforcing steel, anchors, hardware and other embedded items. Shop drawings shall be sealed by a Professional Engineer registered in Manitoba.

.4 Mill test certificates for reinforcing steel shall be provided, at the request of the Engineer, in accordance with CSA G30.18.

.5 Mill test certificates for all nuts, bolts and washers shall be provided, at the request of the Engineer, in accordance with ASTM 307, 325/325M or 490/490M, as appropriate.

.6 Results for concrete testing performed shall be provided, at the request of the Engineer, in accordance with CSA A23.1, A23.2 and A23.4. Included shall be compressive strength tests, slump tests, temperature tests and air entrainment records.

.7 Results for grout compressive strength testing performed shall be provided, at the request of the Engineer, in accordance with CSA A23.1, A23.2 and A23.4.

.8 Manufacturer of precast units' certification by the CPCI Certification Program.

.9 Certification to CSA W47.1 for all welders involved in the construction or installation of precast units.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Manufacturer of precast units shall be certified by the CPCI Certification Program.

.3 All welders, both during manufacturing and installation, shall be certified to CSA W47.1.

.4 All engineers involved in the design of the precast units shall be Professional Engineers registered in Manitoba.

.5 All testing facilities shall be qualified to perform the testing they are undertaking, and be authorized by the Engineer.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The handling and installation of the precast units shall be carried out in a careful manner to avoid damage to the precast units.

.3 Precast units shall be carefully stored in order to prevent damage. This shall include protecting all lifting devices from corrosion and ensuring all holes, blockouts and voids are protected from ice.

.4 Care shall be taken to avoid the chipping or spalling of precast members during transportation and erection.

.5 Any damage resulting from handling and storage shall be repaired by the Contractor.

Part 2 Products

2.1 DESIGN

.1 All components designed by the Manufacturer shall meet the requirements for structural design in Manitoba, as well as the requirements set out in this Section of the Technical Specification.

.2 All components designed by the Manufacturer shall be designed by a Professional Engineer registered in Manitoba. All drawings and calculations shall be sealed by said Professional Engineer.

.3 All precast units shall be designed for exposure to freeze/thaw conditions. Precast units shall be designed to accommodate all contraction and expansion associated with such conditions.

.4 Precast units shall be designed to ensure that maximum deflection requirements, as defined by the relevant codes and standards for the unit, are met.

.5 All precast units shall be designed to resist all loads applied during fabrication, transportation and erection.

2.2 MATERIALS

.1 Formwork

.1 All formwork shall be supplied, fabricated and erected in accordance with CSA A23.4.

.2 Reinforcing Steel

.1 All reinforcing steel shall be fabricated and placed in accordance with the applicable requirements of CSA A23.4 and Section 03 21 00 Reinforcing Steel.

.3 Cement, Aggregate, Water and Admixtures

.1 All cement, aggregate and water for concrete used in casting members shall be in accordance with the applicable requirements of CSA A23.4 and Section 03 30 00 Cast-In-Place Concrete.

.2 All admixtures for concrete used in casting members shall be in accordance with the applicable requirements of CSA A3000 Cementitious Materials Compendium and Section 03 30 00 Cast-In-Place Concrete.

.4 All miscellaneous metal and threaded inserts with bolts shall be installed in accordance with the applicable requirements of CSA A23.4, A231, Section 03 15 19 and Section 05 50 00 Miscellaneous Metal.

.5 Joint filler and sealer shall be applied in accordance with the applicable requirements of Section 07 91 26 Joint Fillers and Section 07 92 00 Joint Sealants.

2.3 CONCRETE MIX

.1 Concrete mix shall be as required for structural design, and as outlined in Section 03 30 00 Cast-In-Place Concrete for the concrete's location and function.

2.4 FABRICATION

.1 General

.1 Fabricate all precast units in accordance with Section CSA A23.1 and A23.4.

.2 Marking of Units

.1 Each unit shall be clearly labelled with the date of concrete casting as well as an identification mark to facilitate locating the unit on erection drawings.

.3 Reinforcement

.1 Reinforcement shall be placed in accordance with Section 03 21 00 Reinforcing Steel, CSA A23.1 and A23.4.

.2 All reinforcement shall be accurately located as shown on the applicable Purchaser's Drawings and Contractor's Documents and secured to prevent movement during the placement of concrete.

.3 Any welding of reinforcing steel required shall be performed to CSA W186.

.4 Formwork

.1 Formwork shall meet all requirements detailed in 03 11 00 Concrete Formwork, CSA A23.1 and A23.4, and be suitable to withstand all applied loads during casting.

.2 Care shall be taken that all embedded material and reinforcing is free of form oil or other deleterious material.

.5 Hardware and Miscellaneous Metal

.1 All hardware and embedded steel is to be accurately located as shown on the applicable Purchaser's Drawings and Contractor's Documents. This includes all lifting hooks and fittings required by the manufacturer for transportation and erection.

.2 Whenever welding is required, electric-arc welding methods shall be employed. All welding of steel shapes shall be performed to CSA W59 by certified welders.

.3 Welding electrodes shall conform to the latest edition of the CSA W48 for iron and steel arc-welding electrodes.

.4 Surfaces shall be finished in accordance with Section 05 50 00 Miscellaneous Metal.

.6 Concrete Placement

.1 Concrete shall be placed by qualified personnel following the requirements outlined in CSA A23.1 and A23.4.

.7 Concrete Finish

.1 The concrete finish shall be in accordance with Section 03 35 00 Concrete Finishing and Repair for a particular exposure and class, A23.4 and as shown on the Purchaser's Drawings and Contractor's Documents.

.2 Attention should be paid to surfaces which will be in contact with flowing water to ensure they are finished with Type F4 finish.

.8 Tolerances

.1 Fabrication tolerances shall be to CSA A23.4 or as detailed on the Purchaser's Drawings or Contractor's Documents, whichever requirement is the most stringent.

2.5 SOURCE QUALITY CONTROL

.1 The Contractor shall notify the Engineer when beginning or resuming this aspect of the Work under the Contract. The Contractor shall provide the services of a recognized testing agency, authorized by the Engineer, for the control of concrete quality in accordance with the Technical Specification. The Contractor shall sample in accordance with CSA A23.4 and A23.1, but may take not less than three cylinders from each pour for one 7-day break and two 28-day breaks. A slump and air test shall be obtained for each set of cylinders and the concrete temperatures shall be recorded.

.2 The Engineer may at his discretion, require the Contractor to perform other tests deemed necessary, at the expense of the Purchaser.

Part 3 Execution

3.1 PREPARATION

.1 Verify that erection area is suitable for erection prior to commencing this aspect of the Work. This includes verifying dimensions of support structure, precast members and anchors.

.2 Inspect precast members to ensure they are in suitable condition for erection, including inspection for damage to concrete, lifting points and anchorage points.

.3 Ensure all temporary bracing required during erection is available and suitable for use.

3.2 CONSTRUCTION AND INSTALLATION REQUIREMENTS

.1 Installation of the precast, prestressed members shall be in accordance with CSA A23.4 except as specified herein or shown on the Purchaser's Drawings and Contractor's Documents.

.2 All lifting of precast members shall be performed in a manner so as not to cause warping or damage to the precast units. Lifts shall be performed in strict accordance with relevant safe work procedures.

.3 All units shall be set within the required tolerances detailed on the Purchaser's Drawings, Contractor's Documents and CSA A23.4.

.4 Whenever welding is required, electric-arc welding methods shall be employed. All welding of steel shapes shall be performed to CSA W59 by certified welders.

.5 Welding electrodes shall conform to the latest edition of the CSA W48 for iron and steel arc-welding electrodes.

.6 Nuts, bolts, washers and other anchors shall be installed as shown on the Purchaser's Drawings, Contractor's Documents and in accordance with CSA S16.

.7 Place grout as indicated on the Purchaser's Drawings and Contractor's Documents and cure in accordance with CSA A23.1, or the recommendations of the grout manufacturer in the case of a manufactured product.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools except as herein provided, and performing all Work necessary for the detailed design, fabrication, deliveries, handling, assembling, installing in place to final locations and grouting of precast, prestressed concrete beams and appurtenances for the load center at spillway transition, spillway upstream and downstream bridges, tailrace electrical gallery, and precast forms as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein.

.2 The appurtenances to be supplied by the Contractor shall include bearing pads, anchor bolts, post-tensioning cables, and complete anchorage assembly for lateral stressing, grout and all other related Items required.

.3 The Contractor shall furnish all stressing chairs, a hollow hydraulic jack, complete with calibrated pressure gauge and any other Items necessary for performing lateral stressing as required or directed by the Engineer.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 21 00 - Reinforcing Steel.

.3 Section 03 35 00 - Concrete Finishing and Repair.

.4 Section 03 53 00 - Concrete Floor Toppings.

.5 Section 05 50 00 - Miscellaneous Metal.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada

.2 Canadian Standards Association (CSA):

.1 A23.1 - Concrete Materials and Methods of Concrete Construction.

.2 A23.2 - Test Methods and Standard Practices for Concrete.

.3 A23.3 - Design of Concrete Structures.

.4 A23.4 - Precast Concrete - Materials and Construction, including Appendices A and B.

.5 A3000 - Cementitious Materials Compendium.

.6 G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.7 G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.8 S6 - Canadian Highway Bridge Design Code.

.9 S16 - Design of Steel Structures.

.10 W47.1 - Certification of Companies for Fusion Welding of Steel.

.11 W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.12 W59 - Welded Steel Construction (Metal Arc Welding).

.13 W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.3 Canadian Precast/Prestressed Concrete Institute (CPCI):

.1 CPCI Design Manual.

.4 American Society for Testing and Materials (ASTM):

.1 A307 - Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 A416/A416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

.5 Precast Concrete Institute (PCI):

.1 MNL 116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor’s Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 03 41 33 (a) to 03 41 33 (d) inclusive shall be made in square metres measured to the neat lines as shown in the Purchaser’s Drawings, Contractor’s Documents and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 03 41 33 (a) to 03 41 33 (d) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the design, submittals, fabrication, delivery, off loading, storage, handling and installation of precast concrete beams and

girders, including all post-tensioning works complete with joint fillers, sealers, finishing and surface preparation, grouting and curing as specified herein, as shown on the Purchaser's Drawings, Contractor's Documents and as follows:

.1 Item 03 41 33 (a) shall cover the girders for the Spillway U/S and D/S Bridge Deck.

.2 Item 03 41 33 (b) shall cover the beams for the Tailrace Electrical Gallery.

.3 Item 03 41 33 (c) shall cover the beams for the Spillway Load Center Floor.

.4 Item 03 41 33 (d) shall cover the Precast Form beams for the Oil Water Separator.

1.5 CERTIFICATIONS

.1 The manufacturer of precast units shall be certified by the CPCI Certification Program, and a member in good standing of the CPCI.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 3.8 Submittals of the General Specification.

.2 The Contractor shall supply the Engineer with:

.1 Calculations detailing the structural design of the precast units sealed by a Professional Engineer registered in Manitoba. These calculations shall include design loads, deflections, cambers and bearing requirements. Prestressing calculations showing the required jacking pressure, including compensation for all losses occurring during stressing and release, shall be included.

.2 Erection drawings for all precast units detailing unit location, as well as all information required to ensure the proper installation of the precast units. Information on location and extents of grouting, connection details, bearing pad details and lateral post tensioning details shall be clearly indicated as applicable. Drawings shall be sealed by a Professional Engineer registered in Manitoba.

.3 Shop drawings of all precast units which clearly identify member dimensions, as well as the location of all reinforcement, tendons, anchors, blockouts and other hardware and embedded items. Shop Drawings shall be sealed by a Professional Engineer registered in Manitoba.

.4 Shop Drawings showing the fabrication details for all reinforcing steel, anchors, hardware and other embedded items. Shop Drawings shall be sealed by a Professional Engineer registered in Manitoba.

.5 Mill test certificates for reinforcing steel in accordance with CSA G30.18.

.6 Mill test certificates for prestressing steel in accordance with ASTM A416, as well as results for tests performed as per this Section.

.7 Mill test certificates for all nuts, bolts and washers in accordance with ASTM 307, 325/325M or 490/490M.

.8 Results for concrete testing performed in accordance with CSA A23.1, A23.2 and A23.4. Included shall be compressive strength tests, slump tests, temperature tests and air entrainment records.

.9 Results for grout compressive strength testing performed in accordance with CSA A23.1, A23.2 and A23.4.

.10 Stressing records in accordance with CSA A23.4 for both prestressing during manufacture of the precast units, as well as lateral post tensioning.

.11 Manufacturer of precast units' certification by the CPCI Certification Program.

.12 Certification to CSA W47.1 for all welders involved in the construction or installation of precast units.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Manufacturer of precast units shall be certified by the CPCI Certification Program.

.3 All welders, both during manufacturing and installation, shall be certified to CSA W47.1.

.4 All testing facilities shall be qualified to perform the testing they are undertaking, and be authorized by the Engineer.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The handling and installation of the precast units shall be carried out in a careful manner to avoid damage to the units. The manufacturer's recommendations for lifting and transportation of units shall be carefully followed.

.3 Precast units shall be stored in accordance with the manufacturer's recommendations. This shall include protecting all lifting devices from corrosion and ensuring all holes, blockouts and voids are protected from ice.

.4 Care shall be taken to avoid the chipping or spalling of precast members during transportation and erection.

.5 Any damage resulting from handling and storage shall be repaired.

Part 2 Products

2.1 PRECAST BEAM AND GIRDER DESIGN REQURIMENTS

.1 All components designed by the manufacturer shall meet the requirements for structural design in Manitoba, as well as the requirements detailed herein.

.2 The floor for the load centre at spillway transition shall be designed for a 25kPa uniform load.

.3 Structural design requirements for the spillway upstream and downstream bridges shall be based on CAN/CSA S6 - Canadian Highway Bridge Design Code, and shall consider loads from Project specific design vehicles.

.4 The floor of the electrical gallery shall be designed to carry a uniform load of 25 kPa and/or equipment loads such as storage tanks, circuit breakers, etc.

.5 All components designed by the manufacturer shall be designed by a Professional Engineer registered in Manitoba. All drawings and calculations shall be sealed by said Professional Engineer.

.6 All precast units shall be designed for their exposure to freeze/thaw conditions. Units shall be designed to accommodate all contraction and expansion associated with such conditions.

.7 Precast units shall be designed to ensure a maximum span deflection of span length/360.

.8 All precast units shall be designed to resist all loads applied during fabrication, transportation and erection.

.9 Design life of precast members is to be 60 years.

2.2 MATERIALS

.1 Formwork

.1 All formwork used in the fabrication of precast units shall meet the requirements of CSA A23.4.

.2 Prestressing Steel

.1 All prestressing steel shall be produced in accordance with ASTM A416/A416M, and meet the requirements of CSA A23.1 and A23.4.

.2 Prestressing tendons shall be 13 mm diameter, Grade 1,860 MPa, seven-wire, uncoated, low-relaxation strands. All prestressing steel shall be subject to review by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.3 Reinforcing Steel

.1 All reinforcing steel shall be deformed Grade 400 bars to CSA G30.18 and as detailed in Section 03 21 00 Reinforcing Steel.

.4 Cement and Admixtures

.1 All cement and included admixtures shall be in accordance with CSA A23.1, A23.2, A23.4 and A3000 (Compilation).

.5 Hardware and Miscellaneous Metal

.1 All miscellaneous metal shall be to CSA G40.21 Grade 300W or 350W, or Engineer's approved equivalent.

.2 Embedded insert for curbs, guardrails, bearing plates, grout tube assemblies, pipe assemblies, ducts, post tensioning assemblies, anchor bolts, drain pipes, and other miscellaneous metal and other parts shall be supplied and/or fabricated according to the Purchaser's Drawings and Contractor's Documents. Fabrication shall be performed in accordance with CSA Standard S6.

.3 All nuts, bolts and anchors shall be to ASTM 307, 325/325M or 490/490M and meet the requirements of Section 05 50 00 Miscellaneous Metal.

.6 Joint Filler and Sealers shall be as detailed in Section 07 91 26 Joint Fillers and Section 07 92 00 Joint Sealants, or Purchaser's approved equivalent.

2.3 CONCRETE MIX

.1 Concrete incorporated in the beams shall have the specified compressive strength of 35 MPa at 28 days based on standard cylinder tests, or as required for structural design and approved by the Engineer.

.2 For Spillway Deck: Exposure class of concrete shall be C-1 as defined in Table 1 of CSA A23.1, and shall meet all requirements for class C-1 exposure detailed in Table 2 of CSA A23.1.

.3 For Electrical Gallery: Exposure class of concrete shall be F-2 as defined in Table 1 of CSA A23.1, and shall meet all requirements for class F-2 exposure detailed in Table 2 of CSA A23.1.

.4 For the Spillway Load Centre: Exposure class of concrete shall be F-2 as defined in Table 1 of CSA A23.1, and shall meet all requirement for Class F-2 exposure detailed in Table 2 of CSA A23.1.

2.4 FABRICATION

.1 General

.1 Fabricate all precast units in accordance with CSA A23.4.

.2 Marking of Units

.1 Each unit shall be clearly labelled with the date of concrete casting as well as an identification mark to facilitate locating the unit on erection drawings.

.3 Reinforcement

.1 Reinforcement shall be placed in accordance with CSA A23.4.

.2 All reinforcement shall be accurately located as shown on Purchaser's Drawings and Contractor's Documents and secured to prevent movement during the placement of concrete.

.3 Any welding of reinforcing steel required shall be performed to CSA W186.

.4 Formwork

.1 Formwork shall meet all requirements detailed in CSA A23.4, and be suitable to withstand all applied loads during casting.

.2 Care shall be taken that all embedded material, reinforcing, and pre-stressing strands shall be free of form oil or other deleterious material.

.5 Hardware and Miscellaneous Metal

.1 All hardware and embedded steel is to be accurately located as shown on the Purchaser's Drawings and Contractor's Documents. This includes all lifting hooks and fittings required by the manufacturer for transportation and erection.

.2 Whenever welding is required, electric-arc welding methods shall be employed. All welding of steel shapes shall be performed to CSA W59 by certified welders.

.3 Welding electrodes shall conform to the latest edition of the CSA W48 for iron and steel arc-welding electrodes.

.4 Surfaces shall be finished in accordance with Section 09 90 00 Painting and Coating.

.6 Stressing of Tendons

.1 Stressing of tendons shall be performed in accordance with CSA A23.4.

.2 The Contractor shall produce records for prestressing as detailed in CSA A23.4. These records shall be submitted to the Engineer and will be reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.7 Concrete Placement

.1 Concrete shall be placed by qualified personnel following the requirements outlined in CSA A23.1 and A23.4.

.8 Concrete Finish

.1 The top of all precast members shall receive a broom finish, perpendicular to the flow of traffic. All other surfaces shall be smooth, sound, and free of honeycomb. Top surfaces of precast concrete members where concrete toppings and secondary curbs are to be placed shall be 'green cut', prepared as noted in Section 03 35 00 Concrete Finishing and Repair, in which the surface is brushed and/or blasted with high pressure water to expose the coarse aggregate. Care should be taken to ensure that the area of green cutting does not extend beyond the projected edge of curb.

.2 Immediately after the removal of the form, any defects in the concrete shall be brought to the attention of the Engineer. Repairs shall be done as specified herein or as directed by the Engineer. Cavities or holes caused by the removing of tie rods, provided they are not too large to cause rejection of the concrete, shall be carefully patched with a cement-sand mortar of the same quality and mix as used in the concrete, using aggregates that pass a 2.5 mm sieve.

.3 Honeycomb, if any, shall be repaired as soon as the forms are removed following notification of the Engineer. Aggregates that are loose or not thoroughly bonded to the surrounding concrete shall be removed and thereafter the sound concrete shall be washed with clean water. 100% solids epoxy bonding compound, accepted by the Engineer, shall be applied to the dried areas before application of cement and mortar. Patched areas shall be rubbed flush with the surrounding surfaces after the mortar has properly set.

.4 All projections, fins, offsets, streaks, or other subsurface imperfections that are objectionable in the opinion of the Engineer, shall be removed by accepted means to the satisfaction of the Engineer.

.5 If in the opinion of the Engineer, the concrete finish does not fulfill the requirements for sound concrete as described in the foregoing paragraphs, the Contractor shall:

.1 Entirely remove honeycomb area and replace with new concrete, or

.2 Rub-finish certain designated portions, or

.3 Replace the member, if in the opinion of the Engineer, the member has sufficient irreparable damage or defect.

.9 Tolerances

.1 Fabrication tolerances shall be to CSA A23.4 or as detailed on the Purchaser's Drawings or Contractor's Documents, whichever requirement is the most stringent.

2.5 SOURCE QUALITY CONTROL

.1 The Contractor shall notify the Engineer when beginning or resuming this aspect of the Work under the Contract. The Contractor shall provide the services of a recognized testing agency, authorized by the Engineer, for the control of concrete quality in accordance with the Technical Specification. The Contractor shall sample in accordance with CSA A23.4 and A23.1, but may take not less than three cylinders from each pour for

one 7 and two 28-day breaks. A slump and air test shall be obtained for each set of cylinders and the concrete temperatures shall be recorded.

.2 The Engineer may at his discretion, require the Contractor to perform other tests deemed necessary, at the expense of the Purchaser.

.3 The Contractor shall test for no less than three specimens from each shipment representing the strands used on the project. The results of these tests shall be supplied to the Engineer. The required tests are those defined in ASTM A416 as breaking strength, yield strength and elongation.

.4 The Contractor shall produce stressing records for pre-stressed tendons as detailed in CSA A23.4.

Part 3 Execution

3.1 PREPARATION

.1 Verify that erection area is suitable for erection prior to commencing this aspect of the Work. This includes verifying dimensions of support structure, precast members and anchors.

.2 Inspect precast members to ensure they are in suitable condition for erection, including inspection for damage to concrete, lifting points and anchorage points.

.3 Ensure all temporary bracing required during erection is available and suitable for use.

3.2 INSTALLATION

.1 Installation of the precast, pre-stressed members shall be in accordance with CSA A23.4 except as specified herein or shown on the Purchaser's Drawings and the Contractor's Documents.

.2 All lifts of precast members shall be performed in a manner so as not to cause warping or damage to the precast units. Lifts shall be performed in strict accordance with relevant safe work procedures.

.3 Install bearing pads as required by manufacturer and detailed on the Purchaser's Drawings and the Contractor's Documents.

.4 All units shall be set straight, level and plumb in the locations identified on the Purchaser's Drawings and Contractor's Documents and within the required tolerances detailed on the Purchaser's Drawings, Contractor's Documents and CSA A23.4.

.5 Whenever welding is required, electric-arc welding methods shall be employed. All welding of steel shapes shall be performed to CSA W59 by certified welders.

.6 Welding electrodes shall conform to the latest edition of the CSA W48 for iron and steel arc-welding electrodes.

.7 Nuts, bolts, washers and other anchors shall be installed as shown on the Purchaser's Drawings, Contractor's Documents and in accordance with CSA S16.

.8 Place grout as indicated on the Purchaser's Drawings, and Contractor's Documents and cure in accordance with CSA A23.1, or the recommendations of the grout manufacturer in the case of a manufactured product.

.9 All post-tensioning cables shall be installed, grouted and tensioned in accordance with details and procedures provided on the Purchaser's Drawings and Contractor's Documents.

.10 Stressing of post-tensioning tendons shall be performed in accordance with CSA A23.4.

.11 Curing shall be undertaken in accordance with the manufacturer's recommendations.

3.3 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 The Contractor shall produce stressing records for post-tensioned tendons as detailed in CSA A23.4.

.3 Compressive strength tests for any grouting shall be performed in accordance with CSA A23.1 and A23.2. Tests shall be performed for 7 day strength and 28 day strength.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools except as herein provided, and performing all Work necessary for the design, supply, transport, handling, assembly, install, and grouting and sealing, of insulated and non-insulated precast concrete wall panels as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein.

.2 This aspect of the Work shall include, but not be limited to the design, supply, delivery and installation of:

- .1 Precast concrete insulated wall panels.
- .2 Precast concrete non-insulated wall panels.
- .3 Sealing of all precast concrete wall panels inside where accessible and outside between precast panels and between precast and foundation walls.
- .4 Cast into precast work boxes/inserts/openings required by other trades.

.3 Supply components required for installation of bracing, supports, inserts and similar accessories required for this aspect of the Work under this Contract supplied and installed by others.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 21 00 - Reinforcing Steel.

.3 Section 03 35 00 - Concrete Finishing and Repair.

.4 Section 05 12 23 - Structural Steel.

.5 Section 05 50 00 - Miscellaneous Metal.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

- .1 National Building Code of Canada.
- .2 Canadian Standards Association (CSA):
  - .1 A23.1 - Concrete Materials and Methods of Concrete Construction.
  - .2 A23.2 - Test Methods and Standard Practices for Concrete.
  - .3 A23.3 - Design of Concrete Structures.
  - .4 A23.4 - Precast Concrete - Materials and Construction, including Appendices A and B.

.5 A3000 - Cementitious Materials Compendium.

.6 G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.7 G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.8 S16 - Design of Steel Structures.

.9 S850 - Design and Assessment of Buildings Subject to Blast Loads.

.10 W47.1 - Certification of Companies for Fusion Welding of Steel.

.11 W48 - Filler Metals and Allied Materials for Metal Arc Welding.

.12 W59 - Welded Steel Construction (Metal Arc Welding).

.13 W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.3 Canadian Precast/Prestressed Concrete Institute (CPCI):

.1 CPCI Design Manual.

.4 American Society for Testing and Materials (ASTM):

.1 A307 - Standard Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength.

.2 A416/A416M - Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.

.5 Precast Concrete Institute (PCI):

.1 MNL 116 - Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.

.2 MNL 117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 03 45 13 (a) and 03 45 13 (b) shall be in square metres made to the neat lines shown in the applicable Purchaser's Drawings, Contractor's Documents and as directed by the Engineer.

.3 Unit Price

.1 The unit prices for Items 03 45 13 (a) and 03 45 13 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for design, submittals, supplying, transporting, handling, storing, assembling, installing in place, grouting and sealing the precast concrete wall panels as specified herein and as shown on the applicable Purchaser's Drawings, Contractor's Documents and as follows;

.1 Item 03 45 13 (a) shall cover the insulated precast concrete wall panels for the powerhouse, service bay and control building.

.2 Item 03 45 13 (b) shall cover the non-insulated precast concrete wall panels for the powerhouse, service bay and control building.

1.5 CERTIFICATIONS

.1 Manufacturer of precast units shall be certified by the CPCI Certification Program, and be a member in good standing of the CPCI.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 The Contractor shall supply the Engineer with**:**

.1 Calculations detailing the structural design of the precast units sealed by a Professional Engineer registered in Manitoba. These calculations shall include design loads, deflections, cambers and bearing requirements. Prestressing calculations showing the required jacking pressure, including compensation for all losses occurring during stressing and release, shall be included.

.2 Erection drawings for all precast units detailing unit location, as well as all information required to ensure the proper installation of the precast units, including sealing and connection details. Drawings shall be sealed by a Professional Engineer registered in Manitoba.

.3 Drawings of all precast units which clearly identify member dimensions, as well as the location of all reinforcement, tendons, anchors, blockouts and other hardware and embedded items. Drawings shall be sealed by a Professional Engineer registered in Manitoba.

.4 Drawings showing the fabrication details for all reinforcing steel, anchors, hardware and other embedded items. Drawings shall be sealed by a Professional Engineer registered in Manitoba.

.5 Mill test certificates for reinforcing steel in accordance with CSA G30.18.

.6 Mill test certificates for prestressing steel in accordance with ASTM A416, as well as results for tests performed as per Section 03 41 33Precast Concrete Beams and Girders, Paragraph 2.5.3.

.7 Mill test certificates for all nuts, bolts and washers in accordance with ASTM 307, 325/325M or 490/490M.

.8 Results for concrete testing performed in accordance with CSA A23.1, A23.2 and A23.4. Included shall be compressive strength tests, slump tests, temperature tests and air entrainment records.

.9 Results for grout compressive strength testing performed in accordance with CSA A23.1, A23.2 and A23.4.

.10 Stressing records in accordance with CSA A23.4 for prestressing during manufacture of the precast units.

.11 Evidence of manufacturer of precast units' certification by the CPCI Certification Program.

.12 Certification to CSA W47.1 for all welders involved in the construction or installation of precast units.

.13 The Contractor shall provide samples of insulated precast panels for review by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Unless otherwise noted, the minimum sample size shall be 300 x 300 x 25 mm, with the exposed face finished as described under "finishes" elsewhere in this Section. All Work shall match the selected production run panel colour range.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Manufacturer of precast units shall be certified by the CPCI Certification Program.

.3 All welders, both during manufacturing and installation, shall be certified to CSA W47.1.

.4 All engineers involved in the design of the precast units shall be Professional Engineers registered in Manitoba.

.5 All testing facilities shall be qualified to perform the testing they are undertaking, and be authorized by the Engineer.

1.8 WARRANTY

.1 Shall be in accordance with Section 25 Warranty of the General Specification.

.2 The manufacturer of the precast units shall provide a standard warranty with a duration of 1 year from installation. The warranty shall be in writing and shall warrant materials and workmanship in accordance with Section 25 Warranty of the General Specifications to be free from defects for the period stipulated.

1.9 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The Contractor shall accept full responsibility for delivery, handling and storage of units and shall deliver, handle and store precast units in a near vertical plane at all times, and by methods accepted by the manufacturer. The Contractor shall not permit the precast concrete wall panels to contact earth or other staining influences, or to rest on corners of the panels.

.3 The handling and installation of the precast units shall be carried out in a careful manner to avoid damage to the units. The manufacturers recommendations for lifting and transportation of units shall be carefully followed.

.4 Precast units shall be stored in accordance with the manufacturers recommendations. This shall include protecting all lifting devices from corrosion and ensuring all holes, blockouts and voids are protected from ice.

.5 Care shall be taken to avoid the chipping or spalling of precast members during transportation and erection.

.6 Any damage resulting from handling and storage shall be repaired to the satisfaction of the Engineer.

Part 2 Products

2.1 DESIGN

.1 All components designed by the manufacturer shall meet the requirements for structural design in Manitoba. In addition to the design loads prescribed by the National Building Code of Canada, the insulated precast wall panels shall be designed to accommodate a project specific blast live load of minimum 5.0 kPa to withstand the effects of exploding transformer bushings or lightning arrestors.

.2 Insulated panels to provide an R20 wall assembly with a 2 hour Fire Rating.

.3 Design life of precast concrete wall panels is to be 60 years.

.4 All components designed by the manufacturer shall be designed by a Professional Engineer registered in Manitoba. All drawings and calculations shall be sealed by said Professional Engineer.

.5 The Contractor shall confirm all site dimensioning related to the construction of the cast-in-place concrete structures and the installation of the powerhouse structural steel and forward this information to the manufacturer prior to commencement of the precast Work.

.6 Requirements: The fabricator shall design and fabricate insulated and non-insulated panels, brackets and anchorage devices so that when installed they will:

.1 Compensate for allowable construction tolerances in structure to which they are secured.

.2 Tolerate structural deflection of span/360 due to live load and distortion of structure, without imposing load on panel assembly, minimize the bowing effects caused by temperature variations.

.3 Adequately sustain themselves, and superimposed wind, snow loads, without exceeding deflection of span/360.

.4 Accommodate details and embedments, as shown on the applicable Purchaser's Drawings and Contractor's Documents, as required by others.

.5 Permit no water infiltration into the building under design loads.

.6 Are structurally adequate around wall openings and blockouts.

.7 Panels to be non-composite to minimize thermal/bridge effects, as required to meet unsupported span requirements.

.8 All precast units shall be designed to resist all loads applied during fabrication, transportation and erection.

2.2 MATERIALS

.1 Formwork

.1 All formwork used in the fabrication of precast units shall meet the requirements of CSA A23.4.

.2 Prestressing Steel

.1 All prestressing steel used shall be produced in accordance with ASTM A416/ A416M, and meet the requirements of CSA A23.1 and A23.4.

.3 Reinforcing Steel

.1 All reinforcing steel shall be deformed Grade 400 bars to CSA G30.18 and as detailed in Section 03 21 00 Reinforcing Steel.

.4 Cement, Coloring and Admixtures

.1 All cement and included admixtures shall be in accordance with CSA A23.1, A23.2, A23.4 and A3000 (Compilation).

.2 Exposed aggregate, if required, to match selected finish sample.

.3 Use same brand and source of cement and aggregate for the Work to maximize the uniformity of coloration and other mix characteristics.

.5 Hardware and Miscellaneous Metal

.1 All miscellaneous metal shall be to CSA G40.21 Grade 300W or 350W, or Purchaser's approved equivalent.

.2 Embedded insert for curbs, guardrails, bearing plates, grout tube assemblies, pipe assemblies, ducts, post tensioning assemblies, anchor bolts, drain pipes, and other miscellaneous metal and other parts shall be supplied and/or fabricated according to the applicable Purchaser's Drawings and Contractor's Documents.

.3 All nuts, bolts and anchors shall be to ASTM 307, 325/325M or 490/490M and meet the requirements of Section 05 50 00 Miscellaneous Metal.

.6 Welding materials to CSA W47.1 and CSA W186.

.7 Steel primer to CGSB 1-GP-40M.

.8 Bearing Pads to be Neoprene, Hardness Durometer No. 60 to ASTM D2240.

.9 Zinc-rich primer to CGSB 1-GP-181M.

.10 Insulation shall be extruded and expanded polystyrene to CAN/ULC S701-97.

2.3 CONCRETE MIXES

.1 Unless otherwise noted or specified, use concrete mix designed to produce a minimum of 35 MPa compressive cylinder strength at 28 days, with a maximum water/cement ratio to CSA A23.4.

.2 Use white or grey cement in facing matrix.

.3 Use of calcium chloride is not permitted.

2.4 FABRICATION

.1 General

.1 Fabricate all precast units in accordance with CSA A23.4.

.2 Marking of Units

.1 Each unit shall be clearly labelled with the date of concrete casting as well as an identification mark to facilitate locating the unit on erection drawings.

.3 Reinforcement

.1 Reinforcement shall be placed in accordance with CSA A23.4.

.2 All reinforcement shall be accurately located as shown on the applicable Purchaser's Drawings and Contractor's Documents and secured to prevent movement during the placement of concrete.

.3 Any welding of reinforcing steel required shall be performed to CSA W186.

.4 Formwork

.1 Formwork shall meet all requirements detailed in CSA A23.4, and be suitable to withstand all applied loads during casting.

.2 Care shall be taken that all embedded material, reinforcing, and pre-stressing strands shall be free of form oil or other deleterious material.

.5 Hardware and Miscellaneous Metal

.1 All hardware and embedded steel is to be accurately located as shown on the applicable Purchaser' Drawings and Contractor's Documents. This includes all lifting hooks and fittings required by the manufacturer for transportation and erection.

.2 Whenever welding is required, electric-arc welding methods shall be employed. All welding of steel shapes shall be performed to CSA W59 by certified welders.

.3 Welding electrodes shall conform to the latest edition of the CSA W48 for iron and steel arc-welding electrodes.

.4 Surfaces shall be finished in accordance with Section 09 90 00 Painting and Coating.

.5 Anchors, lifting hooks, shear bars, spacers and other inserts or fittings required shall be as recommended and/or designed by manufacturer for a complete and rigid installation. Each shall conform to requirements of local building by-laws. Lift hooks shall be adequately sized to safely handle panels according to panel dimension and weight. Anchors/inserts shall be concealed where practical.

.6 Burn off exposed lift cables paint and fill in if required.

.6 Stressing of Tendons

.1 Stressing of tendons, if used, shall be performed in accordance with CSA A23.4.

.2 The Contractor shall produce records for prestressing as detailing CSA A23.4. These records shall be submitted to the Engineer.

.7 Concrete Placement

.1 Concrete shall be placed by qualified personnel following the requirements outlined in CSA A23.1 and A23.4.

.8 Finishing

.1 Ensure that surfaces to receive sealant are smooth and free of laitance to provide a suitable base for adhesion. Ensure that release agents do not deleteriously affect the sealing of the joints.

.2 Finish and colour of precast units to match sample in the Engineer's office.

.3 Interior panel finish to be smooth steel trowel or smooth form finish.

.9 Tolerances

.1 Fabrication tolerances shall be to CSA A23.4 or as detailed on the applicable Purchaser's Drawings and Contractor's Documents, whichever requirement is the most stringent.

Part 3 Execution

3.1 PREPARATION

.1 Verify that erection area is suitable for erection prior to commencing this aspect of the Work. This includes verifying dimensions of support structure, precast members and anchors.

.2 Inspect precast members to ensure they are in suitable condition for erection, including inspection for damage to concrete, lifting points and anchorage points.

.3 Ensure all temporary bracing required during erection is available and suitable for use.

3.2 INSTALLATION

.1 Erect precast Work in accordance with CSA-A23.4.

.2 Supply anchors for precast units required to be attached to the powerhouse superstructure steel or cast into the concrete curb to Contractor for installation. Provide such items in ample time to meet construction program. Supply layout drawings locating accurately the position of all cast in items to be installed in accordance with other Sections of the Technical Specification.

.3 Set precast concrete units, straight, level and square.

.4 Non-cumulative Erection Tolerances as per CSA A23.4:

.1 Joint dimension.

.2 Joint taper.

.3 Edge alignment.

.4 Faces of adjacent panels.

.5 Bowed panels.

.5 Fasten units in place as per connection detail shop drawings. Protect Work from damage by weld splatter.

.6 Clean field welds with wire brush and touch up with Galvafroid paint or zinc rich primer.

.7 Remove temporary shims and spacers from joints of non-load bearing panels after fastening but before sealant is applied.

.8 Apply sealant and joint backing to exterior and interior joints to provide a complete weathertight installation. All exterior joints are to be vented.

3.3 CLEANING

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 If required, Contactor shall clean exposed face work by washing and brushing only, as precast is erected. Use accepted masonry cleaner if washing and brushing fails to achieve required finish. Remove immediately materials which set up or harden.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Material, Plant, and Tools except as herein provided, and performing all Work necessary for supplying, transporting, placing, finishing and curing of concrete floor topping as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 03 35 00 - Concrete Finishing and Repair.

.4 Section 03 35 05 - Floor Hardener/Surface Sealer.

.5 Section 03 39 00 - Concrete Curing.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 Canadian Standards Association:

.1 CSA A23.1 - Concrete Materials and Methods of Concrete Construction.

.2 CSA A23.2 - Methods of Test for Concrete.

.3 CSA A23.3 - Design of Concrete Structures.

.4 CSA A3000 - Cementitious Materials Compendium.

.3 International Concrete Repair Institute.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

.2 Measurement

.1 Measurement for Items 03 53 00 (a) and 03 53 00 (b) shall be in square metres made to the neat lines shown in the Purchaser's Drawings, Contractor's Documents and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 03 53 00 (a) and 03 53 00 (b) in the Bill of Quantities, Unit Price and Target Price Estimate set out in the Contractor's Submission shall be for supplying transporting, surface preparation, placing, finishing and curing concrete including separator strips/angles complete with anchors and the application of bonding agent that is accepted by the Engineer as specified herein, as shown on the Purchaser's Drawings and Contractor's Documents and as follows:

.1 Item 03 53 00 (a) shall cover 50 mm nominal thickness floor toppings.

.2 Item 03 53 00 (b) shall cover 100 mm nominal thickness floor toppings.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submissions for Work to be performed pursuant to this Section shall be in accordance with Section 03 30 00 Cast-In-Place Concrete.

.3 Results for concrete testing performed in accordance with CSA A23.1, A23.2 and A23.4 shall be provided to the Engineer. Included shall be compressive strength tests, slump tests, temperature tests and air entrainment records.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13Project Quality Management of the General Specification.

.2 All performance and quality assurance requirements detailed in Section 03 30 00 Cast-In-Place Concrete shall be met.

.3 All concrete finishing shall be carried out by experienced concrete finishers.

.4 All testing facilities shall be qualified to perform the testing they are undertaking, and be authorized by the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 All products required for this aspect of the Work shall be stored in accordance with CSA A23.1. The requirements set out in Section 03 30 00 Cast-In-Place Concrete shall be met.

Part 2 Products

2.1 GENERAL

.1 Concrete for floor toppings shall be normal density proportioned in accordance with CSA A23.1 to provide a minimum 28 day compressive strength of 35 MPa. The approximate cementitious content of the mix shall be 325 kg/m^3.

Part 3 Execution

3.1 PREPARATION

.1 The contractor shall obtain authorization for all materials, Plant and methods from the Engineer in advance of performing this aspect of the Work.

.2 The Contractor shall remove all laitance, dirt, dust, debris grease or other substances that would interfere with the bond between the base slab and the topping. Final cleanup of the base slab shall be performed as close as practicable to the time of placing of the topping. The slab surface shall be roughened using a "scabbler", 100 MPa (15,000 psi) water blast or "shot blaster" to achieve a CSP 5 profile (International Concrete Repair Institute), followed by cleaning and flushing with water. Care shall be taken to prevent traffic on areas that have been cleaned. The surface of the base slab shall be kept continuously wet for at least 24 hours prior to placing the floor topping. Pools of water shall be removed from the surface of the base slab prior to placing the concrete floor topping.

3.2 INSTALLATION

.1 The topping shall nominally be 50 mm or 100 mm in thickness, dependent on location. The minimum acceptable thicknesses shall be 45 mm and 90 mm respectively. The Contractor shall perform all necessary grinding or chipping of the base slab to obtain the minimum thickness.

.2 A thin coat of neat water/cement grout, mixed to cream-like consistency (maximum water/ cement ratio of 0.5) shall be broomed into the surface of the base slab for a short distance ahead of the placement of the topping. Bonding agents may be used in lieu of the grout when authorized by the Engineer.

.3 Concrete floor toppings shall be finished in accordance with Section 03 35 00 Concrete Finishing and Repair to the finish types indicated on the Purchaser's Drawings and Contractor's Documents.

.4 Tooling of edges and joints shall be performed in areas designated on the Purchaser's Drawings and Contractor's Documents.

.5 The floor topping shall be cured in accordance with Section 03 39 00 Concrete Curing. Membrane curing compounds will not be permitted for curing of the floor topping due to application of floor hardeners and coatings.

3.3 FIELD QUALITY CONTROL

.1 The requirements shall be in accordance with Section 7.13 Project Quality Management of the General Specification.

.2 All quality control requirements identified in Section 03 30 00 Cast-In-Place Concrete shall apply to this Section. This includes the appropriate testing for temperature, air entrainment and compressive strength.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary to pressure grout around the turbine stay ring, bottom ring, and draft tube liner, and to place grout under or around equipment bases and parts, draft tube crane rails, including the supply, cutting and installation of wire mesh reinforcing.

.2 The grout requirements for foundation and structure grouting shall be as per Section 31 81 00 Foundation Grouting.

.3 The grout requirements for structural steel grouting shall be as per Section 05 12 23 Structural Steel.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 21 00 - Reinforcing Steel.

.3 Section 03 30 00 - Cast-In-Place Concrete.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 Canadian Standards Association (CSA):

.1 A23.1 - Concrete Materials and Methods of Concrete Construction.

.2 A23.2 - Methods of Test for Concrete.

.3 A3000 - Cementitious Materials Compendium.

.3 American Standards for Testing Materials (ASTM):

.1 ASTM C1107 - Standard Specification for Packaged Dry, Hydraulic Cement Grout (Nonshrink).

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's

Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 No separate measurement shall be made for grout pads required for equipment supplied and installed or installed by the Contractor.

.2 Measurement for Item 03 60 00 (a) will be in litres and shall be based on the actual amount of grout injected in the field for Bulkhead Doors, Turbine Embedded parts - Draft-tube Liners, the Stay Rings, and the bottom rings as specified herein and as directed by the Engineer.

.3 Unit Price

.1 The unit price proposed for Item 03 60 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply, mixing, injecting and cleanup of grout that may be required for the Steel Bulkhead Doors, Turbine Embedded Parts - Draft tube liners, the Stay Rings, and the bottom rings and as directed by the Engineer. The price shall include all necessary equipment, testing, and submittal of grouting results associated with this Work.

.2 The supply and installation of grout pads for equipment supplied and installed or installed by the Contractor is considered incidental to the Work. Include costs for such Work in the unit prices proposed for the Items to which this Work applies.

.3 The supply and installation for Draft Tube crane rail Work is considered incidental to the Rail Work Section 41 22 13. Include costs for such Work in the unit prices proposed for the Items to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor’s Documents of the General Specification.

.2 Independent test data that certifies compliance of grout requirements for all non pre-packaged grouts.

.3 Product data sheets for accepted pre-packaged supplied products.

.4 Results for grout compressive strength testing performed in accordance with CSA A23.1 and A23.2.

.5 Grouting methodology shall be submitted to the Engineer for review and authorization.

.6 Pressure grouting records acceptable to the Engineer shall be submitted to the Engineer for review in accordance with Section for all pressure grouting Work.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 All testing facilities shall be qualified to perform the testing they are undertaking, and be authorized by the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 All pre-packaged grouting products shall be handled in strict accordance with the manufacturers recommendations. Care shall be taken to ensure requirements relating to shelf life, storage temperature and protection from moisture are met.

.3 All non pre-packaged products shall be stored in accordance with CSA A23.1. The requirements shall be as specified in Section 03 30 00 Cast-In-Place Concrete. This includes storage on elevated platforms, under cover, and in a dry location. Cementitious materials which have become damp shall not be used.

.4 Aggregates shall be stored where grading and other required characteristics can be maintained and contamination avoided.

Part 2 Products

2.1 MATERIALS

.1 Non-shrink grout for flowable and fluid applications shall be Sika 212 HP, or Purchaser's approved equivalent, unless indicated otherwise on the Purchaser's Drawings and Contractor's Documents.

.2 Non-shrink grout for dry pack applications shall be Sika M-bed Standard, or Purchaser's approved equivalent, unless indicated otherwise on the Purchaser's Drawings and Contractor's Documents.

.3 The grout required for steel bulkhead doors and the embedded turbine parts shall be a non-shrink mixture of cement, admixtures and water, and, if required by the Engineer, sand shall be used. The proportions, ingredients and consistency of the grout shall be designed to suit the construction methodology and be authorized by the Engineer. The required strength of the grout mix shall be a minimum of 25 MPa at 28 days.

.4 Cement, fine aggregate and water used for grouting shall conform to the requirements for those materials as specified under Section 03 30 00 Cast-In-Place Concrete. Cement used for grouting shall be supplied in bags by the Contractor, as specified in Section 03 30 00 Cast-In-Place Concrete.

2.2 ACCESSORIES

.1 The equipment for pressure grouting the embedded parts of the turbine shall include the use of a colloidal mixer complete with baffles, paddles and agitators, appropriate for the application and mixed in accordance with the manufacturer's instructions. The equipment shall be capable of mixing and stirring the grout and injecting it continuously and without interruption. The equipment shall be so arranged as to provide a continuous circulation of the grout through the system and permit accurate pressure control,

regardless of the volume of flow. A reliable pressure gauge shall be connected to the system at the grout connection to indicate grout injection pressure.

Part 3 Execution

3.1 INSTALLATION

.1 General

.1 The Contractor shall adhere to the requirements of CAN/CSA A23.1 and to the grout manufacturer's recommendations regarding handling, mixing, preparing, placing, finishing, and curing of the grout.

.2 The surfaces receiving grout shall be cleaned of all debris and prepared to receive grout in accordance with the manufacturer's instructions. This may include the following, as detailed by the grout manufacturer:

.1 The Contractor shall chip away defective concrete and laitance and bush hammer, leaving surface reasonably rough but level. The Contractor shall clean the surface of dirt and loose particles.

.2 The Contractor shall remove oil and grease with caustic solution and rinse the area thoroughly with water. The Contractor shall blow out bolt hole pockets and other recesses using clean, dry, compressed air. The Contractor shall protect anchor bolt threads from corrosion and fouling with grout.

.3 The Contractor shall wet foundations and bases with clean water for at least 24 hours before grouting to prevent rapid drying out and to ensure easy flow of grout. The Contractor shall remove excess water before placing grout and ensure bolt pockets and recesses are free of water.

.3 After equipment crane rails, or base plate has been placed, aligned, levelled and shimmed, and the anchor rods positioned where necessary, the Contractor shall install formwork to contain the grout.

.4 The Contractor shall mount the formwork securely to prevent movement during placing and curing of grout.

.5 The Contractor shall allow adequate clearance between formwork and equipment or base plate, as detailed on the Purchaser's Drawings and Contractor's Documents and meeting the requirements of the grout manufacturer.

.6 The Contractor shall ensure that grout is placed in a manner that results in complete contact between the grout, the substrate and the equipment or baseplate. Attention shall be paid to the prevention of any air pockets or void spaces.

.7 The Contractor shall protect finished surfaces and equipment from grouting materials. The Contractor shall prevent splatter or splash.

.8 The Contractor shall not mix more grout at one time than can be placed in a period of 30 minutes or as per manufacturer's recommendations.

.9 The Contractor shall place the grout quickly and continuously to avoid overworking, segregation, bleeding, and disturbance of initial set. The Contractor shall place from one side only where practicable.

.10 The Contractor shall fill and crown exposed areas to provide drainage and to eliminate depressions where liquid or dust could accumulate. The Contractor shall not extend grout up the sides of equipment or base plate.

.11 During curing, the Contractor shall protect the grout from vibrations or from operating equipment.

.12 The Contractor shall maintain temperature of the grout in place for a time period in accordance with the manufacturer's instructions.

.2 Bulkhead Doors, Turbine - Draft Tube Liner, Stay Ring, and Bottom Ring Embedded Parts Grouting

.1 The grout shall be injected into the spaces between the concrete and the stay ring and bottom ring embedments through pressure grout holes not less than 25mm in diameter provided in the lower shroud ring.

.2 If required, grout ports shall be installed and grout work undertaken and ports plugged and ground flush to the requirements of the Engineer.

.3 Grout shall be injected into the space between the concrete and the steel bulkhead doors providing access to semi-spiral case, intake gate maintenance chamber.

.4 Low pressure grouting of the turbine embedded parts may be done by pumping or by gravity feed. Grout pressure shall not exceed 210 kPa unless otherwise directed by the Engineer. Grouting shall not be undertaken until the temperature of the secondary concrete is within 5°C of the temperature of the primary concrete.

.5 The Contractor shall take care to minimize dust, debris, etc., created during grouting operations and prevent such materials from fouling or coating the turbine and equipment parts.

3.2 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Compressive strength tests for any grouting shall be performed in accordance with CSA A23.1 and A23.2. Tests shall be performed for 3 day strength and 28 day strength. The unconfined compressive strength used in equipment grouting shall equal or exceed the compressive strengths on the manufacturer's data sheets for tests at 3 days and 28 days.

.3 Tests shall be undertaken for every 15 bags of pre-mixed grout employed. A minimum of three sets of gang cube molds shall be taken per sampling.

.4 The grout shall not stiffen rapidly and shall maintain a flowable consistency for at least 20 minutes when batched at a temperature of 23 ±2ºC.

.5 For all pressure grouting, as a minimum, the volume of grout injected, location and injection pressure, shall be recorded. A sample grouting record may be found in CSA A23.1 Annex G.

.6 Sounding test shall be undertaken to map the void locations between the draft tube liner and the secondary concrete works. A report shall be submitted to the Engineer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, materials, Plant, and Tools except as herein provided, and performing all Work necessary including, supplying, transporting, unloading, handling and erecting all 100 mm, 150 mm and 200 mm concrete block walls, some with 2 hour fire rating and installing joint fillers and sealers as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein. This aspect of the Work shall also include supplying and mixing of mortar, heating requirements as necessary, supplying and installing reinforcing, anchors, and construction of reinforced concrete-filled cores and lintels and perimeter bond beams.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification set out below.

.2 Section 03 21 00 - Reinforcing Steel.

.3 Section 08 11 00 - Metal Doors and Frames.

.4 Section 07 91 26 - Joint Fillers.

.5 Section 07 92 00 - Joint Sealers.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Building Code of Canada.

.2 Canadian Standards Association:

.1 CSA A23.1/A23.1 - Concrete Materials and Methods of Concrete Construction/Methods of Test and Standard Practices for Concrete.

.2 CSA A165 Series - CSA Standards on Concrete Masonry Units.

.3 CSA A179 - Mortar and Grout for Masonry.

.4 CSA A370 - Connectors for Masonry.

.5 CSA A371 - Masonry Construction for Buildings.

.6 CSA G30.14 - Deformed Steel Wire for Concrete Reinforcement.

.7 CSA G30.18 - Carbon Steel Bars for Concrete Reinforcement.

.8 CSA G30.3 - Cold-Drawn Steel Wire for Concrete Reinforcement.

.9 CSA G40.21 - Structural Quality Steel.

.10 CSA S304.1 - Design of Masonry Structures.

.11 CSA W186 - Welding of Reinforcing Bars in Reinforced Concrete Construction.

.3 American Society of Testing and Materials (ASTM):

.1 ASTM C90 - Loadbearing Concrete Masonry Units.

.2 ASTM C207 - Hydrated Lime for Masonry Purposes.

.4 International Concrete Repair Institute.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Items 04 22 00 (a) to 04 22 00 (d) shall be in square metres made to the neat lines shown in the drawings and as directed by the Engineer.

.1 For the purpose of measurement, openings in the walls greater than 0.25 m^2 will be deducted from the measured quantity.

.3 Unit Price

.1 The unit prices proposed for Items 04 22 00 (a) to 04 22 00 (d) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply, transporting, unloading, handling and erecting concrete unit masonry walls complete with control joints, rebar and wire type reinforcing, grout, joint fillers and sealers associated to the Masonry Work, as shown on the drawings and as follows;

.1 Item 04 22 00 (a) shall cover 100 mm thick concrete unit masonry walls.

.2 Item 04 22 00 (b) shall cover 150 mm thick concrete unit masonry walls.

.3 Item 04 22 00 (c) shall cover 200 mm thick concrete unit masonry walls.

.4 Item 04 22 00 (d) shall cover 200 mm thick concrete unit masonry walls constructed to a 2 hour fire resistance rating.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor’s Documents of the General Specification.

.2 The Contractor may submit to the Engineer alternatives to the details shown on the Purchaser’s Drawings for review.

.3 Masonry connectors, joints or other components that are not detailed on the Purchaser's Drawings shall be designed by the Contractor and submitted to the Engineer for authorization to proceed with this aspect of the Work. Design shall be based on the limit states design method in accordance with CSA S304.1. Design of masonry connectors shall be in accordance with CSA A370. Masonry block wall connectors and components shall be designed to resist all forces and moments specified on the Purchaser's Drawings and Contractor's Documents.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

.3 Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 All products required for this aspect of the Work shall be stored in accordance with CSA A371.

.3 Masonry units shall be stored on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

.4 Concrete masonry units shall be protected from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.

.5 Cementitious materials shall be stored on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

.6 Aggregates shall be stored where grading and other required characteristics can be maintained and contamination avoided.

.7 Masonry accessories, including metal items, shall be stored in such a way as to prevent corrosion and accumulation of dirt and oil.

Part 2 Products

2.1 MATERIALS

.1 Standard concrete block units shall be supplied to CSA A165.1 Classification: H/15/C/M, or SS/15/C/M, or SF/15/C/M or as shown on the applicable Purchaser's Drawings and Contractor's Documents. The minimum concrete block strength requirement for wall forming the elevator shaft shall be 20 MPa.

.2 Concrete block shall be uniform in colour and texture for all exposed Work.

.3 The Contractor shall provide purpose-made shapes for lintels and bond beams, encasement of steel column or members and additional special shapes as indicated with a minimum required strength of 15 MPa.

.4 Mortar for all concrete blockwalls shall be Type S in accordance with CSA A179, "Mortar and Grout for Unit Masonry". All aggregate shall pass 1.25 mm sieve where 6 mm thick joints are indicated.

.5 Mortar materials shall be measured by weight or by volume, and the methods of measurement shall be such that the proportions can be controlled to an accuracy of 2%.

.6 Grout for filling core, cell or cavity space shall conform to the requirements given in CSA A179 and shall have a minimum strength of 25 MPa. Water for mortars shall be clean and free from oils, acids, alkalies, organic matter or other deleterious materials and shall be in accordance to CSA A23.1.

.7 Bar Reinforcement shall be: to CSA A371Masonry Construction for Buildings and CAN/CSA G30.18 Carbon Steel Bars for Concrete Reinforcement, Grade 400 for bars 10M and larger.

.8 Horizontal Joint (wire type) Reinforcement shall be: to CSA A371and CSA G30.3 Cold-Drawn Steel Wire for Concrete Reinforcement, ladder type. 9-gauge wire hot-dipped galvanized to CSA S304.1. Acceptable products are "Hohmann & Barnard" or Purchaser's approved equivalent.

.9 Connectors shall comply with CAN/CSA A370 and CSA S304.1 standards and shall include anchors, fasteners, ties, joint reinforcements used as a continuous tie, mesh pads and grout filled cores as shown on the Purchaser's Drawings and Contractor's Documents.

.10 Structural quality steel reinforcement for masonry shall comply with CAN/CSA-G40.21. Angle lintels shall be constructed of primed structural steel angles and detailed as on the Purchaser's Drawings and Contractor's Documents.

2.2 FABRICATION

.1 Reinforcing steel shall be fabricated in accordance with CSA A23.1.

.2 Connectors shall be designed and installed in accordance with CAN/CSA A370.

.3 The Contractor shall obtain the Engineer review for changing the location of reinforcement splice for those shown on drawings.

.4 The Contractor shall obtain the Engineer review before welding reinforcing and reinforcing shall be in accordance with CSA W186.

.5 Reinforcement and connectors shall be clearly identified for shipping and installation.

Part 3 Execution

3.1 EXAMINATION

.1 The Contractor shall thoroughly examine other aspects of the Work upon with the Work pursuant to this Section is dependent. The Contractor shall report deficiencies to the Engineer. Commencement of the Work pursuant to this Section shall imply acceptance of the existing conditions.

3.2 INSTALLATION

.1 Masonry construction shall be in accordance to CSA A371standard.

.2 Masonry and other Work shall be protected from marking and other damage. Completed Work shall be protected from mortar droppings using non-staining coverings.

.3 Mortar shall be mixed in a mechanical batch mortar mixer. A continuous mortar mixer will not be permitted. Hand mixing may be permitted by the Engineer, provided that the quantities of materials and water are accurately controlled and that the mixing shall be done on a board or other firm and clean platform.

.4 Mixing time for a mechanical mixer shall be not less than 3 minutes after all materials are in the drum. Hand mixing shall be continued until the mortar is completely and uniformly mixed.

.5 Temporary bracing of masonry Work shall be provided during and after erection until permanent lateral support is in place.

.6 Masonry shall be built plumb, level, and true to line, with the vertical joints in alignment. The Contractor shall layout coursing and bond to achieve correct coursing heights and continuity of bond above and below openings, with a minimum of cutting. All block shall be laid in running bond pattern. The coursing height shall consist of 200 mm and include one block and one mortar joint.

.7 Openings for electrical switches, outlet boxes, and other recessed or built-in objects shall be provided as required. Cuts shall be made straight, clean, and free from uneven edges and shall be grouted.

.8 Masonry lintels and bond beams shall be installed and reinforced as indicated and lintel/ bond beam shall be filled with concrete grout as specified.

.9 Vertical control joints shall be made at all locations shown on the Purchaser's Drawings and Contractor's Documents and filled with PVC joint filler. Continuous vertical control joints shall be installed as detailed complete with foam backer rods and sealant on each side of wall.

.10 Anchors, reinforcing ties, door and opening frames and lintels shall be securely built into block walls at the locations shown on the Purchaser's Drawings and Contractor's Documents. Metal anchors shall be installed as indicated.

.11 Walls shall be built up in a uniform manner, with no portion being raised more than 1 m above adjacent portions except with the review of the Engineer.

.12 Finished floors under block walls shall be prepared by bush hammering to a concrete surface profile (CSP) 5, as indicated by the International Concrete Repair Institute (ICRI).

.13 Masonry Work shall be uniform in color and texture for all exposed Work.

.14 At a minimum, all walls, end cores, corner cores, and cores adjacent to wall openings shall be grouted full height with 1 - 15M bar per core or as noted on the Purchaser's Drawings and Contractor's Documents. Additional reinforcing/grouting shall be as noted on the Purchaser's Drawings and Contractor's Documents.

3.3 HORIZONTAL JOINT REINFORCING

.1 Horizontal joint reinforcing shall be placed as specified at 400 mm o/c (every second mortar joint), top joint, first and second joint above lintels, joints below openings. The

reinforcing shall be set in bedding layer of mortar and covered with equal layer of mortar to provide normal mortar joint height. Reinforcing shall be laid in the middle of the face shell mortar to provide sufficient cover from surface of tooled joint face.

.2 Ladder reinforcing rungs, shall be overlapped 150 mm minimum. Reinforcing laps in subsequent courses shall be staggered. Reinforcement shall stop 25 mm short of each side of control joints unless otherwise indicated.

.3 Reinforcing below an opening shall extend 600 mm beyond the jamb of the opening. All other reinforcing shall be continuous, prefab tees and corners shall lap a minimum 150 mm with joint reinforcing.

3.4 PROTECTION AGAINST FREEZING

.1 Weather protection shall be in accordance with CSA A371.

.2 Concrete blocks shall not be laid when the temperature of the surrounding atmosphere is below 4°C, unless adequate protection is provided. At temperatures below 4°C, adequate equipment shall also be provided for heating the mortar materials.

.3 Mortar containing foreign matter or ice shall not be used. Temperatures of the mortar materials, including mixing water when placed in the mixer, shall not exceed 60°C. At the time of application, mortar shall have a temperature between 10°C and 32°C.

.4 During construction, all block walls shall be fully protected against freezing by a weathertight covering to prevent accumulation of ice on the masonry. When it is necessary to remove frost or excess moisture, the blocks shall be heated.

.5 All finished Work pursuant to this Section shall be protected against freezing for a period of not less than 48 hours by means of enclosures, portable heating appliances, or such protective methods as are authorized by the Engineer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary for supplying, loading, transporting, unloading, clean up, handling and installing drill-in-place adhesive and expansion type anchor bolts, as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein. It shall also include the drilling and cleaning of holes in concrete and concrete block for the setting of expansion-type anchor bolts.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 04 22 00 - Concrete Unit Masonry.

1.3 REFERENCES

.1 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

1.4 MEASUREMENT AND PAYMENT PROCEDURES

.1 The Work of this Section is considered incidental and no separate measurement or calculation of Target Prices shall be made. Include costs for the Work of this Section in the unit prices proposed for Items to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 3.8 Submittals of the General Specification.

.2 Technical Data Sheets for all products to be used in the performance of this aspect of the Work shall be submitted to the Engineer for review prior to use.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 All Materials shall be transported and stored in accordance with the manufacturer's instructions. Attention shall be paid to product shelf life, storage temperature and protection from moisture.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 The Contractor shall supply adhesive and expansion type anchor bolts for miscellaneous fastening applications, specified as follows.

.1 For exterior applications or applications where vibratory or reverse loading can occur, “Hilti HIT RE 500 Epoxy Adhesive Anchor System”, or as identified on the Purchaser’s Drawings and Contractor’s Documents.

.2 For interior applications, “Hilti HSL Heavy Duty Expansion Anchor”, or as identified on the Purchaser’s Drawings and Contractor’s Documents.

.3 For interior applications, “Hilti Kwik Bolt 3 (KB3) Expansion Anchor”, or as identified on the Purchaser’s Drawings and Contractor’s Documents.

.4 For masonry applications, “Hilti HIT-HY 20 Masonry Adhesive Anchor”, or as identified on the Purchaser’s Drawings and Contractor’s Documents.

.5 Material for the anchors shall be as specified on the Purchaser’s Drawings. In general, AISI 316 Stainless Steel anchors shall be used for all exterior applications and zones of high humidity unless otherwise specified on the Purchaser’s Drawings and Contractor’s Documents.

Part 3 Execution

3.1 INSTALLATION

.1 Holes shall be drilled strictly in accordance with the size and depth specified by the manufacturer for the particular anchor bolt to be used.

.2 Care shall be taken to prevent damage to the concrete or concrete block. To ensure as little damage as possible, the Contractor shall use a rotary impact hammer drill, carbide-tipped masonry drill bits, or equipment otherwise specified by the manufacturer. All damage to concrete and concrete block shall be repaired by the Contractor.

.3 Unless otherwise specified, do not drill holes in concrete or masonry units until concrete, mortar, or grout has achieved full design strength.

3.2 TENSIONING OR CURING

.1 All anchors shall be installed and cured as per the recommendations of the manufacturer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour and Materials, except as herein provided, and performing all Work necessary for supplying, fabricating, loading, transporting, unloading, handling, erecting, post-tensioning and where required -fireproofing the structural steel and steel decking, and circuit breaker platforms for the powerhouse, service bay, control building, spillway load centre and intake hoist housing buildings as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein.

.2 The Contractor shall supply and incorporate into this aspect of the Work, design and fabrication of all structural steel member connections including splices in accordance with CSA-S16.

.3 All crane supporting members including the crane runway beams (superstructure of the powerhouse complex) shall be supplied, fabricated, and installed to the tolerances of the Crane Manufacturers Association of America, CMAA #70 - Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 45 13 - Precast Wall Panels.

.3 Section 05 31 23- Steel Decking.

.4 Section 05 50 00 - Miscellaneous Metal.

.5 Section 09 90 00 - Painting and Coatings.

.6 Section 41 22 13 - Crane Rails.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with

.1 Standards of Canadian Standards Association:

.1 CSA-S16 - Limit States Design of Steel Structures.

.2 CSA G40.20 - General Requirements for Rolled or Welded Structural Quality Steel.

.3 CSA G40.21 - Structural Quality Steel.

.4 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.

.5 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.6 CSA S136 - Cold Formed Steel Structural Members.

.7 CSA B167-08 - Overhead Travelling Cranes - Design, Inspection, Testing, Maintenance, and Safe Operation.

.2 Standards and Specifications of the American Society for Testing and Materials

.1 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.2 ASTM A90/A90M - Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

.3 ASTM A123/A123M - Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

.4 ASTM A193/A193M - Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.

.5 ASTM A230/A239M - Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.

.6 ASTM A307 - Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.7 ASTM A325M - Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength (Metric).

.8 ASTM A394 - Steel Transmission Tower Bolts, Zinc-Coated and Bare.

.9 ASTM F436M - Hardened Steel Washers (Metric).

.10 ASTM A653/A653M - Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.11 ASTM A467/A467M - Machine and Coil Chain.

.12 ASTM A490 - Structural Bolts, Alloy Steel, Heat Treated, 150ksi Minimum Tensile Strength.

.13 ASTM A490M - High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints [Metric].

.14 ASTM A500/A500M - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

.15 ASTM A501 - Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.

.16 ASTM A722/A722M - Uncoated High-Strength Steel Bars for Prestressing Concrete.

.17 ASTM F1554 - Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

.3 CMAA Specifications

.1 CMAA No. 70 - Specifications for Top Running Bridge & Gantry Type Multiple Girder Electric Overhead Traveling Cranes.

.4 Canadian Institute of Steel Construction

.1 Crane-Supporting Steel Structures: Design Guide.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Items 05 12 23 (a) to 05 12 23 (d), 05 12 23 (f) and 05 12 23 (h) shall be in kilograms based on the weights shown on the Purchaser's Drawing, Contractor's Documents and as directed by the Engineer.

.2 Measurement for Item 05 12 23 (e) shall be in metres based on the length of runway beam indicated on the Purchaser's Drawings, Contractor's Document and as directed by the Engineer.

.3 Measurement for Item 05 12 23 (g) shall be square metres based on the (soffit) plan area of the steel and metal decking that is to be fire proofed.

.3 Unit Price

.1 The unit price for Item 05 12 23 (a) to 05 12 23 (d) inclusive and 05 12 23 (f) in the Bill Of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for connection design, submittals, supplying, fabricating, loading, transporting, unloading, handling, installation, anchoring, grouting, post-tensioning, painting and touch-up of structural steel as specified herein for the powerhouse, service bay, control building, intake hoist housing and monorail hoist support structure(s), and generator circuit breaker platforms.

.1 Item 05 12 23 (a) shall cover Light weight structural steel < 24.9 kg/m

.2 Item 05 12 23 (b) shall cover Medium weight structural steel that is greater than 25 kg/m and less than 124.9 kg/m

.3 Item 05 12 23 (c) shall cover Heavy weight structural steel that is greater than 125 kg/m

.4 Item 05 12 23 (d) shall cover all shop fabricated beams and columns such as Welded Wide Flange Sections.

.5 Item 05 12 23 (f) shall cover crane rail stops (install only).

.2 The unit price for Item 05 12 23 (e) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for connection design, supplying, fabricating, loading, transporting, unloading, handling and installation of the crane runway beams, inclusive of the crane rails, Gantrex clamps and associated accessories and hardware required for the powerhouse overhead crane in the powerhouse complex to CMAA requirements as specified herein.

.3 The unit price for Item 05 12 23 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for

preparation, fire-proofing and the associated Work for structural steel and metal decking.

.4 The unit price proposed for Item 05 12 23 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for preparation, and galvanizing of structural steel as specified herein.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Prior to fabrication, the Contractor shall submit the description of all Work to be fabricated or repaired and the appropriate weld procedures. These procedures shall be accepted and stamped by the Canadian Welding Bureau as per CSA Standard W47.1.

.3 The Contractor, upon request by the Engineer, shall submit calculations for connection design of the structural steel Work.

.4 The Contractor shall submit a plan indicating the method for post-tensioning of the column anchor bolts and the method for measurement of applied tensile force. Proof of calibration of the stressing jack shall be submitted to the Engineer.

.5 Shop Drawings

.1 All shop drawings shall be prepared in the system of units corresponding to the Purchaser's Drawings.

.2 Unless otherwise specified, the Contractor shall prepare all fabrication and erection documents required to carry out this aspect of the Work. The Contractor's Documents such as assembly details, shop drawings, erection procedures as well as erection drawings shall be submitted to the Engineer for review.

.3 Shop drawings shall show all the fabrication details for each part that makes up the structure, such as cuts, notches, connections, drillings including fall arrest tie-off points, welds, sizes of members and connections and identification of parts. In addition, the shop drawings shall present the bill of materials indicating the number and weight of each element, including the bolts and total weight of each structure delivered in only one assembly.

.4 All shop drawings shall be stamped by an Engineer who is a member in good standing of the Association of Professional Engineers and Geoscientists of Manitoba, (APEGM).

.5 The Contractor shall not commence the fabrication of structural steel before the shop drawings have been reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.6 All reviews by the Engineer are for the sole purpose of ascertaining conformances with the general design concept and do not relieve the Contractor of any responsibilities as to dimensioning, detailing or fabrication.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 All parts shall have at least the weight due to their drawing dimensions, and shall be built in accordance with reviewed drawings only.

.3 Materials and workmanship not conforming to the above standards may be rejected by the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The Contractor shall exercise care in storing, handling and erecting all structural and miscellaneous metalwork delivered to the Site and shall properly support it at all times so that no piece will be bent or twisted or stored in contact with the ground or in such a manner as to hold water, or be otherwise damaged. Damaged material shall be replaced or repaired by Contractor to the satisfaction of the Engineer.

.3 The Contractor shall store steel on heavy timbers, clear of the ground, contaminants and muddy areas.

.4 The Contractor shall store bolts, other fastenings and welding materials in their original containers in storage sheds.

.5 The Contractor shall keep welding electrodes in a warm and dry storage area in their sealed protective coatings until required for the Work. The Contractor shall protect electrodes in opened containers from moisture.

.6 The Contractor shall employ hoisting equipment of adequate capacity and provide proper support for sections during handling and delivery.

.7 The Contractor shall prevent impact to members being handled and swung into position.

Part 2 Products

2.1 MATERIALS

.1 All materials supplied by the Contractor for the permanent Work shall be new and shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Except as otherwise specified or shown on the Purchaser's Drawings and Contractor's Documents or otherwise authorized by the Engineer, materials shall conform to the following specifications.

.1 Structural steel shapes and bars - CSA G40.21 - 350W.

.2 Structural steel angles and channels - CSA G40.21 - 300W.

.3 Structural steel plates - CSA G40.21 - 350W.

.4 Structural steel (hollow structural sections) - CSA G40.21 - 350W.

.5 Floor plates - CSA G40.21.

.6 Steel pipe - ASTM A53/A53M

.1 Standard - Schedule 40.

.2 Extra strong - Schedule 80.

.7 Welding materials - CSA W48.1 to W48.6.

.8 Arc welding electrodes - E49XX.

.9 Bolts, nuts and washers

.1 High strength - ASTM A325M or ASTM A490.

.2 Stainless steel - ASTM A193/A193M.

.3 Standard strength - ASTM A307 Grade A or B.

.4 Washers, hardened - ASTM F436M.

.5 Bevelled washers - Malleable iron or steel.

.6 High strength anchor bolts, nuts and washers - ASTM F1554.

.10 Drill-in-place anchor bolts - see specification Section 05 05 19.

.3 Unless otherwise specified herein or shown on the Purchaser's Drawings and Contractor's Documents, all exposed fastenings shall be of the same material, colour and finish as the metal to which they are attached.

.4 Grout for base plates and bearing plates shall be a non-shrink cementitious grout. Sika Grout 212 HP or Purchaser's approved equivalent.

.5 All screws, bolts and nuts shall be of Canadian Standard sizes and shall have Canadian Standard form of threads in accordance with ASME Standard B1.1. All bolts used for field assembly of structural joints and connections shall be of a high strength steel, except as otherwise noted on the Purchaser's Drawings, Contractor's Documents or as specified herein.

.6 Design Requirements

.1 Design is based on the limit states design method in accordance with CSA S16.

.2 In case of discrepancy between the Purchaser's Drawings, Contractor's Documents and this Section of the Technical Specification, the discrepancy shall be brought to the attention of the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.7 Connections

.1 Connections that are not detailed on the Purchaser's Drawings shall be designed by the Contractor and submitted to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Connections shall be designed and detailed in accordance with the requirements of CSA S16 to resist forces, moments, and shears as specified on the Purchaser's Drawings and Contractor's Document.

.3 Connections shall be designed to a common Work point unless noted otherwise, such that no eccentric loads will be introduced into loaded members.

.4 Spliced structural members to be connected in the field shall be match marked in the shop and each connecting member shall be clearly marked to correspond with the erection marks shown on the erection drawings.

.5 Grounding tabs suitable for the connection of two-hole NEMA pad compression connectors shall be provided at all bolted splice locations in addition to the locations shown on the Purchaser's Drawings and Contractor's Documents.

.6 End plate (shop welded) or double angle header connections (shop bolted or shop welded) shall be used for all simply supported beam connections unless otherwise noted.

.7 Moment connections shall be provided where shown on the Purchaser's Drawings and Contractor's Documents.

.8 Connection angles and end plates with lengths of not less than one half of the depth of the connected member shall be used.

.9 All beams shall be connected with at least two rows of bolts. Use a minimum of two bolts.

.10 Unless shown otherwise on the Purchaser's Drawings and Contractor's Documents, all bolts shall be 19 mm diameter, high strength bolts.

.11 Shear beam connections shall be designed to resist the greater of the following two conditions:

.1 50% of the member's shearing strength.

.2 100% of reactions in the case where they are indicated on the Purchaser's Drawings and Contractor's Documents.

.12 Bolted or welded connections of continuous and/or fixed beams as well as moment connections shall be designed for the combined action of reactions, moments, and axial forces indicated on the Purchaser's Drawings and Contractor's Documents. When reactions are not shown on the Purchaser's Drawings and Contractor's Documents, the connections shall be designed for loads equal to 100% of the bending and shear capacity of the smaller member of the two larger members in the connection.

.13 Connections for tension and/or compression members shall be designed to resist the greater of the following two conditions:

.1 50% of the gross area tensile strength of the member.

.2 100% of the reactions indicated on the Purchaser's Drawings and Contractor's Documents.

.14 Connections for hollow tubular sections (HSS) shall be designed for the loads indicated on the Purchaser's Drawings and Contractor's Documents and shall be continuous welds.

.15 Bolting through HSS is not allowed.

.16 All plates and/or gussets used for connections shall have a thickness equal to or greater than 10 mm.

.17 All cross bracings shall be joined mid-span. In addition, the spacer plates between the double angles shall be spaced such that the "kl/r" ratio of one angle between the spacers is less than the "kl/r" ratio of the double angles acting together. The maximum spacing shall be 1,200 mm.

.18 Bearing type bolted connections shall be used except at joints where slippage cannot be tolerated and where shown on the Purchaser's Drawings and Contractor's Documents, e.g., connections subjected to excessive vibrations, fatigue, or frequent load reversal, crane runway beams and hoist beams. Slip critical bolted connections shall be used at these locations.

.19 Bolt values associated with a Class A contact surface shall be used for slip-critical connections.

.20 A minimum 5 mm continuous structural fillet weld shall be used except as shown otherwise on the Purchaser's Drawings and Contractor's Documents.

.21 Where it is necessary to cope beam flanges, the capacity of the coped connection shall be checked by the fabricator and where required, reinforcement shall be provided to maintain the connection capacity.

.22 Recesses which cannot be painted shall be avoided. Where packing plates and shims are required, plates wider than the smallest member in the connection shall be provided.

.23 Stud anchors shall be welded to metalwork as shown on the Purchaser's Drawings, Contractor's Documents or as required by the Engineer and in accordance with the stud manufacturer's instructions.

.8 Splicing

.1 Splices in vertical or horizontal members shall not be permitted unless necessary to accommodate shipping lengths. Splicing shall not commence until proposed methods shown on shop drawings have been reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Connections for column splices shall be designed for the greater of the following conditions:

.1 100% of the axial resistance of the top column.

.2 The reactions in the case where they are indicated on the Purchaser's Drawings and Contractor's Documents.

.3 Beam splices generally are not allowed unless shown on the Purchaser's Drawings and Contractor's Documents.

.9 Fire proofing shall be Grace Construction Products – Monokote Z-106 for 2 hour fire rating or Purchaser's approved equivalent.

2.2 FABRICATION

.1 All Work shall be equal to the best modern practice in the manufacture and fabrication of materials of the type covered in this Section of the Technical Specification. The design, fabrication and erection of structural metalwork and associated bracing, base plates, connections splices, fittings, ties, hangers, bearings, brackets, anchors and associated metalwork shall be in accordance with the requirements of CSA S16, Limit State Design of Steel Structures and CISC Code of Standard Practice for Structural Steel, except as otherwise specified herein or shown on the Purchaser's Drawings and Contractor's Documents.

.2 Fabrication tolerances for the crane runway beam and its supporting structures shall be requirements of CSA S16, and CMAA Specification No. 70, the more stringent of which shall apply.

.3 Shop connections shall be welded. Field connections shall be either welded or bolted for structural members that are painted, and bolted for members that are required to be galvanized.

.4 High strength friction type bolts shall be used for bolted connections, except as otherwise specified or shown on the Purchaser's Drawings and Contractor's Documents. All connections associated with the crane runway beam shall be pre-tensioned.

.5 Spliced structural members to be connected in the field shall be match marked in the shop and each connecting member shall be clearly marked to correspond with the erection marks shown on the erection drawings.

.6 All joints that depend upon contact bearing for transfer of load shall have the bearing surfaces machined to a common plane.

.7 Stud anchors shall be welded to metalwork as shown on the Purchaser's Drawings and Contractor's Documents or as required by the Engineer and in accordance with the stud manufacturer's instructions.

.8 Welding

.1 All welding shall conform to the requirements of CSA W59 except as modified herein. Welding shall be performed by the arc welding process. The Contractor shall be fully accepted by the Canadian Welding Bureau in accordance with CSA Standard W47.1 (Division 1 or 2).

.2 Welding performed by the Contractor shall be done under the supervision of a welding supervisor qualified under the requirements of CSA W47.1. Welding operators shall have been certified within 2 years of the date of performing the Work.

.3 All shop welding performed on the Work shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. All weldments on the Work shall be identified with the Contractor's and welding operator's assigned symbol.

.4 Prior to welding, the Contractor shall submit the description of all Work to be fabricated or repaired and the appropriate weld procedures. These procedures shall be accepted and stamped by the Canadian Welding Bureau as per CSA Standard W47.1.

.5 The welding sequence shall be planned to control and minimize distortion and where necessary shall include stress relief to minimize residual stresses.

.6 Exposed welds shall be ground smooth and flush with the adjacent metal on all angles, frames, ladders, handholds, and upper rails of handrails, on bearing surfaces where weld projections would prevent proper seating or bearing of contacting members, and on the surfaces of runways and guides for moving parts. Welding of galvanized steel will not be permitted except where shown on the Purchaser's Drawings and Contractor's Documents or directed by the Engineer.

2.3 PAINTING

.1 All painting and coatings shall be done in accordance with Section 09 90 00 Painting and Coating of the Technical Specification.

Part 3 Execution

3.1 EXAMINATION

.1 Areas of the Work shall be examined by the contractor and unsatisfactory conditions reported to the Engineer. Commencement of this aspect of the Work shall imply acceptance of the existing conditions.

.2 Before commencing erection, the Contractor shall take such measurements as are necessary to verify the location of all adjacent Work and structures that might affect installation of the structural and miscellaneous metalwork. If the measurements indicate that irregularities are present in the Work, the Contractor shall submit to the Engineer, for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, proposals to rectify the irregularities prior to any adjustments being made to the structural or miscellaneous metalwork or adjacent Work or structures.

3.2 INSTALLATION

.1 Structural steelwork for the powerhouse, intake, service bay and control building superstructure, spillway diesel generator facility and generator circuit breaker platforms

shall be supplied and installed complete with splice plates, bearing plates, shims, mounting brackets, joint and fastening material and all other accessories as shown on the Purchaser's Drawings, Contractor's Documents and in strict accordance with the requirements of CSA S16.

.2 Structural metalwork for the crane runway beams shall be supplied and installed complete with splice plates, bearing plates, mounting brackets, end stops, joint and fastening material and all other accessories as shown on the Purchaser's Drawings and Contractor's Documents. Tolerances for steel Work supporting crane runway beam and the crane shall meet the requirements of CSA S16 and CMAA Specification No. 70; whichever is more stringent. This Work shall include the installation and alignment of the crane rails to CMAA No. 70 requirements complete with rail splices, clamps and accessories.

.3 The Contractor shall provide structural metalwork not shown or specifically described herein but necessary for the Work.

.4 The Contractor shall install Work square, straight, plumb and accurate to the required dimensions.

.5 Temporary bracing shall be provided where necessary to keep the structural and miscellaneous metalwork plumb and in true alignment during construction. Bracing members, if shown on the Purchaser's Drawings, are required for the finished structures and it shall not be assumed that they are adequate for erection purposes. It shall be the responsibility of the Contractor to make proper and adequate provisions for erection stresses.

.6 Every failure of the fabricated material to fit together properly shall be reported to the Engineer before any corrective measures are taken.

.7 Enlarging or relocating bolt holes on bolted connections, when authorized by the Engineer, shall be done by drilling. Flame cutting of bolt holes will not be permitted.

.8 Base plates and bearing plates to be grouted shall be shimmed and levelled with steel shims or levelling nuts and washers.

.9 Embedded metalwork shall be accurately set in place before the concrete is placed. Subject to the authorization of the Engineer, formed recesses may be left in the concrete and the metalwork placed, anchored and grouted in place at a later time.

.10 The positioning, as well as the elevation tolerances of base plates, vertical heights of columns and the horizontality of structural members shall conform to CSA S-16.

.11 Before installation, embedded Items shall be thoroughly cleaned of loose rust, grease, paint, concrete spatter or other coatings that will reduce the bond.

.12 The Contractor shall provide and use templates from setting anchor bolts, in order to meet the tolerances specified in Section 03 15 19 Embedded Anchors or as shown on the Purchaser's Drawings and Contractor's Documents.

.13 The Contractor shall obtain the authorization of the Engineer before making modifications to a structural element.

.14 All fire proofing shall be as shown on the Purchaser's Drawings and Contractor's Documents, undertaken in accordance with the manufacturer's recommendations. All surfaces shall be cleaned to the Engineer's satisfaction, prior to application of the material.

3.3 INSPECTION AND TESTING

.1 In addition to the provisions of the General Conditions regarding inspection and testing, the following shall apply.

.2 On beginning or resuming this aspect of the Work under the Contract, the Contractor shall notify the Engineer sufficiently in advance to enable him to arrange for inspection of the Work, whether the inspection and tests take place on the Site, at the Contractor's factory or at the factory of a subcontractor, the Contractor shall supply all necessary labour, material, equipment, apparatus, instruments and competent test personnel who shall be able to take complete charge of the inspection and tests and shall be authorized to represent and make decisions for the Contractor for the proper carrying out of the inspection and tests to the entire satisfaction of the Engineer.

.3 Waiving of, or delay in execution of inspection by the Engineer will not relieve the Contractor from the responsibility of supplying material and workmanship acceptable to the Engineer.

.4 Shop and field tests of materials shall be made by the Contractor as required by the appropriate material specification, and as required by the Engineer. Such tests shall be made in accordance with the latest ASTM, CSA, or applicable standards in effect at the time the testing is performed.

.5 Test pieces which were rejected shall be preserved for a period of time to be mutually agreed upon between the Contractor and the Engineer. In case of dissatisfaction with the results of the tests, the Contractor may make claim for a rehearing within that agreed time.

.6 Mill test certificates for each lot of steel used in the Work by the Contractor shall be forwarded to the Engineer at least 2 weeks prior to commencement of fabrication. These certificates shall record results of tests indicating for the following:

.1 Yield strength.

.2 Ultimate tensile strength.

.3 Percentage of elongation.

.4 Chemical composition.

.7 Sufficient information shall be given on all test certificates to ensure identification of the material to which the certificates refer.

3.4 INSPECTION OF WELDMENTS

.1 Visual Examination of Welds

.1 All structural steel welding and adjacent surfaces shall be 100% visually inspected in accordance with the requirements of CSA W59 for cracks in the weld or adjacent surfaces, slag inclusions, porosity, lack of fusion at the edge of the weld, undercut, concave weld profile, excessively convex weld bead, poor transition between weld and members welded, lack of penetration of the root of the weld, excessive penetration bead, and other examinations as required in CSA W59.

.2 The acceptance criteria and corrective requirements shall be in accordance with CSA W59. The cost of all corrective Work shall be borne by the Contractor.

.3 Non-Destructive Testing (NDT) of Welds

.1 Non-destructive testing of welds shall be performed at weld locations specified on the Purchaser's Drawings and Contractor's Documents or if the results of the visual inspection indicates additional non-destructive testing is required. The Contractor shall arrange its fabrication program to permit testing to be carried out in accordance with Table 3.1 for the type of weld specified.

.2 All non-destructive testing shall be carried out in accordance with CSA W59.

Table 3.1 NDT of Welds

Type of Weld	NDT Test	Extent of Test
Butt Welds - Complete Joint Penetration (CJP)	Radiographic Test (RT) and/or Ultrasonic Test (UT)	• 10% of weld at locations where testing is specified on the Purchaser's Drawings and Contractor's Documents. • 100% for all shop member splices for full length of welds. • 100% of the welded joints and base metal if 38 mm thick or thicker. • 10% of weld if visual inspection shows a concern.
Fillet Welds	Magnetic Particle Inspection (MPI)	• 10% of weld at locations where testing is specified on the Purchaser's Drawings and Contractor's Documents. • 10% of weld if visual inspection shows a concern.
Groove welds - Complete Joint Penetration (CJP) and Tee joints	Ultrasonic Test (UT)	• 10% of weld at locations where testing is specified on the Purchaser's Drawings and Contractor's Documents. • 10% of weld if visual inspection shows a concern.

.3 Where welds from doubler plates or continuity plates occur in the k-area of rolled shapes in the main frame columns, the k-area base metal adjacent to the welds shall be tested for post-weld cracks using magnetic particle testing procedure. The magnetic particle testing inspection area shall include the k-area base metal within 75 mm of the weld. Magnetic particle testing shall be performed no sooner than 48 hours following the completion of welding.

.4 In locations where steel plates and/or shapes are more than 20 mm thick, lamellar testing shall be performed in accordance with CSA W59 before welding.

.4 Corrective Actions

.1 All defects in welds beyond the limits indicated in W59 shall be removed to sound metal and such areas shall be ultrasound inspected to determine that the defect has been completely removed before repair welding will be permitted. Where build-up of weld metal occurs on butt welds subject to radiographic examination, the weld shall be ground as per the governing code.

.2 If the discontinuity requires repair as per the governing code, it shall be repaired using the related welding procedure at no additional cost to the Purchaser.

.3 The onus of proof of sound weldments lies with the Contractor to demonstrate to the Engineer the soundness of the Work.

.4 Contractor shall submit for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification a corrective action plan for each rejection specified.

.5 100% of rework and repair areas shall be subjected to testing.

.6 Defects, except cracks, in weld deposits may be repaired without prior authorization by any recognized method (use of oxy-acetylene flame gouging is not permitted), resultant cavities shall be power disc ground or grit blasted to remove all traces of residual carbon and oxidation.

.7 Cracks in weld deposits or base metal shall be repaired and the repair procedure shall be reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. The crack shall be removed by grinding or arc-air gouging to the sound metal along the length of the crack plus 20% of crack length on each end of the crack. The depth of grinding and gouging shall be limited to not more than 1/3 of the plate thickness unless directed otherwise by the Engineer. Liquid penetration test shall be performed at each step of the weld repair process to ensure all defects are removed.

3.5 POST-TENSIONING OF ANCHORS

.1 Main building column anchor bolts for the powerhouse structure will be post-tensioned following all erection procedures and sequencing details as outlined on the Purchaser's Drawings and Contractor's Documents.

.2 Anchor bolts shall be pre-tensioned to 10% of the final load prior to grouting under base plates. The underside of baseplates shall be grouted with non-shrink grout, and cured to attain a compressive strength of minimum 30 MPa.

.3 Once the grout has reached a compressive strength of 30 MPa, all anchor bolts shall be re-tensioned and locked off at their final load as per the tensioning sequence on the Purchaser's Drawings and Contractor's Documents.

.4 After the anchor bolts are locked off at their final load, the anchor bolts will be grouted through their grout tubes into their anchor bolt sleeves until full.

.5 Post tensioning loads per anchor bolt shall be 400kN or higher as indicated on the Purchaser's Drawings and Contractor's Documents.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools except as noted herein, and performing all Work necessary for supply, transportation, handling, and installation of the metal deck for the roofing systems, and floor decking systems as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 05 12 23 - Structural Steel.

.3 Section 03 30 00 - Cast-In-Place Concrete.

.4 Section 05 50 00 - Miscellaneous Metal.

.5 Section 09 90 00 - Painting and Coating.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with

- .1 National Building Code of Canada.
- .2 Canadian Standards Association:
  - .1 CSA-S16 - Limit States Design of Steel Structures.
  - .2 CAN/CSA-S136 - North American Specification for the Design of Cold-Formed Steel Structural Members.
  - .3 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.
  - .4 CSA W55.3 - Certification of Companies for Resistance Welding of Steel and Aluminum.
  - .5 CSA W59 - Welded Steel Construction (Metal Arc Welding).
- .3 Canadian General Standards Board (CGSB)
  - .1 CAN/CGSB-1.181 - Ready-Mixed Organic Zinc-Rich Coating.
- .4 American Society for Testing and Materials (ASTM)
  - .1 ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - .2 ASTM A792/792M- Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
- .5 Canadian Sheet Steel Building Institute (CSSBI)
  - .1 CSSBI 10M - Standard for Steel Roof Deck.

.2 CSSBI 12M - Standard for Composite Steel Deck.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Items 05 31 23 (a) and 05 31 23 (b) shall be in square metres made to the neat lines shown in the drawings and as directed by the Engineer.

.2 For the purpose of measurement, holes, penetrations or openings greater than 1.0 m^2 in area shall be deducted in accordance with the dimensions shown in the drawings.

.3 Unit Price

.1 The unit prices proposed for Items 05 31 23 (a) and 05 31 23 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for fabrication, painting, supplying, handling and installing metal decking complete with closure strips as specified herein, as shown on the Purchaser’s Drawings and Contractor’s Documents and as follows;

.1 Item 05 31 23 (a) shall cover steel decking for roofing.

.2 Item 05 31 23 (b) shall cover steel decking for floors.

.2 The unit price for Fire Proofing of steel decking is covered in Section 05 12 23.

1.5 SUBMITTALS

.1 The requirements shall be in accordance with Section 21.7 Contractor’s Documents of the General Specification.

.2 The Contractor shall submit shop drawings stamped and signed by a qualified Professional Engineer registered or licensed in the Province of Manitoba, Canada.

.3 The shop drawings shall indicate the deck plan, profile, dimensions, base steel thickness, metallic coating designation, connections to supports and spacings, projections, openings, including reinforcement details and accessories.

.4 Provide product literature for chosen steel deck materials.

.5 The shop drawings shall indicate details of temporary shoring of steel deck, such as location, time, duration of placement and removal of shoring for concrete filled decks, where required.

1.6 QUALITY MANAGEMENT

.1 The requirements shall be in accordance with Section 7.13 Project Quality Management of the General Specification.

.2 Contractor's Document submission shall include shop drawings that incorporate product specific details of a sufficient level to allow for construction in accordance with reviewed shop drawings only.

.3 Materials and workmanship not conforming to the above standards may be rejected by the Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The Contractor shall exercise care in storing and handling all steel decking delivered to the Site and shall properly support it at all times so that no piece will be bent or twisted or stored in contact with the ground, or in such a manner as to hold water, or be otherwise damaged. Damaged material shall be replaced or repaired by Contractor to the satisfaction of the Engineer.

Part 2 Products

2.1 MATERIALS

.1 Zinc-iron Alloy (ZF) coated steel sheet: to ASTM A653/A653M structural quality Grade 230, with ZF75 coating, for interior surfaces not exposed to weather.

.2 Roof and Floor Decking soffits shall shop painted to the requirements of Section 09 90 00 Painting and Coating.

.3 Roof deck to be 22 gauge (0.76 mm) in thickness for span lengths up to 1.520 m.

.4 Cover plates, cell closures and flashings: steel sheet with minimum steel core thickness of 0.76 mm (22 gauge). Metallic coating same as deck material.

.5 Primer: zinc rich, ready mix to CAN/CGSB-1.181.

.6 Deck to be fastened to the supports using corrosion resistant powder actuated fasteners complete with sealing caps by Hilti or Purchaser's approved equivalent in accordance to the manufacturer's recommendations. Side laps to be button punched at 600 o/c.

2.2 DESIGN

.1 Design metal roof (steel) deck using limit states design methods in accordance with CSA S136 and CSSBI 10M and CSSBI 12M.

.2 Design steel floor deck based on CSA S136, CSA S16, and in reference to Civil Design Criteria for floor loadings.

.3 Steel deck and connections to steel framing to carry dead, live and other loads including lateral loads, diaphragm action, composite deck action, and uplift as indicated.

.4 Deflection under specified live load not to exceed 1/360 of span.

Part 3 Execution

3.1 EXAMINATION

.1 The Contractor shall thoroughly examine other aspects of the Work upon with the Work pursuant to this Section is dependent. The Contractor shall report deficiencies to the Engineer. Commencement of the Work pursuant to this Section shall imply acceptance of the existing conditions.

3.2 INSTALLATION

.1 Perform structural steel Work in accordance with CSA S16, CAN/CSA S136, CSSBI 10M and CSSBI 12M.

.2 Install deck fasteners in accordance with the manufacturer's recommendations.

.3 Perform welding in accordance with CSA W59, except where indicated otherwise.

.4 Companies to be certified under Division 1 or 2.1 of CSA W47.1 for fusion welding of steel structures and/or CSA W55.3 for resistance welding.

.5 Erect steel deck as indicated and in accordance with CAN/CSA-S136, CSSBI 10 and CSSBI 12 and reviewed Contractor's Documents.

.6 For cellular deck installations, butt ends: to 1.5 mm gap. Install steel cover plates over gaps wider than 1.5 mm.

.7 For non-cellular deck locations, lap ends: to 75 mm minimum, and formed over supports.

.8 Weld and test stud shear connectors through steel deck to steel beams below in accordance with CSA W59.

.9 Allow minimum 75 mm bearing for roof deck and full top flange bearing for floor deck, when supported by structural steel.

.10 Mechanically fasten male/female side laps at 600 mm on centre unless noted on the Purchaser's Drawings and Contractor's Documents.

.11 Immediately after decking is permanently secured in place, touch up metallic coated top surface with primer where burned by welding.

.12 For areas where concrete fill on steel deck is used:

.1 Prior to sheathing placement, steel deck is to be free of soil, debris, standing water, loose mil scale and other foreign matter.

.2 Temporary shoring, if required, is to be designed to support construction loads and other construction equipment. Do not remove temporary shoring until deck has sufficient capacity to support whatever construction loads will be imposed on the floor.

.3 Place and support reinforcing steel as indicated on the Purchaser's Drawings, or Contractor's Documents or as authorized by the Engineer.

3.3 CLOSURES

.1 Closure pieces shall suit project for appearance, acoustical, and thermal requirements. If more than one type is required, code reference each type and ensure shop drawings indicate locations.

.2 Install closures, where needed, to ensure effective closures against weather, thermal and acoustic effects.

.3 Install closures to details indicated, to manufacturer's recommendations and as specified herein.

.4 Where flutes are at right angles to exterior walls, and deck extends beyond these walls

.1 Caulk interlocking side laps of decking for 400 mm immediately over walls. Install interior and exterior closures.

.2 Caulk exterior closures to prevent air infiltration. Caulk interior closures to prevent water vapour exfiltration.

.3 In addition, provide roofing Subcontractor with glass fibre pads to close off topside flutes directly over face of wall or use closures as recommended by manufacturer.

.5 Where flutes run at right angles to interior partitions

.1 Fill web spaces with double run of steel closures or as recommended by manufacturer.

.6 Where flutes are parallel to interior partitions

.1 Install steel closure flashing to provide neat juncture between two materials or as recommended by manufacturer.

.7 Attach metal cell closures at locations required to contain roofing mastic or other related debris as recommended by manufacturer.

3.4 OPENINGS AND AREAS OF CONCENTRATED LOADS

.1 Where applicable, no reinforcement is required for openings cut in deck that are smaller than 150 mm square.

.2 Frame deck openings greater than 150 mm square as per the Purchaser’s Drawings and Contractor’s Documents.

.3 Roof top projections, and mechanical and electrical equipment are to be independently supported, transferring loads to roof support framing and not the deck structure.

3.5 CONNECTIONS

.1 Install connections in accordance with CSSBI recommendations unless otherwise indicated on the Purchaser’s Drawings, herein, or as directed by the Engineer.

3.6 PAINTING

.1 All metal deck surfaces which will be exposed shall be painted prior to installation.

.2 Fire proofing of steel deck shall be to the requirements indicated on the Purchaser’s Drawings, Contractor’s Documents and as per manufacturer’s recommendations.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour and Materials and performing all Work necessary as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein for submittals, supplying, transporting, unloading, storing, handling, galvanizing, painting, installing and cleaning up, all Items of miscellaneous embedded and non-embedded metalwork.

.2 The Contractor shall supply with proper painting or coating requirements outlined in Section 09 90 00 Painting and Coating, and the Contractor shall install in the permanent Works, the following Items of miscellaneous embedded and non-embedded metalwork together with all fastenings, including embedment in concrete or in blockwalls.

- .1 Hatchway, manhole and trench frames and covers.
- .2 Steel bulkhead doors complete with frames for the intake gate maintenance galleries and scrollcase access.
- .3 Air vents and screens including frames.
- .4 Guard rails and posts, bollards, door guard posts.
- .5 Stairs and landings, ladders, and cages.
- .6 Platforms, handrails (fixed and removable), and accessories.
- .7 Pipe sleeves for electrical and mechanical Work.
- .8 Pipe sleeves for pressure relief drains and pressure grouting.
- .9 Aluminum dividing strips for concrete floor topping.
- .10 Metal abrasive nosings for concrete stairs.
- .11 Miscellaneous embedded and non-embedded metalwork including, but not limited to:
  - .1 Corner protection angles.
  - .2 Anchor Plates.
  - .3 Wall mounted handrails and plates.
- .12 Draft tube pier nose armour.
- .13 Spillway pier nose armour.
- .14 Miscellaneous structural steel framing (not included in superstructure steel package) including:
  - .1 Elevator roof and floor (painted not galvanized).
  - .2 Roofs on Battery rooms and other miscellaneous framing members (painted not galvanized).
  - .3 Hoist beams complete with end stop for intake bulkhead gate monorail.
  - .4 Galvanized disconnect switch support structure and post insulator support structure located on the tailrace deck.
  - .5 Galvanized dead end assemblies for conductor lines and skywires associated to the transmission lines.
- .15 Contraction joint angles (road deck).
- .16 Dome hatches at the draft tube and dewatering sump accesses.

.17 Corrugated pipe sleeves for stay ring anchors.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 15 19 - Embedded Anchors.

.3 Section 03 21 00 - Reinforcing Steel.

.4 Section 03 30 00 - Cast-In-Place Concrete.

.5 Section 03 40 00 - Precast Concrete.

.6 Section 03 45 13 - Precast Wall Panels.

.7 Section 03 60 00 - Equipment Grouting.

.8 Section 04 22 00 - Concrete Unit Masonry.

.9 Section 05 05 19 - Drilled-In-Place Anchors.

.10 Section 05 12 23 - Structural Steel.

.11 Section 09 90 00 - Painting and Coating.

.12 Section 14 20 00 - Elevators.

.13 Section 35 20 13 - Bulkhead Gates, Stoplogs and Trashracks.

.14 Section 35 20 17 - Embedded Guides.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Standards of Canadian Standards Association:

.1 CSA S16 - Limit States Design of Steel Structures.

.2 CSA G40.20 - General Requirements for Rolled or Welded Structural Quality Steel.

.3 CSA G40.21 - Structural Quality Steel.

.4 CSA W47 - Certification of Companies for Fusion Welding of Steel Structures.

.5 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.6 CSA S136 - Cold Formed Steel Structural Members.

.7 CSA G164 - Hot Dip Galvanizing of Irregularly Shaped Articles.

.8 CISC Code of Standard Practice for Structural Steel.

.2 American Society for Testing and Materials:

.1 ASTM A36 - Carbon Steel.

.2 ASTM A53/A53M - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.

.3 ASTM A123/A123M - Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

.4 ASTM A307 - Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.5 ASTM A325M - Structural Bolts, Steel, Heat Treated 830 MPa Minimum Tensile Strength (Metric).

.6 ASTM A394 - Steel Transmission Tower Bolts, Zinc-Coated and Bare.

.7 ASTM A467/A467M - Machine and Coil Chain.

.8 ASTM A490 - Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.

.9 ASTM A490M - High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric).

.10 ASTM A500/A500M - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

.11 ASTM A653/A653M - Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Items 05 50 00 (a) to 05 50 00 (p) shall be in kilograms as indicated on the applicable Purchaser's Drawings and Contractor's Documents and as directed by the Engineer.

.2 Measurement for Items 05 50 00 (q) and 05 50 00 (r) shall be in metres as shown on the Purchaser's Drawings, Contractor's Documents and as directed by the Engineer.

.3 Measurement for Item 05 50 00 (s) and 05 50 00 (t) shall be the number shown on the Purchaser's Drawings, Contractor's Documents and as directed by the Engineer.

.4 No separate measurement will be made for embedded anchor plates that are required for the installation.

.3 Unit Price

.1 The unit prices proposed for Items 05 50 00 (a) to 05 50 00 (s) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the

Contractor's Submission shall be for submittals, fabrication, galvanizing or painting as specified herein, supplying, unloading, loading, storing, handling, installing complete with anchors and touch-ups for all Work associated with the Item as specified herein and as follows:

.1 Item 05 50 00 (a) shall cover frames and covers/gratings for hatchways, manholes, gate slot covers, trench frames and covers/gratings that are to be galvanized.

.2 Item 05 50 00 (b) shall cover frames and covers for hatchways, manholes, trench frames and covers that are to be painted.

.3 Item 05 50 00 (c) shall cover Steel bulkhead doors and frames (painted), including anchoring, and touch-up.

.4 Item 05 50 00 (d) shall cover stairs and landings with handrails, ladders with and without cages, platforms complete with accessories that are to be galvanized.

.5 Item 05 50 00 (e) shall cover all fixed and removable handrails for platforms, equipment hatches, and openings that are to be galvanized.

.6 Item 05 50 00 (f) shall cover Draft tube pier nose armor (painted).

.7 Item 05 50 00 (g) shall cover Spillway pier nose armor (painted).

.8 Item 05 50 00 (h) shall cover miscellaneous structural steel framing, not included in superstructure steel package that are to be galvanized.

.9 Item 05 50 00 (i) shall cover miscellaneous structural steel framing, not included in superstructure steel package that are to be painted.

.10 Item 05 50 00 (j) shall cover galvanized guard rails and posts.

.11 Item 05 50 00 (k) shall cover galvanized wall rails.

.12 Item 05 50 00 (l) shall cover galvanized corner protection angles.

.13 Item 05 50 00 (m) shall cover galvanized Bollards and door guard posts.

.14 Item 05 50 00 (n) shall cover domed hatches with liner for the Draft tube and dewatering sump accesses.

.15 Item 05 50 00 (o) shall cover galvanized contraction joint angles for use with joint sealers Type A and B.

.16 Item 05 50 00 (p) shall cover all galvanized pipe sleeves for embedded electrical conduits and mechanical openings.

.17 Item 05 50 00 (q) shall cover all non-galvanized pipe sleeves for pressure relief drains and grout curtain.

.18 Item 05 50 00 (r) shall cover metal abrasive nosings for concrete stairs.

.19 Item 05 50 00 (s) shall cover the corrugated pipe sleeves for Stay Ring Anchors.

.2 The supply and installation of embedded anchor plates are considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices set out for the Items to which this Work applies.

.3 The costs associated with the supply and installation of grout for the bulkhead doors shall be included in the unit prices proposed in Section 03 60 00 Equipment Grouting.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 All reviews by the Engineer are for the sole purpose of ascertaining conformance with the general design concept and do not relieve the Contractor of any responsibilities as to dimensioning detailing and fabrication.

.3 Shop drawings shall provide all fabrication details for each part that makes up the structure such as cuts, holes, notches and connections. As well, each drawing must present the bill of materials indicating the number and weight of each element including the bolts, and the total weight of each delivered structure in a single assembly.

.4 Shop drawings and installation drawings submitted for review shall be certified and stamped by a Professional Engineer registered in the Province of Manitoba.

.5 The Contractor shall not commence fabrication of structural steel before the shop drawings have been reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Shop drawings shall be submitted a minimum of 15 days in advance of the required fabrication date to avoid construction delays.

.6 Technical data sheets shall be submitted for all products to be used in this Work.

.7 Prior to welding, the Contractor shall submit the description of all Work to be fabricated or repaired and the appropriate weld procedures. These procedures shall be accepted and stamped by the Canadian Welding Bureau as per CSA Standard W47.1.

.8 The Contractor shall submit alternatives to construction details shown on the Purchaser's Drawings for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification prior to proceeding with the relevant Work.

.9 All shop drawings including erection drawings shall be prepared in the system of units corresponding to the engineering drawings.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Contractor's Document submission shall include shop drawings that incorporate product specific details of a sufficient level to allow for construction in accordance with reviewed shop drawings only.

.3 Materials and workmanship not conforming to the above standards may be rejected by the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The Contractor shall exercise care in storing, handling and erecting all miscellaneous metalwork delivered to the Site and shall properly support it at all times so that no piece will be bent or twisted or stored in contact with the ground or in such a manner as to hold water, or be otherwise damaged. Damaged material shall be replaced or repaired by Contractor to the satisfaction of the Engineer.

.3 The Contractor shall store steel on heavy timbers, clear of the ground, contaminants and muddy areas.

.4 The Contractor shall store bolts, other fastenings and welding materials in their original containers in storage sheds.

.5 The Contractor shall keep welding electrodes in a warm and dry storage area in their sealed protective coatings until required for the Work. The Contractor shall protect electrodes in opened containers from moisture.

.6 The Contractor shall employ hoisting equipment of adequate capacity and provide proper support for sections during handling and delivery.

.7 The Contractor shall prevent impact to members being handled and swung into position.

Part 2 Products

2.1 MATERIALS

.1 All materials supplied by the Contractor for the permanent Work shall be new and shall be subject to Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Except as otherwise specified or shown on the Purchaser's Drawings or otherwise authorized by the Engineer, materials shall conform to the following specifications:

- .1 Structural steel shapes and bars - CSA G40.20/G40.21 - 350W.
- .2 Structural steel angles and channels - CSA G40.20/G40.21 - 300W.
- .3 Structural steel plates - CSA G40.20/G40.21- 350W.
- .4 Structural steel (hollow structural sections) - CSA G40.20/G40.21 - 350W.
- .5 Sheet Steel - ASTM A653.
- .6 Floor plates - CSA G40.21.
- .7 Cast iron - ASTM A48 Class 25.
- .8 Steel Pipe - ASTM A53/A53M.
  - .1 Standard - Schedule 40.
  - .2 Extra Strong - Schedule 80.
- .9 Chains - ASTM A467/A467M.
- .10 Welding materials - CSA W48.1 to W48.6.
- .11 Arc welding electrodes - E49XX.
- .12 Bolts, nuts and washers:
  - .1 High strength - ASTM A325M or ASTM A490.
  - .2 Stainless steel - ASTM A193/A193M.
  - .3 Standard strength - ASTM A307 Grade A or B.
  - .4 Threads - Coarse thread series to ANSI/ASME B1.1.
  - .5 Washers, hardened - ASTM F436M.
  - .6 Washers, standard strength - Standard commercial quality.
  - .7 Bevelled washers - Malleable iron or steel.
  - .8 High strength anchor bolts, nuts and washers - ASTM A722/A722M.
- .13 Drill-in-place anchor bolts - see Specification Section 05 05 19 Drilled-In-Place Anchors.

.14 Abrasive Nosing - 4" wide Safety Nosing Alumogrit Type 101 by Wooster Products or accepted equal connected with anchors cast into the body of the nosing.

.2 Unless otherwise specified herein or shown on the applicable Purchaser's Drawings and Contractor's Documents, all exposed fastenings shall be of the same material, colour and finish as the metal to which they are attached.

.3 All joints that depend upon contract bearing for transfer of load shall have the bearing surfaces machined to a common plane. All bolts used for field assembly of structural joints and connections shall be of a high strength steel, except as otherwise noted on the applicable Purchaser's Drawings and Contractor's Documents or in the Technical Specification.

.4 Unless reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, materials or workmanship not conforming to the above standards may be rejected.

2.2 FABRICATION

.1 All fabrication shall be in accordance with the specified codes and standards referred to in this Section of the Technical Specification and the applicable Purchaser's Drawings and Contractor's Documents. All parts shall be fabricated in accordance with the dimensions on the Purchaser's Drawings and shall conform to the specification and reviewed shop drawings.

.2 The Contractor shall fabricate the Work true, square, straight, plumb, and accurate to the required dimensions and free from defects detrimental to the appearance or performance.

.3 Work shall be shop assembled as shown on the applicable Purchaser's Drawings and Contractor's Documents. Components to be field assembled shall be trial assembled in the shop and the components shall be clearly match marked and dowelled, if required.

.4 Exposed welds shall be ground smooth and flush with the adjacent metal on all angles, frames, ladders, handholds, and upper rails of handrails, on bearing surfaces where weld projections would prevent proper seating or bearing of contacting members, and on the surfaces of runways and guides for moving parts. Welding of galvanized steel will not be permitted except where shown on the applicable Purchaser's Drawings and Contractor's Documents or authorized by the Engineer.

.5 The Contractor shall clearly mark pieces by stamping or painting to prevent obliteration during shipping and handling.

.1 If galvanized - 12 mm punched numbers prior to galvanizing.

.2 If painted - painted numbers after shop painting.

.6 All individual pieces shall be identified in accordance with the identification schedule used on the shop and erection drawings and Bill of Materials to clearly indicate the position of this Work for erection.

.7 This aspect of the Work shall be adequately braced and protected to avoid damage and distortion during shipment.

.8 In general, all miscellaneous metalwork shall be galvanized, unless otherwise indicated herein, or as shown on the Purchaser's Drawings, or directed by the Engineer. The exceptions are as follows.

.1 Structural steel for the elevator hoist structure.

.2 Structural steel for battery room roofs.

.3 Pipe sleeves for pressure relief drains and grout curtains.

.4 Draft-tube and spillway pier nose armor.

.5 Steel bulkhead door for access to scrollcase and intake gate maintenance chamber.

.6 Metal abrasive nosings for concrete stairs.

.7 Interior hoist beams for chain hoists and monorails.

Part 3 Execution

3.1 EXAMINATION

.1 Prior to commencing installation, thoroughly examine any other Work upon which this Work is based. Report any deficiencies discovered and propose adjustments to the Engineer and obtain written authorization before proceeding. Commencement of Work implies acceptance of surfaces and conditions.

3.2 INSTALLATION:

.1 Installation of miscellaneous embedded and non-embedded metalwork shall conform to Canadian Standards Association, Specification CSA S16 and CISC code of Standard Practice for Structural Steel.

.2 Miscellaneous metalwork to be embedded in concrete or grouted shall be accurately set and shall be held firmly in position while concrete, concrete topping or grout is being placed and cured. Subject to the authorization of the Engineer, formed recesses may be left in the concrete and metalwork placed, anchored and grouted at a later time.

.3 All embedded metalwork shall be installed true and square and to the elevations and dimensions shown on the Purchaser's Drawings or as authorized by the Engineer.

.4 Any embedded metalwork that is incorrectly placed or that moves during embedment to an extent that will affect its proper operation shall be removed and replaced correctly or shall be corrected by other accepted means to the complete satisfaction of the Engineer at no additional expense to the Purchaser.

.5 Faces of miscellaneous metalwork against which concrete is to be placed shall receive no galvanizing or painting.

.6 Any areas on which the paint or galvanizing is damaged during transportation, handling, assembly, or erection shall be wire brushed and given one coat of primer authorized by the Engineer, or one coat of "Galvafroid" or Purchaser's approved equivalent, respectively.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary for supplying, transporting, storing, handling and placing compressible foam plastic sheet, compressible closed-cell backer rod and firestop material, as shown on the Purchaser's Drawings, as directed by the Engineer, and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 07 92 00 - Joint Sealants.

1.3 DEFINITIONS

For the purpose of this Section of the Technical Specification, the following definitions shall apply:

.1 Construction joints (CJ): joints in concrete surfaces on or against which new concrete is to be placed and to adhere to the initial concrete surface, which has become so rigid that the new concrete cannot be incorporated integrally within that previously placed.

.2 Contraction joints (CTJ): joints whose primary function is to allow relative movements of adjacent, independent structures or concrete units, as a result of thermal expansion/contraction, shrinkage or differential settlement.

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all regulations applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 Standards and Specifications of the American Society for Testing and Materials:

.1 ASTM C553 - Mineral Fibre Blanket Thermal Insulation for Commercial and Industrial Applications.

.2 ASTM C665 – Mineral Fibre Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

.3 ASTM C1330 - Cyldindrical Sealant Backing for Use with Cold Liquid - Applied Sealants.

.4 ASTM D1667 - Flexible Cellular Materials - Poly (Vinyl Chloride) Foam (Closed-Cell).

.5 ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types). ASTM D1752 - Preformed Sponge Rubber Cork and Recycled

PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 No separate measurement shall be made for joint fillers associated with precast concrete, precast beams and girders, precast wall panels, concrete unit masonry, concrete floor toppings and for all openings associated to electrical and mechanical systems and equipment.

.2 Measurement for Items 07 91 26 (a) and 07 91 26 (b) shall be in square metres made to the neat dimensions of joints requiring Type 1 and 2 joint filler as shown in the Purchaser’s Drawings and as directed by the Engineer.

.3 Measurement for Item 07 91 26 (c) shall be in metres made to the neat dimensions of joints requiring Type 3 joint filler as shown in the Purchaser’s Drawings and as directed by the Engineer.

.4 Measurement for Item 07 91 26 (d) shall be in cubic metres made to the neat dimensions of joints requiring Type 4 joint filler as shown in the Purchaser’s Drawings and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 07 91 26 (a) to 07 91 26 (d) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, transporting, storing, handling and placing joint filler materials as specified herein and as follows;

.1 Item 07 91 26 (a) shall cover Type 1 Joint Filler.

.2 Item 07 91 26 (b) shall cover Type 2 Joint Filler.

.3 Item 07 91 26 (c) shall cover Type 3 Joint Filler.

.4 Item 07 91 26 (d) shall cover Type 4 Joint Filler.

.2 The supply and installation of joint fillers for precast concrete, concrete unit masonry, concrete floor toppings and openings for mechanical and electrical systems and equipment are considered incidental to the Work. Includes costs for such Work in the unit prices proposed for Items to which this Work applies.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Certified Manufacturer's Data Sheets and samples of the materials the Contractor proposes to use shall be provided to the Engineer for authorization not less than 30 days prior to the scheduled date of first installation.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Products shall be delivered in each manufacturer's original, intact, labelled containers and be stored off the ground, protected from weather and construction activities, in a dry location until installed as per manufacturer's recommendations.

1.8 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 The following types of joint filler materials shall be supplied by the Contractor.

.1 Type 1 shall be a preformed joint filler of compressible foam plastic, 13 mm, in thickness, "Ceramar Flexible Foam Expansion Joint Filler", or Purchaser's approved equivalent. Type 1 joint filler shall typically be used for indoor applications.

.2 Type 2 shall be a preformed joint filler of compressible foam plastic, 25 mm, in thickness, "Ceramar Flexible Foam Expansion Joint Filler", or Purchaser's approved equivalent. Type 2 joint filler shall typically be used for outdoor applications.

.3 Type 3 shall be a preformed joint filler of compressible closed-cell backer-rod conforming to ASTM C1330, such as "Sonolastic Closed-Cell Backer Rod", or Purchaser's approved equivalent. Size as per manufacturer's recommendation.

.4 Type 4 shall be a firestop material such as Hilti CP 620 Fire Foam, Hilti Fire Pillow, A/D Fire Barrier SL (Self-Levelling) Silicone, or Purchaser's approved equivalent. Type 4 joint filler shall typically be used for wall and ceiling penetrations.

Part 3 Execution

3.1 INSTALLATION

.1 Joint fillers shall be cut, bent, or otherwise fabricated or applied in the locations shown on the Purchaser's Drawings and Contractor's Documents, or as directed by the Engineer, all in accordance with the procedures recommended by the manufacturer of the material used.

.2 The Contractor shall cut the preformed joint filler of compressible foam plastic to cover the abutting surface of the concrete at the joint.

.3 Care shall be exercised to ensure that joints in the material fit tightly to prevent the seepage of concrete to the opposite concrete face.

.4 The joint filler shall be held securely in place against the concrete face on the side of the joint placed first, by means of galvanized nails. The nails shall be driven into the filler to project into the first concrete placement, prior to the placement of adjacent concrete. The Engineer may accept alternative methods of securing the joint filler if proposed by the Contractor. The softer grade of compressible foam plastic shall also be wrapped around drain pipe sleeves as shown on the Purchaser's Drawings and Contractor's Documents, or as directed by the Engineer.

.5 The Contractor shall install joint filler in concrete joints, as shown on the Purchaser's Drawings and Contractor's Documents. The Contractor shall comply with the manufacturer's written instructions applicable to the products and application indicated. Only fillers that are undamaged, dry and unsoiled and that have not been left exposed at any time to ice and snow shall be utilized.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary for supplying, transporting, storing, handling and placing joint sealers as shown on the Purchaser's Drawings, as directed by the Engineer, and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 04 22 00 - Concrete Unit Masonry.

.4 Section 05 50 00 - Miscellaneous Metal.

.5 Section 07 91 26 - Joint Fillers.

1.3 DEFINITIONS

For the purpose of this Section of the Technical Specification, the following definitions shall apply:

.1 Construction Joints (CJ): joints in concrete surfaces on or against which new concrete is to be placed and to adhere to the initial concrete surface, which has become so rigid that the new concrete cannot be incorporated integrally within that previously placed.

.2 Contraction Joints (CTJ): joints whose primary function is to allow relative movements of adjacent, independent structures or concrete units, as a result of thermal expansion/contraction, shrinkage or differential settlement.

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all regulations applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 Canadian Standards Association:

.1 CAN/CSA S6 - Canadian Highway Bridge Design Code.

.2 Standards and Specifications of the American Society for Testing and Materials:

.1 ASTM E814 - Fire Tests of Penetration Firestop Systems.

.2 ASTM D4070 - Adhesive Lubricant for Installation of Preformed Elastomeric Bridge Compression Seals in Concrete Structure.

.4 The elastomer used in joint seals shall conform to the requirements of CAN/CSA-S6, Section 11.6.6.2.2.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 No separate measurement shall be made for joint sealers associated to Precast Concrete, Precast Beams and Girders, Precast Wall Panels, Concrete Unit Masonry, Concrete Floor Toppings and for all openings associated to Electrical and Mechanical Systems and Equipments.

.2 Measurement for Items 07 92 00(a) and 07 92 00(b) shall be in metres measured along the centerline of the joints to the neat dimensions shown in the drawings and as directed by the Engineer.

.3 Measurement for Items 07 92 00 (c) and 07 92 00 (d) shall be in litres made to the neat dimensions shown in the drawings and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 07 92 00 (a) to 07 92 00 (d) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying transporting, storing, handling and placing joint sealer materials as specified herein and as follows:

.1 Item 07 92 00 (a) shall cover Type A joint sealer.

.2 Item 07 92 00 (b) shall cover Type B joint sealer.

.3 Item 07 92 00 (c) shall cover Type C joint sealer.

.4 Item 07 92 00 (d) shall cover Type D joint sealer.

.2 The supply and installation of joint sealants for precast concrete, concrete unit masonry, concrete floor toppings and openings for mechanical and electrical systems and equipment are considered incidental to the Work. Includes costs for such Work in the unit prices proposed for Items to which this Work applies.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor’s Documents of the General Specification.

.2 The Contractor shall provide certified manufacturer's test reports for joint sealants and primer/adhesives (when use of primer is recommended by the sealant manufacturer) one (1) month prior to fabrication.

.3 The Contractor shall submit typical expansion joint cross-section(s) indicating pertinent dimensioning of blockout recess and adjacent construction, if different from the Purchaser's Drawings and Contractor's Documents.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Products shall be delivered in each manufacturer's original, intact, labelled containers and be stored off the ground, protected from weather and construction activities in a dry location until installed as per manufacturer's recommendations.

.3 Samples of the materials, which the Contractor proposes to use, shall be provided for the Engineer's authorization, not less than thirty(30) days prior to the scheduled date of first installation.

1.8 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Compression Seals

.1 A multi-cellular elastomeric seal profile shall be provided that is capable of accommodating movement and variation in joint widths through compression and flexure of its internal web structure. The seals shall have a web structure with truss-like features that exhibit the ability to support heavy vehicle traffic where applicable and exert continuous and uniform pressure against joint side walls effectively providing a watertight seal and application. The top of the seal shall have a surface that is non-slip. Multiple sizes of joint openings shall be accommodated by providing a variety of sizes and cross-sections.

The seals shall be preformed and manufactured from vulcanized elastomeric compound using polymerized chloroprene (neoprene) as the base polymer. The seals shall meet the requirements of the properties listed in the table below, exclusive of recovery and pressure sensitive tests, unless specified otherwise.

Physical Properties of Polychloroprene (Neoprene) Seal Element:

Physical Properties	ASTM Test Method	Requirements
Tensile strength, min.	D-412	13.8 MPa
Elongation at break min.	D-412	250%
Hardness, Type A Durometer	D-2240 (Modified)	(55 +/-5)
Compression set	D-395, Method B	40%
Oven aging, 70 h at 100°C	D-573	
Tensile strength, loss, max.		20%
Elongation, loss, max.		20%
Hardness, Type A Durometer (change)		0 to +10
Oil Swell, ASTM oil 3, 70 hr at 100°C weight change, max.	D-471	45%
Ozone resistance	D-1149	No Cracks
20% strain, 300 pphm, in air		
At 40°C (wiped w/toluene to remove contamination)		
Low temperature recovery,		
72 h at -10°C 50% deflection, min.	D-2628	88%
22 hr at -29°C 50% deflection, min.		83%
High temperature recovery, 70 hr at 100°C 50% deflection, min.		85%

.1 For horizontal contraction joints Wabo® Compression Seal Type A or Type B manufactured by Watson Bowman Acme Corp., or Purchaser's approved equivalent, shall be provided as indicated on the Purchaser's Drawings and Contractor's Documents.

.2 Lubricant Adhesive: Prima-Lub Adhesive (as recommended by the joint manufacturer) shall be a one part moisture curing polyurethane and aromatic hydrocarbon solvent mixture which complies with ASTM D-4070.

.2 Elastic Joint Sealant

.1 Elastic joint sealant shall be a thixotropic single component joint sealant with a polyurethane base that, after curing, forms a flexible, elastic and adhesive material capable of sealing joints in concrete effectively against the infiltration of moisture throughout repeated cycles of expansion and contraction. The sealant shall be Degussa Sonolastic NP1, or Purchaser's approved equivalent.

.2 Firestop sealant shall be an elastomeric one component silicone based sealant in accordance with ASTM E-814, UL 2079 test for "Fire Resistance of Building Joints", Hilti CP 601S, or Purchaser's approved equivalent.

2.2 SEALANT SELECTION

.1 Compression Seals

.1 Type A shall be Watson Bowman Acme "Wabo" Compression Seal Type WA 175, which is a preformed elastic joint seal manufactured of neoprene and installed with a manufacturer recommended adhesive, or Purchaser's approved equivalent. It shall be used on road decks for bridges and concrete structures such as intake, tailrace, service bay and transitions and shall be capable of joint movements up to 20 mm.

.2 Type B shall be Watson Bowman "Wabo" Pavement Seal Type WB-562, which is a preformed elastic joint seal manufactured of neoprene and installed with a manufacturer recommended adhesive, or Purchaser's approved equivalent and shall be capable of joint movements up to 6 mm.

.2 Elastic Joint Sealants

.1 Type C shall be a one-part polyurethane elastic joint sealant, Degussa Sonolastic NP1, or Purchaser's approved equivalent.

.2 Type D shall be an elastomeric one component silicone based sealant in accordance with ASTM E-814, UL 2079 test for "Fire Resistance of Building Joints", Hilti CP 601S, A/D Fire Barrier SL (Self-Levelling) Silicone, or Purchaser's approved equivalent.

Part 3 Execution

3.1 EXAMINATION

.1 The Contractor shall thoroughly examine other aspects of the Work upon with the Work pursuant to this Section is dependent. The Contractor shall report deficiencies to the Engineer. Commencement of the Work pursuant to this Section shall imply acceptance of the existing conditions.

3.2 INSTALLATION

.1 Work of other trades shall be protected from staining or contamination.

.2 Joint surfaces shall be cleaned of all loose and foreign material, cement laitance, rust, dirt, dust and rough projections. Grease and form oil shall be removed with white spirits and wiped off clean. Where required, the joint surfaces shall be scrubbed with water and a stiff brush.

.3 Immediately prior to the application of joint seals, adhesive or primer, the joint surfaces shall be blown out with compressed air to remove all traces of dust and loose particles of dirt. Joint surfaces shall be thoroughly dry before the application of joint material.

.4 The preparation of joint surfaces, application of joint sealers and primers, and curing shall be done strictly in accordance with the manufacturer's recommendations.

.5 Seal profiles shall be shipped in the longest practical continuous length in manufacturer's standard shipping carton or on wooden pallets, shrink wrapped. Seals shall be cut to length on Site, as required.

.6 Joint sealers and primers shall be heated and applied/installed in strict accordance with the manufacturer's instructions and shall be applied and allowed to dry under controlled temperature conditions.

.7 The application shall not, under any circumstances, proceed when the temperature is below 4°C, during rainy weather, when the relative humidity exceeds 85%, or on wet, frosted, or ice-coated surfaces.

.8 The application of joint sealers shall be done smoothly and uniformly to form a continuous seal. Runs, sags, and bulges, lack of adhesion to surfaces and poor coverage shall be cause for rejection. Any damage which may occur, due to the Contractor's operations, shall be repaired.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, except as noted herein, and performing all Work necessary for the supply, transportation, handling, storage, installation, painting, and adjusting of the service bay door, as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wire and Cable Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Works shall be performed in accordance with:

.1 ASTM A36 - Structural Shapes and Plates.

.2 ASTM A48 - Standard Specification for Gray Iron Castings.

.3 ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

.4 CAN/CGSB-1.105 - Quick Drying Primer.

.5 CAN/CGSB 1.181 - Ready-Mixed Organic Zinc-Rich Coating.

.6 CAN/CSA C22.2 No. 14 - Industrial Control Equipment.

.7 CSA S16 - Design of Steel Structures.

.8 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.9 SSPC - Society for Protective Coatings Surface Preparation Standards.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 No separate measurement will be made for the Work of this Section.

.3 Unit Price

.1 The Estimated Cost for Item 08 36 19 (a) shall be for supply, transportation, handling, storage, installation, painting, and adjusting of the service bay door as specified herein.

.2 Submittals and training are considered incidental to the Work. Include the cost of these Items in the Estimated Cost proposed for the service bay door.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data, roughing-in diagrams, electrical rough-in instructions, shop drawings, loading information, installation and test plans, testing procedures, commissioning procedures, and operation and maintenance manuals. Operation and maintenance manual shall include a detailed list of recommended spare parts and detailed listing of maintenance procedures.

.3 Shop drawings shall show construction details, clearance requirements, metal gauges, finish, schematic and wiring diagrams for controls, electrical power requirements, and design data, and interface requirements for Work of other Sections of the Technical Specification.

.4 Submit written certifications and calculations that verify the door assembly's ability to support its own weight and the specified loads.

.5 The Contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Control of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 Furnish each electric vertical lift door as a complete unit produced by one manufacturer, including hardware, accessories, mounting and installation components.

.4 Door manufacturer shall have at least 10 years of experience in manufacturing doors of the type specified.

.5 Inserts and anchorages: furnish setting drawings, templates, instructions, and directions for installation of anchoring devices. Coordinate delivery with Work in other divisions to avoid delays.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All Items shall be delivered, handled and stored with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

.5 The Contractor shall deliver, handle and store materials in original wrappings and containers with manufacturer's seals and labels, intact, protect from freezing, moisture and water.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 MANUFACTURERS

.1 Acceptable material: Electric Power Door, or Purchaser's approved equivalent.

2.2 DESIGN CRITERIA

.1 Service Bay Door shall be a steel, multi-leaf, vertical lift, overhead door.

.2 Clear opening size: 9 m x 9 m.

.3 Service life: 50 years.

.4 The exterior vertical lift door assemblies shall be designed to withstand wind load of 1.5 kPa with a maximum horizontal deflection of 1/120 of opening width.

.5 The maximum horizontal deflection of any panel shall be limited to 1/120 clear span of opening width.

.6 All components of the service bay door shall be sized to provide minimum clearances to building elements and the powerhouse crane as recommended by the crane manufacturer, and as shown on the applicable Purchaser's Drawings and Contractor's Documents.

2.3 MATERIALS

.1 The materials for required Items of Work shall comply with the following standards.

.1 Structural Shapes and Plates: CSA S16, Grade 300W or 350W.

.2 Castings, Cast Iron: ASTM A48.

.3 Hot Rolled Steel, 14 Gauge Minimum: ASTM A1011.

.2 Where required, all steel surfaces shall be galvanized or painted with one shop coat of standard shop primer. Surface preparation prior to shop priming shall be SSPC-SP2 - Hand Tool Cleaning.

.3 Primer shall conform to CAN/CGSB-1.105.

.4 Cable shall be 6x37 Independent Wire Rope Core (IWRC) Type.

.5 Insulation shall be fibrous glass-batt type.

2.4 DOOR

.1 Door panel frames shall be constructed of standard structural steel channel and angles of ample size and strength for loads and stresses imposed under the specified conditions.

.2 Intermediate panel frame members shall run vertically at not more than 610 mm on center.

.3 Door panel frames shall be of welded construction and all joints shall develop the full strength of the framing members.

.4 Door panel frames shall be sheeted on both sides with 14 gauge flat hot rolled steel, which is welded to door panel/leaves.

.5 Door panels/leaves shall be true to dimension and square in all directions.

.6 Door frame shall not be bowed, warped, or out of line by more than 3 mm in 6 m.

.7 Exposed welds and welds which interfere with the installation of other parts shall be ground smooth.

.8 All exposed edges and seams of door sheeting on the interior and exterior sides of the door panel shall be caulked with Eclectic Brand E6100 caulk, or Purchaser's approved equivalent prior to prime painting.

.9 All welds shall be per CSA W59 welding requirements.

.10 Door panels/leaves shall be insulated with minimum 75 mm insulation, providing an R-value of 10 or more. The insulating material shall be fitted to cover the entire surface of the door panel between the structural members.

.11 Door guide assemblies shall consist of a series of structural shapes and plates (arranged as shown on the plans supplied by manufacturer). Guide assemblies shall be fabricated for field bolting or welding to the structural framing as required for a rigid installation. Minimum thickness of the door guide plate and angles material shall be 6 mm.

.12 A steel plate sectional counterweight shall be provided to properly balance door leaves for easy operation. Cast iron counterweight shall not be allowed. The counterweight shall be contained in a steel plate box, which is suspended on cables attached to the door's operating over cast iron sheaves. Counterweight box shall be guided throughout the full height of travel by a counterweight enclosure (tower) with internal guides. Counter-weight guide tower material shall be 6 mm minimum. The full height of the counterweight tower shall be covered with 14 gauge steel.

.13 Bottom sill beam shall be provided as recommended by the door manufacturer. Bottom door panel/leaf shall be provided with a bottom seal, meeting the weathering requirements specified herein.

2.5 HARDWARE

.1 The Contractor shall provide all hardware necessary for a complete installation.

.2 Hardware shall be heavy-duty type, including all bolts and fittings for the hardware as follows.

.3 Guide Rollers

.1 The doors shall have a minimum of eight anti-friction bearing cam followers per panel.

.2 Two cam followers at each corner shall engage single angle steel door guides and guide the panels up and down.

.3 The cam followers and support brackets shall be of sufficient size to transmit the wind load from the door panel to the steel door guides.

.4 Metal-to-metal sliding guides are not permitted.

.5 Cam followers shall not extend above or below the door panels.

.6 The cam rollers shall be easily accessible through the door access panels and shall be easily removable for maintenance or replacement purposes.

.7 Cam follower brackets shall be bolted on.

.4 Cable System

.1 Door panels/leaves shall be placed one behind the other with vertical travel so arranged that all panels/leaves shall start to move at the same time, travel at differential speeds and arrive at their fully opened or closed position simultaneously.

.2 All necessary wire rope, sheave assemblies, and fittings to make the system operable shall be provided.

.3 Panel sheaves shall be mounted on the interior of the panel with easy access by removable covers.

.4 Wire ropes shall be designed to sustain the dead weight door leaves plus 25% impact allowance with minimum safety factor of five.

.5 The ends of the wire ropes at door leaves shall be equipped with turnbuckles or other means for independent adjustment.

.6 Traction sheaves shall be 200 mm diameter minimum and idler sheaves shall be 200 mm diameter minimum.

.7 All idler sheaves shall be provided with sealed roller bearings.

.8 All cable supporting the doors and counterweight shall be 6X37 IWRC type.

.5 Mechanical Emergency Stop Devices

.1 Each door panel/leaf shall be provided with two mechanical emergency stop devices, one at each side.

.2 The mechanical emergency stop device shall be a cam action device, which shall engage the single angle guide and impede the downward slide of the door panels should a cable break or there is an attachment failure. The device in the bottom or single panel shall have a three-point contact action, and in the upper panels, the device shall have a two-point contact action. The device shall be required to be reset by hand once the broken cable is replaced or the attachment devices have been repaired or replaced. The emergency stop device shall be factory tested with verification by an independent testing laboratory.

.6 Weathering

.1 Special wind lock seals shall be dual durometer with flexibility to -40°C.

.2 Wind lock seals shall be push-on type with built-in wear strip.

.3 No external fasteners shall be allowed.

.4 Air leakage shall not exceed 0.2 L/s per linear foot of seal with a 40 km per hour wind.

.7 Operating Unit

.1 Doors shall be suspended on wire ropes reeved from leaves over traction sheaves to counterweights.

.2 Traction sheaves shall be driven by motor operator mounted at floor level with auxiliary hand crank operation.

.3 Electric power operator shall be complete with electric gear motor, magnetic brake, brackets, push button control, limit switches, magnetic reversing starter and other accessories specified and required.

.4 The power operator shall be designed such that the gear motor may be removed without disturbing the limit switch setting and without affecting the emergency auxiliary operators.

.5 Provisions shall be made for immediate emergency manual operation of door in the event of electrical failure.

.6 The emergency operating mechanism shall be arranged such that it can be placed in and out of operation from the floor and its use shall not affect the timing of the limit switches.

.8 Manual Operator

.1 Manual operation shall be by means of a hand crank connected to the drive system by a roller chain drive.

.2 Pull required on hand crank to open the door shall not exceed 9 kg.

.3 A manual interlock switch shall be provided to disconnect the motor when the manual operating hand crank is engaged.

.4 Emergency operation of door by operating through the motor gearing shall not be permitted.

.9 Gearmotor

.1 Motor shall be high-starting torque type, with sufficient torque output to move door in either direction from any position and produce a door travel speed of 0.2 m to 0.3 m/s, without exceeding the rated capacity.

.2 Motor shall be equipped with a magnetic brake.

.3 Motor shall conform to NEMA standards and shall be suitable for operation on 600 Vac, 3-phase, 60 Hz current, unless otherwise specified.

.10 Push Buttons

.1 Push buttons shall be located on the interior of the building where shown and shall be the three-button type, with the buttons marked “OPEN”, “CLOSE”, and “STOP”.

.2 The “OPEN” button shall be of the type requiring only momentary pressure by the operator to cause the door to go from the closed to the fully open position.

.3 The "CLOSE" button shall require constant pressure from the operator to maintain the closing motion of the door.

.4 When the door is in motion and the "STOP" button is pressed, the door shall stop instantly and remain in the stop position; from the stop position, the door may then be operating in either direction by pushing the "OPEN" or "CLOSE" button.

.5 Push buttons shall be NEMA 12 rated, or Purchaser's approved equivalent.

.11 Control Panel

.1 The door shall be furnished with a NEMA 12 control panel enclosure, housing a reversing, across-the-line type magnetic motor starter having thermal-overload protection.

.2 The control panels shall contain relays, fuses, terminal strips, and other electronic components as required and necessary to provide the specified operating sequences.

.3 All components shall be prewired to the terminal strip and neatly labelled. Power circuits in excess of 200 V shall be provided with control transformers to reduce voltage on the control circuit to 120 V.

.4 Control panel assembly shall be UL labelled.

.5 Wiring and terminations shall be in accordance with Section 26 05 21Wire and Cable Systems of the Technical Specification and Section26 05 00 Electrical General Requirements of the Technical Specification.

.6 Control panel shall be located in the interior of the building.

.12 Limit Switches

.1 Shall be NEMA rated snap-action type with an adjustable roller arm.

.2 Open, close, and reversing edge limits shall be mounted on the door counterweight tower and activated by a cam attached to the lower door panel.

.3 The motor operator limit switch shall be mounted on the operator.

.13 Photo Eye

.1 The door shall be provided with one photo eye.

.2 Photo eye to be infrared type with transmitter and receiver.

.3 Units to be provided in NEMA 4X or IP6 housing.

.4 Photo eye to be a non-reflective through beam system with LED alignment indicator and supervised relay output for providing a detect signal in case of power failure.

.14 Reversing Device

.1 The bottom edge of the lower door panel/leaf shall be equipped with a reversing device which shall immediately stop and reverse the downward travel of the door upon contact with an obstruction in the door opening.

.2 The reversing device shall not substitute for a limit switch.

Part 3 Execution

3.1 INSTALLATION

.1 The installation of the door shall be by an authorized representative of the door manufacturer or with factory supervision.

.2 Install door, hardware, accessories to manufacturer directions in locations indicated.

.3 Apply finish painting in accordance with Section 09 90 00 Painting and Coating of the Technical Specification.

.4 Install electric operators, push button stations, other electrical equipment required for door operation.

.5 Wire, connect components together from disconnect switch, power supply located near openings, as shown on the Purchaser's Drawings and Contractor's Documents or as directed by the Engineer.

.6 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification and Section 26 05 21 Wire and Cable Systems of the Technical Specification.

3.2 PRE-COMMISSIONING

.1 The Contractor shall perform all pre-commissioning tests and adjustments to the service bay door.

.2 Door and equipment shall be lubricated, tested and adjusted to ensure proper and easy operation and correct function, to the satisfaction of the Engineer. Door operation shall be free from warp, twist, or distortion and fit weather-tight for entire perimeter.

3.3 COMMISSIONING

.1 The Purchaser will commission the service bay door.

.2 The Contractor shall provide commissioning support as requested. An authorized representative of the door manufacturer shall be made available during commissioning.

3.4 TRAINING

.1 The Contractor shall provide a detailed list of recommended spare parts and a detailed listing of maintenance procedures to be performed on the door. Door manufacturer shall provide instruction to Site staff on how to perform outlined maintenance.

END OF SECTION

1.0 GENERAL

This technical specification has been prepared to standardize the coating systems and colors for turbines, generators, heavy machinery and industrial equipment designed or specified by the Mechanical Engineering Dept. New installations, fabrications, repairs, refurbishments etc. done either by Manitoba Hydro staff or by Contractors shall follow this specification unless specifically directed by Manitoba Hydro's Engineer. All proposed deviations, substitutions, etc. shall be approved by Manitoba Hydro's Engineer.

2.0 SURFACE PREPARATION

Surfaces to be painted shall be properly prepared and shall be dry and suitable for finishing before painting is commenced.

Prepared surfaces shall be kept indoors in a heated area and shall not under any circumstances be exposed to the weather. If rusting has occurred on any prepared surface prior to application of the coating, the surfaces shall be prepared again.

Caution shall be taken to protect machined surfaces, machinery, bearings and other equipment from sand, solvent, dirt, rust and grit.

2.1 Metal Surfaces Blast Cleaning

Prior to blast cleaning, heavy deposits of oil or grease shall first be removed in accordance with SSPC SP-1 "Solvent Cleaning". Small quantities of oil or grease may be removed by the blasting process, in which case, the abrasive shall not be reused if it contains sufficient oil or grease to render it unsuitable for blast cleaning purposes.

2.2 Metal Surfaces Power Tool Cleaning

All deposits of oil, grease, dirt, welding flux and salts, shall first be removed in accordance with SSPC SP-1 "Solvent Cleaning".

Edges of existing painted surfaces shall be feathered into the prepared surfaces. All welds, torch cut surfaces, or other mechanical damage shall be ground smooth and weld splatter removed before surface preparation commences.

2.3 Protection For Surfaces Not To Be Coated

Masking shall be used to prevent over-spray and to protect finished surfaces adjacent to areas being prepared or painted.

Factory finished materials such as baked enamel, chrome plating, stainless steel, bronze, copper, brass, aluminum, porcelain, ceramic tile, door and cabinet hardware, vinyl, pre finished metals, laminated plastics, acrylics, latex rubber, fiberglass, acoustic tile, open or louvered electrical cable trays shall not be painted unless otherwise directed by the Engineer.

For short term storage, machined metal surfaces shall be protected with a light coat of Cosmoline 1102 or other light machine oil. For long term storage, apply a liberal coat of Valvoline Tectyl 506 or Houghton International Rust Veto 344.

3.0 MATERIALS & WORKMANSHIP

3.1 General

Surfaces to be coated shall be completely dry and shall be at a minimum temperature of 10ºC and at least 3ºC above the dew point of the surrounding air.

Newly cleaned or painted surfaces shall be protected from moisture, condensation, contamination and freezing temperatures until the paint is thoroughly cured. Care shall be taken to prevent contamination of surfaces between coats of paint.

Thinners shall not be added to any paint except as recommended by the paint manufacturer. Paint thinners, if used, and solvents shall be compatible with the paint materials used. Each coat shall be thoroughly cured in accordance with the manufacturer's instructions before application of succeeding coats.

3.2 Spray Application

Air lines shall be equipped with water traps for removal of moisture.

3.3 Curing Time

Curing schedules as recommended by the paint manufacturers shall be followed for each coating.

Parts shall be cured to "Hard Dry" before handling. If parts must be moved before they are fully cured, care shall be taken to ensure the coating is not damaged.

3.4 Inspection

The painted surface will be considered to lack uniformity, continuity and soundness, and will be rejected if any of the following defects are apparent:

- runs, sags, holidays, non-uniformity or shadowing caused by inefficient application methods or,

- evidence of poor coverage at plate lap joints, crevices, pockets, corners and re-entrant angles or,

- damage to coating because of handling before the paint is sufficiently dry, or any other contributory causes.

Rejected surfaces shall be re-cleaned and/or recoated. Small affected areas may be touched up; large affected areas or where insufficient dry film thickness has been attained shall require the application of another complete coat. Runs, sags, or paint damaged in handling shall be removed prior to further application of paint.

3.5 Coating Systems & Color Schedule

Coating systems shall be in accordance with Table P-1. Colors shall be in accordance with Table P-2.

Any deviations from the coating systems or colors in Tables P1 or P2 shall be approved by Manitoba Hydro's Engineer.

Insulated pipes shall be painted white with 4" wide color bands applied at intervals not greater than 10' or as otherwise directed by Manitoba Hydro's Engineer. In the event that an item requiring paint is not listed in Table P-2, contact Manitoba Hydro's Engineer for instructions.

TABLE P-1: COATING SYSTEMS AND SURFACE PREPARATION

Coating System	S - 1	S - 2	S - 3	S-4
Coating System Type	Industrial Equipment Enamel	2-Part Epoxy	2-Part Epoxy (Oil Immersion)	Anti-Slip Epoxy
Service Type	Indoor exposure, generator components, etc.	All turbine components and embedded parts not subject to oil immersion. Includes hand railings.	Tank and gearbox interior linings, etc. subject to oil immersion	Platforms, walkways and stairs.
Surface Preparation	Blast cleaning to SSPC SP-6 “Commercial Blast Cleaning”	Blast cleaning to SSPC SP-10 “Near White Metal”	Blast cleaning to SSPC SP-10 “Near White Metal”	Blast cleaning to SSPC SP-6 “Commercial Blast Cleaning”
Re-Preparation, If Coating Delayed	Blast cleaning to SSPC SP-6 “Commercial Blast Cleaning” or Solvent Cleaning to SSPC SP-1 or Power Tool Cleaning to SSPC SP-2 or SP-3 as directed	Blast cleaning to SSPC SP-10 “Near White Metal” or Solvent Cleaning to SSPC SP-1 or Power Tool Cleaning to SSPC SP-2 or SP-3 as directed	Blast cleaning to SSPC SP-10 “Near White Metal” or Solvent Cleaning to SSPC SP-1 or Power Tool Cleaning to SSPC SP-2 or SP-3 as directed	Blast cleaning to SSPC SP-6 “Commercial Blast Cleaning” or Solvent Cleaning to SSPC SP-1 or Power Tool Cleaning to SSPC SP-2 or SP-3 as directed
Approved Primers	One coat, minimum dry film thickness 1.5 - 2.0 mils • Cloverdale Paint Grey Rustex Primer No. 71024. • General Paint Universal Grey Primer 06164 • International Paint Grey Primer Interprime 198 CPA098	None	None	None
Approved Finish Coats	Two coats, minimum dry film thickness 1.25 - 1.75 mils / coat • Cloverdale Paint Industrial Enamel No. 74 • General Paint Industrial Enamel No. 16 • International Paint Interlac 665FD Industrial Enamel	Two coats, minimum dry film thickness 5.0 - 8.0 mils / coat • Cloverdale Paint ClovaMastic Epoxy 83110 • PPG Protective & Marine Coatings Amerlock 2 Epoxy • International Paint Interseal 670HS Epoxy	Two coats, minimum dry film thickness 5.0 - 7.0 mils / coat • PPG Protective & Marine Coatings Amercoat 90HS Epoxy • International Paint Interline 850 Epoxy	One coat, minimum dry film thickness 13.0 - 16.0 mils. • Clovagrip Anti-Slip Epoxy 83355 • General Paint 11-890 • International Paint 670HS, with addition of grit media (aluminum oxide) or a polymeric bead added during mixing.

TABLE P-2: COLOR SCHEDULE

ITEM	COATING SYSTEM	FINISH COAT COLOR *
Generator Covers	S-1	Grey
Air Intake Baffles	S-1	Grey
Generator Brackets	S-1	Grey
Exciter Housing	S-1	Grey or Alternate
Exciter Cone	S-1	Grey
SAC Supports	S-1	Grey
Rotor Spider	S-1	Grey
Stator Frame & Supports	S-1	Grey
Stator Air Box Covers	S-1	Grey
PMG	S-1	Grey or Alternate
Brush Gear Support	S-1	Grey
Control Panels	S-1	Grey or Alternate
Bearing Oil Sump Interior	S-3	White
Turbine Pit Liner	S-2	White
Stay Ring (Dry Side)	S-2	Grey
Stay Ring (Wet Side)	S-2	White
Head Covers (Dry Side)	S-2	Grey
Head Covers (Wet Side)	S-2	White
Runner Hub & Cone	S-2	White
Operating Ring	S-2	Yellow
Links & Levers	S-2	Yellow
Servomotors	S-2	Yellow
Connecting Links	S-2	Yellow
Bearing Shell Exterior	S-2	Grey
Governor Tanks (Air, Exterior)	S-1	Grey
Governor Tanks (Air, Interior)	S-2	White
Governor Tanks (Oil, Exterior)	S-1	Grey
Governor Tanks (Oil, Interior)	S-3	White
Water Passage Doors	S-2	Grey
Wicket Gates	S-2	White
Special Tools	S-1	Yellow
Air Piping	S-1	Blue
Water Piping	S-1	Green
Fire Protection Piping	S-1	Red
Oil Piping	S-1	Purple
Water With Trace Oil Piping	S-1	Green
Platforms, Walkways & Stairs	S-4	Grey or Alternate

* COLOR CODES:

White	– RAL 9003
Green	– RAL 6032
Grey	– RAL 7042
Blue	– RAL 5015
Red	– RAL 3020
Purple	– RAL 4006
Yellow	– RAL 1023
Alternate	– Select RAL color code to match existing equipment

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour and Materials, except as herein provided, and performing all Work necessary including, transporting, unloading, handling, cleaning, and surface preparation for all painting and coating (including galvanizing) of piping, HVAC equipment, structural steel, miscellaneous metal, metal decking, concrete, and concrete block and drywalled walls as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein.

.2 This Section of the Technical Specification covers the technical requirements for the painting and coatings applied pursuant to this Project.

.3 The painting of electrical equipment is covered under Section 26 05 00 Electrical General Requirements.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 05 12 23 - Structural Steel.

.3 Section 05 50 00 - Miscellaneous Metal.

.4 Section 40 50 01 - Mechanical & Piping General Requirements.

.5 Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Works shall be performed in accordance with:

.1 Canadian Standards Association:

.1 CSA G164 - Hot Dip Galvanizing of Irregularly Shaped Articles.

.2 Standards and Specifications of the American Society for Testing and Materials:

.1 ASTM A123/A123M - Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

.2 ASTM A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

.3 ASTM A653/A653M - Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

.4 ASTM D4258 - Standard Practice for Surface Cleaning Concrete for Coating.

.5 ASTM D4261 - Standard Practice for Surface Cleaning Concrete Masonry Units for Coating.

.6 ASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting.

.3 International Organization for Standardization:

.1 ISO 12944 - Paints and Varnishes - Corrosion Protection of Steel Structures by Protective Paint Systems.

.4 Standards of the Steel Structures Painting Council:

.1 Paint Application:

.1 SSPC-PA 1 - Shop, Field and Maintenance Painting of Steel.

.2 SSPC-PA 2 - Procedure for Determining Conformance to Dry Coating Thickness Requirements.

.2 Preparation Methods:

.1 SSPC SP 1 - Solvent Cleaning.

.2 SSPC SP 2 - Hand Tool Clean.

.3 SSPC SP 3 - Power Tool Cleaning.

.4 SSPC SP 5 - Surface Preparation and Cleaning of Metals by Water-Jetting Prior to Re-Coating.

.5 SSPC SP 6 - Commercial Blast Cleaning.

.6 SSPC SP 10 - Near-White Blast Cleaning.

.7 SSPC SP 20 - Zinc-Rich Coating.

.5 Canadian General Standards Board:

.1 CAN/CGSB-85.100 - Painting.

.2 CAN/CGSB-85.10 - Protective Coatings for Metals.

.6 National Fire Code of Canada.

.7 Workplace Hazardous Materials Information System (WHMIS).

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 09 90 00 (a) to 09 90 00 (e) shall be in square metres as measured and approved in the field by the Engineer.

.2 No separate measurement or Target Price will be made for painting/coating of piping systems.

.3 No separate measurement or Target Price will be made for painting/coating of electrical mechanical equipment.

.4 No separate measurement or Target Price will be made for painting/coating of any materials or equipment where the painting/coating is to be shop applied. Include costs for this Work in the unit prices for the Items to which it applies.

.3 Unit Price

.1 The unit prices for Items 09 90 00 (a) to 09 90 00 (e) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply and application of the specified field paint systems including surface preparation and all required primer and finish coat(s) and cleanup as shown on the applicable Purchaser's Drawings and Contractor's Documents, specified herein, and as directed by the Engineer and as follows:

.1 Item 09 90 00 (a) shall cover painting and coatings for concrete block walls.

.2 Item 09 90 00 (b) shall cover painting and coatings for concrete surfaces including walls, ceiling, and floors.

.3 Item 09 90 00 (c) shall cover painting and coatings for interior steel surfaces.

.4 Item 09 90 00 (d) shall cover painting and coatings for exterior steel surfaces.

.5 Item 09 90 00 (e) shall cover painting and coatings for interior drywall or wood surfaces.

.2 The supply and application of painting/coating of piping systems shall be considered incidental to the Work. Include costs for such Work in the unit prices proposed for the Items to which the Work applies.

.3 The supply and application of painting/coating of electrical equipment shall be considered incidental to the Work. Include costs for such Work in the unit prices proposed for the Items to which the Work applies.

.4 The supply and application of all shop coats and field touch-up paint shall be considered incidental to the Work. Include costs for such Work in the unit prices proposed for the Items to which the Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 The Contractor shall submit all painting and surface preparation procedures for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.3 The Contractor shall submit full records of all products used. Each product shall be listed in relation to finish formula and include the following: finish formula designation, product type and use, manufacturer's product number, color number(s), Manufacturer's Material Safety Data Sheets (MSDS).

.4 The Contractor shall obtain written instructions from the paint manufacturers and these instructions shall be submitted to the Engineer. These instructions along with the

requirements specified in this Section of the Technical Specification shall be followed by the Contractor.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Control of the General Specification.

.2 Applicator Qualifications: Company specialized in performing the type of Work specified with a minimum of 5 years experience.

.3 A minimum of one qualified journeyman painter shall be present while the Work of that trade is being performed. The Work shall be done by skilled personnel, experienced in this type of Work and shall be performed in a workmanlike manner.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 All of the manufacturer's recommendations for storage and handling shall be observed.

.3 Paint shall be delivered to the Site in quantities sufficiently large enough so that several different batches of the same colour will not be required.

.4 The Contractor shall deliver and store materials in original containers, sealed, with labels intact. Containers not in use, shall be sealed.

.5 Dry, temperature controlled, weatherproof, and secure storage shall be provided and maintained.

.6 Materials and supplies shall be stored away from heat generating devices. Temperature sensitive products shall be stored above the minimum temperature recommended by manufacturer.

.7 The Contractor shall ensure that all applicable federal, provincial, territorial and local regulations for safety precautions are taken to avoid fire and personnel hazards of stored materials and while working with inflammable and toxic materials.

.8 The Contractor shall permit access to storage and application areas and allow the Engineer and their inspection staff to verify the materials being used.

.9 The Contractor shall exercise care during loading, transport, unloading, storing and installation of coated Items to minimize damage to coating.

.10 The Contractor shall ensure that coating is not exposed to dirt, contaminants and immersion.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with the requirements of Section 7.40 Clean-Up and Removal of Plant, Surplus, Materials and Debris of the General Specification.

.2 The Contractor shall store oily rags, waste products, empty containers and materials subject to spontaneous combustion in ULC accepted, sealed containers and shall remove them from site on a daily basis. The Contractor shall handle, store, use and dispose of flammable and combustible materials in accordance with the National Fire Code of Canada.

.3 The Contractor shall comply with requirements of Workplace Hazardous Materials Information System (WHMIS) regarding use, handling storage, and disposal of hazardous materials.

Part 2 Products

2.1 GENERAL

.1 Unless recommended by the manufacturer, all paint materials within a specific painting/ coating system shall be compatible with each other and be from the same manufacturer.

.2 Specified paint materials shall be as manufactured by Pittsburgh, Benjamin Moore, Pratt and Lambert or as noted.

.3 The material supplied shall be, as far as possible, pre-mixed by the paint manufacturer, at the factory.

.4 The material formulation specified shall be followed without change, unless written permission for variation has been received from the Engineer, for all mixing done at Site.

.5 The Contractor shall provide all paint materials and all other materials required to complete the Work.

.6 The Contractor shall supply adequate amounts of approved primer as well as paint for each of the systems. The Contractor shall supply adequate coatings for locations where field application/touch-up is required.

.7 Due to the current variances in volatile organic compound (V.O.C) regulations, this Section of the Technical Specification may reference materials that do not comply with local Laws. It is expected that local manufacturers and/or suppliers will comply with local regulations and submit equivalent alternative products for use on this Project that meet the quality and performance intent of this Section of the Technical Specifications while complying with applicable Laws.

.8 Painting and/or galvanizing of all metal surfaces for structural and miscellaneous metalwork shall be in the shop prior to shipment to the Site, unless accepted by the Engineer.

2.2 MECHANICAL EQUIPMENT AND PIPING

.1 Unless otherwise specified, mechanical equipment such as pumps, compressors, fans, procured by the Contractor shall be coated by the manufacturer with their factory standard coating system; additional painting at Site is not required except that the Contractor shall touch-up paint any equipment coating that is damaged during shipping, handling, storage, installation and/or testing.

.2 Paint all piping systems (piping, fittings, valves, etc.) and custom-fabricated mechanical equipment (e.g. oil tanks, compressed air receivers, etc) in accordance with the coating systems/materials specified in Appendix A “Mechanical Coatings Standard”.

2.3 PAINTING FOR HVAC EQUIPMENT NOT GALVANIZED

.1 All HVAC equipment not protected by a galvanized coating shall be painted as follows:

.1 Primer: one coat of zinc chromate Northern Paint Company Norco No. 1165, minimum dry film thickness 0.040 mm.

.2 Finish Coat: one coat of alkyd machinery enamel, Northern Paint Company Norco Industrial and Equipment Enamel 6600 Line.

.3 Colour: the Engineer shall provide a colour schedule with references to colour chips using CGSB or ANSI numbers for the use of the Contractor.

2.4 EXTERIOR STRUCTURAL STEEL AND MISCELLANEOUS METALWORK

.1 All exterior structural steel and both interior and exterior miscellaneous metalwork such as ladders, stairs, hatch covers, grating, guardrails and handrails shall be hot-dip galvanized after fabrication unless stated otherwise on the applicable Purchaser's Drawings and Contractor's Documents.

.2 Bollards and steelwork, when as noted on the applicable Purchaser's Drawings and Contractor's Documents, shall be galvanized and painted. Bollards shall be painted "Safety Yellow".

2.5 INTERIOR STRUCTURAL STEEL

.1 All interior structural steel shall be coated in accordance with the requirements of ISO 12944 Standard corresponding to a high durability (>15 years) requirement and corresponding to a Class 3 classification (areas with high humidity).

2.6 ARCHITECTURAL WORK [ON HOLD]

.1 The Contractor shall refer to the applicable Purchaser's Drawings and Contractor's Documents for details of the finish schedules.

.2 All paint material shall be as specified below:

.1 Drywall:

.1 Primer - one coat of Interior Latex Emulsion Primer.

.2 Finish - Two coats of Alkyd Low Gloss Enamel (Eggshell Finish).

.2 Interior Steel (Doors and Frames, Grills, etc.):

.1 Primer - One coat of Alkyd Enamel Undercoater (Doors and Frames - Touch-up only).

.2 Finish - Two coats of Alkyd Satin Enamel.

.3 Concrete and Concrete Block (except Showers):

.1 Primer - One coat of Block Filler.

.2 Finish - Two coats of Alkyd Low Gloss Enamel (Eggshell Finish).

.4 Concrete Block (Showers):

.1 Primer - One coat of Block Filler.

.2 Finish - Two coats of Epoxy Coating.

.5 Formula 1 (Epoxy): for concrete floors:

.1 One prime coat Epirex Akva WD self-priming water based epoxy (thin 25%).

.2 One finish coat Epired Akva WD self-priming water based epoxy.

.6 Formula 2 (Alkyd): for new concrete block walls:

.1 One coat latex block filler.

.2 One coat primer sealer.

.3 Two coats semi-gloss alkyd enamel.

.7 Formula 3 (Alkyd): for shop primed ferrous metal:
- .1 Touch-up shop primer with primer as provided by fabricator.
- .2 One coat marine alkyd metal primer CGSB1-GP-48M.
- .3 Two coats exterior gloss enamel CAN/CGSB-1.60.

.8 Formula 4 (Alkyd): for wood trim, plywood paneling:
- .1 Spot prime knots and resinous areas CAN/CGSB-1.126.
- .2 One coat enamel undercoat CAN/CGSB-1.38.
- .3 Two coats semi-gloss enamel CAN/CGSB-1.195.

.9 Formula 5 (Alkyd): for steel doors and frames**:**
- .1 One coat cementitious primer to CAN/CGSB-1.198.
- .2 Two coats exterior semi-gloss enamel to CAN/CGSB-1.60.

.10 Formula 6 (Alkyd): for zinc coated and galvanized metal:
- .1 One coat vinyl wash primer.
- .2 One coat alkyd enamel undercoat.
- .3 Two coats semi-gloss alkyd enamel.

.11 Formula 7 (Alkyd): for existing painted concrete block:
- .1 One coat primer sealer.
- .2 Two coats semi-gloss alkyd enamel.

.12 Formula 8 (Alkyd): for existing painted miscellaneous metal work:
- .1 One coat primer sealer.
- .2 Two coats high gloss alkyd enamel.

.13 Formula 9 (Non-slip Epoxy): for ventilation housing checkered plate floors:
- .1 One coat American Safety MS-5C Industrial Metal Primer.
- .2 One coat American Safety AS-150 Anti-Slip Coating.

Part 3 Execution

3.1 GENERAL

.1 All materials supplied by the Contractor shall be new and of the best quality conforming to the requirements set out in this Section of the Technical Specification. Materials declared as expired by the manufacturer will be rejected. Also, materials which, in the opinion of the Engineer, are defective or otherwise unsatisfactory shall not be incorporated into the Work, and shall be replaced by the Contractor at no cost to the Purchaser.

.2 Continuous ventilation shall be provided during and after application of paint.

.3 Adequate illumination shall be provided during preparation for and application of paint.

.4 Exterior finishes shall only be painted when conditions forecast for entire period of application fall within manufacturer's recommendations. Painting operations shall be scheduled such that surfaces exposed to direct, intense sunlight are scheduled for completion during early morning. The painted surface shall be appropriately protected against the environment as required until the paint is sufficiently cured.

.5 The Contactor shall apply paint finish only when dust is no longer being generated by related construction operations or when wind conditions are such that airborne particles will not affect the quality of the finished surface.

.6 The final coat shall exhibit uniformity of color and texture as well as uniformity of sheen across full surface area.

.7 Surfaces which will be inaccessible after assembly and/or erection or after installing of the cladding shall receive a minimum of two coats of the specified primer. Wherever two coats of primer are to be applied, the preceding coat shall be tinted to a contrasting colour.

.8 All tinting operations shall be performed prior to delivery of paint to Site unless reviewed by Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.9 The Contractor shall take all precautions necessary to protect personnel and equipment from noxious fumes and against all fire hazards. Signs shall be posted by the Contractor to prevent grinding, welding, smoking and other unsafe activities from being performed in the painting areas.

.10 The Contractor shall not paint factory finished materials such as baked enamel, chrome plating, stainless steel, bronze, copper, brass, aluminum, porcelain, ceramic tile, door and cabinet hardware, vinyl, vinyl asbestos, pre-finished metals, laminated plastics, acrylics, fiberglass, acoustic tile, open or louvered electrical cable trays, unless specifically noted otherwise in the finish or color schedules.

.11 The Purchaser will confirm all colors after award of Contract.

.12 Additional execution requirements for painting of mechanical equipment and piping shall be as specified in Appendix A "Mechanical Coatings Standard".

3.2 SURFACE PREPARATION

.1 The Contractor shall clear and sweep clean areas in which the Contractor proposes to paint. Thereafter, the Contractor shall maintain each Work area clean to the extent required for proper execution of the Work. Under no circumstances shall rags, paper and other debris be allowed to accumulate. The Contractor shall be solely responsible for initial and subsequent cleaning of surfaces to be painted or finished.

.2 Surfaces to be painted shall be cleaned in accordance with the paint manufacturer's recommendation. The Contractor shall prevent contamination of cleaned surfaces before prime coat is applied and between applications of remaining coats. Primer, paint, or pre-treatment shall be applied as soon as possible after cleaning and before deterioration occurs. Under no circumstances shall the elapsed time between commencement of surface cleaning operation and application of coating exceed 8 hours.

.3 Steel surfaces shall not be abrasive blast cleaned when the surface temperature is less than 3°C (5°F) above the dew point, when relative humidity is greater than 85%, or when there is a possibility that the abrasive blast cleaned surface will be subjected to wetting before the first prime coat can be applied.

.4 Surfaces to be coated shall be completely dry and shall be at a minimum temperature of 10°C and at least 3°C above the dew point of the surrounding air. The Contractor shall provide heat in the various areas where this aspect of the Work will be performed, to ensure these conditions are met.

.5 Special attention shall be paid to areas at fasteners and welds, to ensure all products of corrosion and other deleterious materials are removed to bright metal. Prior to abrasive blast cleaning, deposits of sealing compound, oil or grease shall be removed by solvent cleaning in accordance with SSPC Specification SP-1 or Purchaser's approved equivalent method.

.6 No more surface area shall be abrasive blast cleaned than can be prime coated by the end of the same Working Day. A 6 in. wide strip of un-coated abrasive blast cleaned surface shall be left between primed and non-abrasive blast cleaned surfaces.

.7 Existing paint, welding spatter, slivers, laminations, and underlying mill scale not removed by the abrasive blast cleaning operation shall be removed by the best mechanical means and edges smoothed or rendered flush. Abrasive blast cleaned surfaces shall be kept under protective cover if necessary and shall not be exposed to rain under any circumstances. If rusting has occurred on any abrasive blast cleaned surface prior to application of the prime coat, the surface shall be re-abrasive blast cleaned.

.8 If, in opinion of the Engineer, sufficient rusting has occurred on the previously cleaned surface so as to reduce the effectiveness of the bonding of the paint, such surface shall be cleaned of rust to the satisfaction of the Engineer. Painting shall take place as soon as practicable after inspection, but in any event not later than 8 hours and before any visible or detrimental rusting or contamination occurs.

.9 Surfaces Not to be Painted

.1 Surfaces which will be in contact with concrete, grout, mortar.

.2 Steel surfaces requiring field welding.

.3 Underside of base plates where grouted.

.4 Faying surfaces on field connections to be high strength bolted shall be blanked off during shop painting to prevent accumulation of oil, paint, lacquer or other coatings. Should any contamination occur on the faying surfaces they shall be cleaned to the Engineer's satisfaction before the members leave the shop.

.5 Machine finished or similar surfaces that should not be painted but which require protection shall be protected with a coating of rust inhibiting compound authorized by the Engineer.

.10 Preparation of Surfaces to be Galvanized

.1 Preparation for galvanizing shall meet the requirements of CSA G164 Appendix B and ASTM A123.

.2 Prior to galvanizing, all material to be galvanized shall be cleaned carefully of rust, loose scale, dirt, oil, grease and other foreign substances. Weld spatter, rough welds or sharp protrusions shall be removed by chipping and grinding.

.3 Vent holes shall be provided where required for galvanizing.

.11 Preparation of Metal Surfaces to be Painted

.1 Scale, flux, rust, burnt or damaged paint and other foreign matter shall be completely removed by hand tool cleaning in accordance with SSPC Specification SP2.

.2 Where the existing primer is in a satisfactory condition, the surfaces shall be cleaned of all soil, cement splatter and other foreign matter by brushing and scraping. Damaged areas shall be spot primed prior to applications of finish coats.

.3 The general procedure to remove oil and grease shall be by solvent cleaner in accordance with SSPC-SP1.

.4 All metal for fabrication shall be sandblast cleaned in accordance with SSPC-SP6 Commercial Blast Cleaning to a 30 to 50 µm profile.

.5 Metal in which zinc-rich epoxy primer is being applied shall be sandblast cleaned in accordance with SSPC-SP10 Near White Metal Blast Cleaning.

.6 Checkered plate surfaces that will receive anti-slip coating shall be cleaned to a "Commercial" condition, in accordance with SSPC Specification SP6, to a 30 - 50 µm profile.

.7 For all methods of surface preparation, and prior to paint application, loose dirt, rust, deteriorated coatings, blasting abrasives or other foreign materials shall be removed from the surface with clean brushes, compressed air and vacuum cleaner. Care shall be taken to ensure complete removal of such debris from joints, angles, fasteners, and corners. Special attention shall be paid to areas at fasteners and welds, to ensure all products of corrosion and other deleterious materials are removed to bright metal.

.12 Preparation of Galvanized Surfaces to be Painted:

.1 Galvanized steel and zinc coated steel surfaces such as bollards and steel doors and frames shall be prepared to CAN/CGSB-85.10 and ASTM D6386.

.2 Galvanized Surfaces shall first be solvent cleaned in accordance with SSPC Specification No. SP1, to remove dust, dirt and moisture. This shall be followed by a one-stage brush or spray application by Met-L-Etch vinyl wash primer. If this primer is applied by spray, it shall be airless spray equipment.

.13 Preparation of Concrete and Concrete Block Surfaces to be Painted

.1 Concrete and masonry surfaces shall be prepared to CAN/CGSB-85.100, ASTM D4258 and ASTM D4261.

.2 All cracks, faults and projecting fins shall be repaired and all loose particles, foreign matter, stains, grease and oil shall be removed by scraping, wire brushing and/or use of detergents to the satisfaction of the Engineer.

.3 Efflorescence shall be removed by wetting the surface with water, applying a solution of muriatic acid at least 20% in strength and after five minutes, scouring off the salt deposits with a stiff brush. After each acid treatment, the surface shall be washed thoroughly with water.

.4 Surfaces shall be neutralized with a solution of 1 kg zinc sulphate to 2 L warm water, which has been allowed to settle for 48 hours. The liquid shall be drained off for application by brush or spray, wetting the surfaces thoroughly. After bubbling action has stopped, the surfaces shall be washed with clean water to ensure removal of all solution. Prior to application of prime coat, the surfaces shall be allowed to dry and brushed to remove crystalline residue.

.14 Preparation of Wood Surfaces to be Painted

.1 Wood surfaces shall be prepared to CAN/CGSB-85.100.

.2 Nail holes, cracks and blemishes shall be filled prior to priming. Woodwork shall be sanded smooth with No. 2/0 garnet paper, and the surface cleaned before proceeding with the application of the first coat.

.15 Preparation of Drywall Surfaces to be Painted

.1 Surfaces shall be prepared to CAN/CGSB-85.100.

.2 Rough areas shall be sanded smooth. Cracks, nail holes, and other surface blemishes shall be filled flush with the adjoining surface. Joints and repaired areas shall be spot primed prior to application of prime coat, to prevent shading and suction.

.16 Preparation of HVAC Equipment to be Painted

.1 The Contractor shall prepare all surfaces to be painted and shall apply primer and finish coats in accordance with the requirements specified herein.

.2 Surfaces shall be pre-cleaned using solvents to SSPC Specification SP1 and shall be power tool cleaned to SSPC Specification SP3. As an alternative to power tool cleaning, the Contractor may use "Commercial" sand blast cleaning to SSPC Specification SP6. Paint application shall be undertaken immediately following final cleaning of the surfaces. Under no circumstances shall the elapsed time between commencement of the surface cleaning operation and application of primer coats exceed a period of 6 hours.

3.3 PROTECTION

.1 Shall be in accordance with the requirements set out in Section 7.18 Proactive Measures of the General Specification.

.2 Adjacent building surfaces, that are not to be painted, shall be protected from paint spatters, markings and other damage. If damaged, the Contractor shall clean and restore such surfaces as directed by the Engineer. Windows and other ornamental hardware adjacent to areas being painted shall be covered to prevent damage and to protect them from paint drops and splatters. Non-staining coverings shall be used. Items that are permanently attached such as fire labels on doors and frames shall be protected. Factory finished products and equipment shall also be protected.

.3 The Contractor shall provide and use drop cloths for draping and covering adjacent surfaces and machinery from dust, dirt and overspray in open areas. Masking tape shall be used in confined areas to prevent overspray and to protect finished surfaces adjacent to areas being painted. Portable equipment shall be covered or moved around the building as necessary to carry out painting operations.

.4 The Contractor shall remove installed surface fittings, hardware, electrical fixtures, door knobs and electrical cover plates, during surface preparation and shall store and reinstall such items at the completion of the Work in each area.

.5 Newly cleaned or painted surfaces shall be protected from moisture, condensation, contamination and freezing temperatures until the paint is thoroughly cured. Care shall be taken to prevent contamination of surfaces between coats of paint.

3.4 APPLICATION OF GALVANIZING

.1 Hot-dip galvanizing shall be in accordance with the relevant sections of CSA G164, ASTM A123, and ASTM A653.

.2 The galvanizing of bolts, nuts and washers shall conform to and be carried out in accordance with the requirements of CSA G164 and ASTM A153. Nuts shall be tapped after being galvanized and the threads of nuts left bare.

.3 Materials shall be galvanized after fabrication, machining and shop work is completed unless approved by the Engineer.

.4 The Contractor shall be responsible to take necessary means to ensure that materials are not distorted during the galvanizing process. If the Contractor proposes additionally to reinforce, brace, or otherwise stiffen the materials, the Contractor shall submit details of the proposed measures to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification prior to proceeding with the relevant Work.

.5 Galvanized surfaces damaged during construction shall be touched up with Galvafroid or Fastenal Galvax as per manufacturer's recommendations at no additional expense to the Purchaser.

.6 Galvanized piping materials and supports shall be touched up with Fastenall Galvax, or the Purchaser's approved equivalent, at welds and areas where the zinc coating is damaged.

3.5 APPLICATION OF PAINT

.1 The storage, handling, mixing and application of protective coatings on all metal surfaces shall be in strict conformity with the manufacturers' instructions and the applicable sections of SSPC-Steel Structures Painting Council Manual, Volumes 1 and 2 except as otherwise required herein.

.2 Coatings shall be applied only under conditions of humidity and of surface and ambient air temperatures that encourage evaporation and discourage condensation. Exterior surfaces to be coated shall be dry and interior surfaces shall be free of observable moisture.

.3 Thinners shall not be added to any paint except as recommended by the paint manufacturer. Paint thinners and solvents shall be compatible with the paint materials used. The Contractor shall determine that paint or varnish materials are compatible with the primer or sealer previously used.

.4 The Contractor shall provide all necessary scaffolds, ladders, drape cloths, masking tape, wipers and other supplies and Materials to carry out this aspect of the Work. The Contractor shall provide necessary mechanical paint mixing equipment.

.5 All sandblasted, ground or wire-brushed surfaces shall be primed as soon as possible after such treatment, but in any case the maximum time before priming shall be 8 hours.

.6 Material shall be evenly applied, well brushed out, so as to be uniform, free of runs, sags, crawls, with clean corners and minimum of brush marks. Finishes shall be uniform as to sheen, color and texture, even and smooth.

.7 All surfaces shall be inspected by the Contractor to ensure continuity of the coating.

.8 Undercoats shall be tinted one shade lighter than final colors. Specified coats are intended to cover surfaces perfectly. The Contractor shall apply further coats, if the surfaces are not covered, until a satisfactory finish is achieved.

.9 Painted surfaces damaged during construction shall be repainted to the requirements set out in this Section of the Technical Specification and ISO 12944 at no additional cost to the Purchaser.

.10 Brush Application

.1 Brushes shall be of the full type either round or oval shape, and in good condition. Paint for brush application shall be applied in flowing coats, each coat of uniform coverage, well brushed out, leaving no defects. On all surfaces which

are accessible for brushes and where spraying is not being employed, the paint shall be applied with sheepskin daubers specially constructed for the purpose.

.2 Runs and sags shall be brushed out. The paint shall be worked into cracks, crevices and corners.

.11 Spray Application

.1 The Contractor shall provide and maintain equipment that is suitable for the intended purpose, capable of properly atomizing the paint to be applied, and equipped with suitable pressure regulators and gauges.

.2 Paint ingredients shall be properly mixed in containers during paint application either by continuous mechanical agitation or by intermittent agitation as frequently as necessary.

.3 The paint shall be applied in parallel passes as a heavy wet coat with overlapping of each pass by 50% to avoid thin spots.

.4 Brushes shall be used to work paint into cracks, crevices and places, which are not adequately painted by spray.

.5 Each coat of paint shall be applied as a continuous film of uniform thickness. Thin spots or bare areas shall be repainted before the next coat of paint is applied.

.6 Surfaces shall be allowed to dry and properly cure after cleaning and between subsequent coats for the minimum time period, as recommended by the manufacturer.

.7 The Contractor shall sand and dust between each coat to remove visible defects. Tops of projecting ledges shall be finished both above and below sight lines as specified for surrounding surfaces.

.8 Where requested by the Engineer, spray application shall be done with airless spray equipment.

.9 Paint pots shall be equipped with means of controlling air or liquid pressure on the pot independently of the pressure at the gun.

.10 Airlines shall be equipped with water traps for positive removal of condensed moisture.

.12 Roller Application

.1 Paint to be applied by rollers shall be applied in uniform and even coats, without defects. The second coat shall be applied at right angles to the first coat. Interior angles and other areas inaccessible to rollers shall be painted by brush.

.13 Curing and Film Thickness

.1 Curing schedule as recommended by the paint manufacturers shall be followed for each coating.

.2 Minimum requirements of prime and finish coating thicknesses shall be as in accordance with manufacturers' recommended thicknesses and as specified. Prime coats of paint shall be at least 1.5 to 2 mils thick when dry and each intermediate and finish coat of paint shall have a dry film thickness of at least 1.5 mils.

.3 To ensure that specified dry film thicknesses are being obtained, wet thickness shall be checked regularly and recorded by the Contractor at the time the coatings are being applied. The Contractor shall measure and record the dry film thickness of each coating.

.14 Field Touch-Up Painting

.1 When damage to the paint is considered to be excessive by the Engineer, the Contractor shall repaint all or part of the Work with additional coats of primer where required.

.2 Touch-up Painting:

.1 Areas lacking adequate protective coating and requiring repair shall be abrasive spot blast cleaned, power tool cleaned or abraded or solvent washed as required to provide a substrate equivalent to the original surface. Fully cured coatings adjacent to the prepared substrate shall be feather edged and abraded to approximately (25 mm) from the edge to ensure sound bonding between the existing coating and new coating. Surfaces shall be cleaned of all foreign matter and contaminants before application of touch-up primer and finish coatings.

.3 Application of coatings shall be in accordance with the paint manufacturers' product standards sheets. Touch-up painting by brush may require several applications to attain the total dry film thickness specified.

.4 The Contractor shall provide and apply all paint materials required for touch-up of damaged components after installation at Site.

.5 Items damaged during installation shall receive two coats of paint, which is compatible and in accordance with the manufacturer's recommendations.

3.6 CLEANING

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 The Contractor shall, upon completion of painting Work, remove paint materials where splashed, spilled or splattered on surfaces, including fixtures, glass, furniture and fittings.

.3 The Contractor shall remove all waste materials, solvents, rubbish, and leave the Site in a neat, clean and safe condition acceptable to the Engineer.

.4 The Contractor shall clean-up and remove all blast cleaning materials and debris immediately following completion of blast cleaning.

.5 Disposal of the paint shall meet the requirements of local Laws.

3.7 INSPECTION

.1 The Contractor shall request the Engineer's review of the Work only after the Contractor's thorough inspection and after verification that all of the requirements set out in this Section of the Technical Specification have been satisfied.

.2 Paint shall not be applied until the surface preparation has been reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.3 Each coat, when dried, shall be reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification before application of succeeding coats. No payment will be made for paint coats that have not been reviewed by the Engineer, otherwise no credit will be given for the coat.

.4 The painted surface will be considered to lack uniformity, continuity and soundness, and will be rejected if any of the following defects are apparent to the Engineer:

.1 Runs, sags, holidays or shadowing caused by inefficient application methods.

.2 Evidence of poor coverage at plate, lap joints, crevices, pockets, corners and re-entrant angles.

.3 Damage to coating because of handling before the paint is sufficiently dry, or any other contributory causes.

.5 Cleaned and/or coated surfaces rejected by the Engineer shall be prepared again and re-coated by, and at the expense of, the Contractor.

.6 Small affected areas may be touched up; large affected areas or where insufficient dry film thickness has been attained shall involve the application of another complete coat.

APPENDICES

APPENDIX A – MECHANICAL COATINGS STANDARD

END OF SECTION

Appendix A
Mechanical Coatings Standard

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Material, Plant, and Tools and performing all Work necessary for the design, supply and installation of machine room-less geared or gearless electric traction elevators as follows:

.1 Control building elevator;

.2 Upstream service bay elevator; and

.3 South transition elevator;

as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification set out below.

.2 Section 03 15 13 - Waterstops.

.3 Section 03 30 00 - Cast-In-Place Concrete.

.4 Section 04 22 00 - Concrete Unit Masonry.

.5 Section 05 50 00 - Miscellaneous Metal.

.6 Section 22 14 00 - Clearwater Drainage System.

.7 Section 26 05 00 - Electrical General Requirements.

.8 Section 26 32 13 - Standby Diesel Generators.

.9 Section 27 00 00 - Communications Systems.

.10 Section 28 31 00 - Fire Detection and Alarm Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 CSA B44 - Safety Code for Elevators and Escalators.

.2 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.3 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.

.4 CSA S16.1 - Limit States Design of Steel Structures.

.5 NBC - National Building Code.

.6 CSA G4 - 92 - Steel Wire Rope for General Purpose and for Mine Hoisting and Mine Haulage.

.7 AGMA 6010 - F97 - Standard for Spur, Helical, Herringbone and Bevel Enclosed Drives.

.8 CSA C22.2 - Safety Standard for Electrical Equipment.

.9 CSA C22.2 No. 14-95 - Industrial Control Equipment.

.10 CSA C22.2 No. 77 - Motors with Inherent Overheating Protection.

.11 CSA C22.2 No. 100-95 - Motors and Generators.

.12 CSA C22.1 - Canadian Electrical Code Part I.

.13 CSA C22.1 - Canadian Electrical Code Part II.

.14 NEMA ICS - Industrial Control Systems.

.15 NEMA MG-1 - Motors and Generators.

.16 SSPC - Steel Structures Painting Council.

.17 Manitoba WorkPlace Safety and Health Act and Regulations.

.18 Province of Manitoba - C.C.S.M.c.E60 “The Elevator Act”.

.19 NFPA 80 - Fire-Rated Hoistway Entrance Assemblies.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 14 20 00 (a)i to 14 20 00 (a)iii will be based on the quantity shown in the Purchaser’s Drawings and Contractor’s Documents.

.2 No separate measurement will be made for Items 14 20 00 (b) and 14 20 00 (c).

.3 Unit Price

.1 The unit prices proposed for Items 14 20 00 (a)i to 14 20 00 (a)iii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the design, supply, transporting, unloading, handling, storage, installation, pre-commissioning tests, repairs and trouble-shooting of the equipment specified herein.

.1 Preparation and pre-installation examination are considered incidental to the Work and no separate measurement or calculation of Target Prices shall be made. Include the costs for these Items in the Estimated Cost proposed for the Item to which it applies.

.2 Supplies and equipment necessary for pre-commissioning and putting into service the equipment as specified herein are considered incidental to the Work and no separate measurement or calculation of Target Prices shall be made. Include the costs for these Items in the Estimated Cost proposed for the Item to which it applies.

.3 Administrative requirements such as coordination and pre-installation meetings are considered incidental to the Work and no separate measurement or calculation of Target Prices shall be made. Include the costs for these Items in the Estimated Cost proposed for the Item to which it applies.

.2 The Estimated Cost proposed for Item 14 20 00 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the Item for provision of all close-out activities, such as training and demonstration services, as specified herein.

.3 The Estimated Cost proposed for Item 14 20 00 (c) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the Item for provision of initial maintenance services, as specified herein.

1.5 ADMINISTRATIVE REQUIREMENTS

.1 Pre-Installation Meetings

.1 Prior to installation of the elevators, the Contractor shall review elevator installation with the Province of Manitoba Inspection and Technical Services.

.2 Coordination

.1 Coordinate installation of all elevator equipment with integral anchors, and other Items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Site in time for installation.

.2 Coordinate sequence of elevator installation with other Work.

.3 Coordinate locations and dimensions of other Work relating to electric traction elevators including pit ladders, sumps, entrance sub sills, machine beams, and electrical service: electrical outlets, lights, and switches in pits and machine/ control rooms.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor’s Documents of the General Specification.

.2 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification, all applicable Contractor’s Documents including, installation manuals including installation drawings, installation and test plans, testing procedures, commissioning procedures, and operating and maintenance manuals.

.3 Submit to the Engineer’s review in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification, all applicable Contractor’s Documents including the maximum loads that the elevators will impose on the structure, including but not limited to:

.1 Maximum loads imposed on guide rails requiring load transfer to building structure.

.2 Maximum loads on pit floor during dynamic support of car and buffer engagement.

.4 Elevator general arrangement drawings:

.1 Hoist beam requirements and loads on hoisting beams.

.2 Travel of car.

.3 Clear inside hoistway, overhead and pit dimensions.

.4 Location and sizes of access doors, hoistway entrance frames, and rough openings required.

.5 Location and layout of equipment and signals.

.6 Expected heat dissipation of elevator equipment in machine room (BTU/hr or kW).

.7 Electrical requirements for power supply.

.8 Egress ladders in car and hoistway.

.5 Product Data

.1 Signal and operating fixtures, operating panels and indicators.

.2 Control signals and operating systems.

.3 Cab design dimensions and layout.

.4 Entrance door and frame details.

.6 Installation drawings

.1 Car, guide rails buffers and other components in hoistway.

.2 Maximum rail bracket spacing.

.7 Operations and Maintenance Manuals

.1 Manufacturer’s standard operations and maintenance manual.

.8 Tools

.1 Diagnostic or other special tools required for maintenance.

.9 Special Procedures

.1 Sequence of construction and coordination of components.

.10 All test results shall be submitted to the Engineer.

.11 The contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Manufacturer shall have a minimum of 15 years experience in the fabrication, installation and service of elevators of the type and performance specified.

.3 The elevators shall be installed by the manufacturer or manufacturer’s representatives who is trained and approved for installation of units required for this aspect of the Work.

.4 Inspection and testing shall be in accordance with requirements of the Province of Manitoba, obtain required permits, inspections and tests.

.5 Design work to be performed by Professional Engineers licensed in the Province of Manitoba.

.6 Regulatory Requirements: Comply with CSA B44- Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks.

.7 Fire-Rated Hoistway Entrance Assemblies: Provide door and frame assemblies complying with NFPA 80 that are listed and labelled by a testing and inspecting agency acceptable to authorities having jurisdiction.

.8 Comply with Manitoba Electrical Code amendments to Canadian Electrical Code CSA C22.1.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials, components, and equipment delivered to the Site shall be clearly tagged for easy identification.

.3 Materials, components, and equipment shall be stored in a secure area that will prevent contamination from deleterious materials. Store materials, components, and equipment off of ground, under cover, and in a dry location and in accordance with the manufacturer's recommendations.

.4 Store and handle materials, components, and equipment in manufacturer's protective packaging.

.5 Handle all materials, components, and equipment with care to avoid damage prior to installation. Handle according to manufacturer's written recommendations to prevent damage, deterioration, or soiling.

.6 If the Site is not prepared to receive the materials, components, and equipment (including but not limited to elevator equipment) at the agreed ship date, a safe, dry, and easily accessible storage area on or off the Site is acceptable, but at no additional costs for double handling.

.7 Determine handling requirements adjacent to each hoistway as required.

1.9 SITE CONDITIONS

.1 Shall be in accordance with the requirements of Section 4 Site Location and Access of the General Specification.

1.10 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 MANUFACTURERS

.1 The design for electric traction elevators shall be based on standard models provided by the manufacturer. Acceptable manufacturers are ThyssenKrupp, OTIS, and KONE or Purchaser's approved equivalent.

2.2 OPERATING REQUIREMENTS

.1 Power Supplies

.1 The Purchaser's power supply to the elevator will be 600 V (+5% -10%) 60 Hz 3-phase 3-wire AC. Station service power may vary by +/-1% of nominal frequency when the station is separated from the electric power transmission system, and the elevator shall operate normally at full capacity over this frequency range. During certain transmission system faults the frequency of the Purchaser's power supply may transiently (over several seconds) vary between 55 Hz and 85 Hz. The electrical components shall safely withstand such frequency changes. Station service power may be briefly interrupted during transfers between sources. The elevator controls shall permit normal operation after a momentary interruption.

.2 The elevator electrical demand shall be approximately balanced between phases within 5% of the full load current. Power factor of the elevator system (including the effects of displacement and distortion) measured at the Purchaser's point of supply shall be not less than 0.85 at maximum current demand.

.3 Lighting, convenience outlets and ventilation fans less than 1 kW rating shall be 120 Vac.

.2 Safety Considerations

.1 Each elevator car shall be equipped with a telephone and emergency lighting powered by the Purchaser's 125 V battery system. For details on telephone equipment requirements see Article 2.11.6 in this Section. To provide emergency egress, the elevator controls shall incorporate a manual operation where the elevator can be raised or lowered to the nearest landing.

.2 Emergency Egress: To be determined and reviewed at a later date with Purchaser and Province of Manitoba Inspection and Technical Services.

.3 Operation under Fire and Flooding Conditions

.1 Operation under fire and flooding conditions described in Article 2.7.1.2 in this Section.

.4 Layout for the elevator and its components shall not impede access to egress ways.

2.3 DESCRIPTION

.1 Three elevators will be provided for the Keeyask Generating Station; one for the Control Building, one for the Upstream Service Bay, and one for the Powerhouse in the South Transition.

.2 Type: Geared or gearless traction; machine-roomless design with variable speed motor.

.3 Rated Load: Load capacity should not be less than 2270 kg.

.4 Rated Speed: Not less than 50 m/min.

.5 Stopping Accuracy: +/- 3.2 mm under any loading condition or direction of travel.

.6 Operation System: Selective collective automatic control.

.7 Auxiliary Operations: Standby power operation, and automatic dispatching of loaded car.

.8 Security Features: Keyswitch in elevator car required to engage controller into manual operation.

.9 Car Enclosures

.1 Inside Width: Not less than 1,800 mm from side wall to side wall.

.2 Inside Depth: Not less than 2,600 mm from back wall to front wall.

.3 Inside Height: 2,743 mm to underside of ceiling.

.10 Cab configuration

.1 Front opening for control building elevator.

.2 Front and Rear opening for upstream service bay elevator and powerhouse south transition elevator.

.11 Front Walls (Return Panels): Satin stainless steel, No. 4 finish.

.12 Car Fixtures: Satin stainless steel, No. 4 finish.

.13 Side and Rear Wall Panels: Satin stainless steel, No. 4 finish.

.14 Reveals: Satin stainless steel, No. 4 finish.

.15 Door Faces (Interior): Satin stainless steel, No. 4 finish.

.16 Door Sills: Aluminum, mill finish.

.17 Ceiling: Luminous ceiling with fluorescent lighting.

.18 Handrails: 38 mm round, satin stainless steel, No. 4 finish, at sides and rear of car. Provide an additional set of guard rails near floor level to prevent damage from equipment and materials moved within interior of the elevator car.

.19 Floor: Aluminum checker plate.

.20 Hoistway Entrances:

.1 Width: Not less than 1,400 mm.

.2 Height: Not less than 2,100 mm.

.3 Type: Single-speed side sliding.

.21 Fire Protection Rating: 1-1/2 hours with a temperature rise of 250°C.

.22 Frames (all floors): Satin stainless steel, No. 4 finish.

.23 Doors (all floors): Satin stainless steel, No. 4 finish.

.24 Sills (all floors): Aluminum, mill finish.

.25 Hall Fixtures (all floors) Satin stainless steel, No. 4 finish.

.26 Additional Requirements:

.1 Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No.4 finish.

.2 Provide blanket (protection pad) hooks for both elevators and one complete set of full-height protective blankets for each elevator.

2.4 SHAFT DIMENSIONS AND LANDINGS

.1 Control building elevator:

Shaft Dimensions:	
Width (max)	3,000 mm
Depth (max)	3,000 mm

Landings:	
Dewatering Gallery	el 126.60 m
Semi-Spiral Case Access	el 131.50 m
Basement	el 141.70 m
Lower level Service Bay	el 146.60 m
Erection Floor (Home)	el 152.10 m
2nd Floor Control Building	el 156.00 m
3rd Floor Control Building	el 159.90 m
Total Rise	33.30 m
Elevator Pit Maximum Depth	1,525 mm

.2 Upstream service bay elevator:

Shaft Dimensions:	
Width (max)	3,000 mm
Depth (max)	3,000 mm

Landings:	
Basement	el 141.70 m
Lower level Service Bay	el 146.60 m
Erection Area (Home)	el 152.10 m
2nd Floor	el 157.00 m
Building Entrance Intake Deck Level	el 161.80 m
Intake Hoist Housing	el 173.50 m
Total Rise	31.80 m
Elevator Pit Maximum Depth	1,525 mm

.3 Powerhouse south transition elevator:

Shaft Dimensions:	
Width (max)	3,000 mm
Depth (max)	3,000 mm

Landings:	
Dewatering Gallery	el 126.60 m
Generator Floor (Home)	el 150.10 m
Crane Access Platform	
South Transition Deck	el 161.80 m
Intake Hoist Housing	el 173.50 m
Total Rise	46.90 m
Elevator Pit Maximum Depth	1,525 mm

.4 Note: Emergency egress door elevations as per Article 2.13.2 in this Section.

2.5 DESIGN CRITERIA

.1 Design and construction of the elevator shall be in accordance with CSA B44.

.2 Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to minimize transmission of vibrations to structure and thereby minimize structure-borne noise from elevator system.

.3 Maximum noise levels to be 55 dB in the cab with the car running and doors closed, 63 dB in the cab while the door is opening and closing, and 80 dB in the machine room.

2.6 SYSTEMS AND COMPONENTS

.1 General: Provide manufacturer's standard elevator systems. Where components are not otherwise indicated, provide standard components published by manufacturer as included in standard pre-engineered elevator systems and as required for complete system.

.2 Buffers: Spring type preferred. If oil buffers are used, use only fire-resistant hydraulic fluid containing antioxidant, anticorrosive, antifoaming, and metal-passivating additives.

.3 Elevator Machines: Provide high-efficiency variable voltage/variable frequency motor drive. Provide solid-state power converters.

.4 Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator Work where installation of devices is specified.

.5 Machine Beams: Provide framing to support elevator hoisting machine and deflector sheaves from the building structure.

.6 Car Frame and Platform: Bolted or welded steel units.

.7 Guides: Provide sliding guides at top and bottom of car and counterweight frames.

.8 Contactor and relays: All contactor and relay coils shall have arc suppressors. The Contractor shall install voltage surge suppressors or other measures, as recommended by the drive manufacturer, to protect the elevator drive electronics from transient voltages.

.9 Motors: Motors operated by variable-frequency drives shall have inverter-duty-rated insulation systems as described in NEMA standard MG 1. The motor power circuits shall include filters, reactors, or other measures as recommended by the drive manufacturer to protect motor insulation. Motors shall have Class F (155°) insulation operated at Class B (130°) temperature rise. Motors shall include a winding RTD and relay, thermostat, or equivalent protection against overload and over-temperature.

.10 Electrical Cables: All cables for elevator controls and power circuit shall be FT4-FT6 rated or coated with an Engineer authorized fire-retardant cable coating.

.11 Special Controls: Float switches for elevator pit water level alarm shall be waterproof automatic float switch, FLYGT Model ENM-10. Contractor shall install float switches and interconnecting cabling to control panel.

2.7 OPERATION SYSTEMS

.1 General: Provide manufacturer's standard microprocessor operation system for each elevator as required to provide type of operation system indicated below:

.1 Selective, collective, automatic control.

.2 Auxiliary Operations: In addition to primary operation system features, provide the following operational features for elevators:

.1 Emergency Recall Operation:

.1 Upon receipt of a contact closure signal from the fire alarm system, the car will automatically park at a predetermined 'home' landing and leave its doors in the open position.

.2 Automatic Dispatching of Loaded Car:

.1 When car load exceeds 80% of rated capacity, doors will begin closing.

.3 Automatic Lighting and Ventilation Control:

.1 Power down lighting and ventilation when elevator is not in use.

.4 Operation under Detection of Flood:

.1 The high water level alarms shall provide the controller with a contact closure signal that will override all other controls and automatically return the car to the predetermined 'home' landing, where the doors shall open and the elevator shall become inoperative. A waterproof automatic float switch shall be located in the elevator pit to return the elevator to normal operation.

2.8 DOOR REOPENING DEVICES

.1 Infrared Array: Provide door reopening devices with uniform array of 40 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more of the light beams shall cause doors to stop and reopen.

.2 Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound. Doors shall begin to close at reduced kinetic energy when the re-opening device is deactivated.

2.9 CAR ENCLOSURES

.1 General: Provide enamelled-steel car enclosures to receive removable wall panels, with removable ceiling frame, access doors, power door operators, and ventilation.

.2 Materials and Finishes: All materials shall be well suited to heavy use. Provide manufacturer's standard materials/finishes for the following Items as selected by the Engineer: subfloor, floor, wall panels, doors, sills, ceiling panels, handrails and grouting. Provide standard railings complying with CSA B44 on car tops where required by CSA B44.

2.10 HOISTWAY ENTRANCES

.1 Provide manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Provide frame size and profile to coordinate with hoistway wall construction. Where gypsum board wall construction is indicated, provide self-supporting frames with reinforced head sections.

2.11 SIGNAL EQUIPMENT

.1 General: Provide car-call buttons that light when activated. Fabricate lighted elements with LEDs.

.2 Car Control Stations: Provide manufacturer's standard recessed car control stations. Mount in return panel adjacent to car door, unless otherwise indicated.

.3 Remote Monitoring: Provide at least one serial connection at the control panel to allow for system flexibility if remote monitoring is required in the future.

.4 Mark buttons and switches with standard identification for required use or function that complies with CSA B44. Use both tactile symbols and Braille.

.5 Provide a "No Smoking" sign matching car control station, either integral with car control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.

.6 Emergency Communication System: Supply and install a telephone handset with keypad, compatible with the telephone system specified in Section 27 00 00 Communication Systems. Supply and install the travelling cable between elevator car and service room with terminals at the service room. The service room telephone set, protector blocks, distribution terminal blocks, and interconnecting telephone cabling from the service room to the telephone equipment, to be as per Section 27 00 00 Communication Systems.

.7 Car Position Indicator: Provide illuminated, digital-type car position indicator, located above car door. Also provide audible signal to indicate to passengers that car is stopping at each of the floors served.

.8 Provide jamb-mounted illuminated car call assignment panels in both car door jambs.

.9 Hall Push-Button Stations: Provide hall push-button stations at each landing as indicated. Provide manufacturer's standard wall-mounted units. Equip units with buttons for calling elevator and for indicating desired direction of travel.

.10 Corridor Call Station Pictograph Signs: Provide signs matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station, unless otherwise indicated.

.11 Video Surveillance: Provide a coaxial cable in the wiring to the elevator car for video surveillance, which may be required by the Purchaser in the future.

2.12 ACCESS FOR MAINTENANCE

.1 Provide an access hatch in the ceiling of each elevator car suitable for removal/ installation of elevator equipment and machinery for maintenance purposes. Access to the hoistway machinery shall be via the access hatch with the elevator parked at its highest landing. Access to the underside of each elevator shall be via the hoistway entrance of the lowest landing. The elevator supplier shall provide suitable access to the elevator equipment and machinery with platforms and ladders as necessary. The access system shall be reviewed with the Engineer prior to construction.

.2 For maintenance purposes, the elevator shall be manually operable such that the elevator car can be parked where necessary. Provide a locking mechanism on each elevator car to ensure the elevator is secured in place while maintenance is performed.

2.13 PROVISIONS FOR EMERGENCY EGRESS

.1 A permanent ladder shall be installed inside the powerhouse elevator car for access to the ceiling hatch. Signage shall be provided to clearly indicate that the ladder is for emergency use only. The ladder system shall incorporate a breaking seal or tag to discourage use in non-emergency situations and to indicate that the ladder has been used.

.2 Emergency egress doors and self closing barriers conforming to CSA B44 Section 2.11.1.2 shall be provided in blind portion of the hoistways where the elevation

between floors exceeds 11 m. The door edge shall be within 100 mm of the barrier and the hoistway to prevent someone from being able to stand in-between the barrier and the emergency door. In addition, the following shall be provided:

.1 Permanent ladder with fall arrest system in the hoistways (location in hoistways to be reviewed by Engineer). The ladder shall run from an elevation with the top of the car (when parked at landing No. 1) to the emergency egress elevation(s).

.2 Two fall arrest safety harnesses, stored in a container on top of the elevator car.

2.14 IDENTIFICATION

.1 Provide elevator nameplates fabricated from stainless steel stating the following information:

.1 Manufacturer's name and contract number.

.2 Year of manufacture or installation.

.3 Equipment model and serial number.

.4 Elevator capacity.

Part 3 Execution

3.1 INSTALLERS

.1 Installers shall be the elevator manufacturer or the manufacturer's trained representative.

3.2 PREPARATION

.1 Provide procedure/schedule demonstrating the sequence of construction and coordination with the delivery of required components. For example, if the elevator drive frame is required prior to completion of roof structure, etc.

3.3 PRE-INSTALLATION EXAMINATION

.1 Examine elevator areas, with equipment manufacturer's installation staff present, for compliance with requirements for installation tolerances and other conditions affecting performance. Examine hoistways, hoistway openings, pits, and machine rooms as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator Work is to be installed.

.2 For the record, prepare a written report, listing dimensional discrepancies and conditions detrimental to performance or indicating that dimensions and conditions were found to be satisfactory.

.3 Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 INSTALLATION

.1 Comply with elevator manufacturer's written instructions.

.2 Coordinate installation of all elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Site in time for installation.

.3 Coordinate sequence of elevator installation with other Work to avoid delaying this aspect of the Work.

.4 Coordinate locations and dimensions of other Work relating to electric traction elevators including pit ladders, sumps, entrance sub sills, machine beams, and electrical service: electrical outlets, lights, and switches in pits and machine/control rooms.

.5 Welded Construction: Provide welded connections for installing elevator Work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with CWB standards for workmanship and for qualifications of welding operators.

.6 Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts as required.

.7 Lubrication: Lubricate operating parts of systems, including ropes (if required), as recommended by manufacturers.

.8 Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

.1 Levelling Tolerance: 3.2 mm, up or down, regardless of load and direction of travel.

.2 Set sills flush with finished floor surface at landing. Fill space under sill solidly with non-shrink, non-metallic grout.

.9 Hall Signal Equipment Locations: Locate hall push-button stations in a wheelchair accessible location most convenient for approaching passengers.

3.5 PRE-COMMISSIONING

.1 Acceptance Testing/Pre-Commissioning: On completion of elevator installation and before permitting use (either temporary or permanent) of elevators, perform acceptance tests as required and recommended by CSA B44 and by governing regulations and agencies.

.2 The Contractor shall provide pre-commissioning support as requested. An authorized representative of the crane manufacturer shall be made available during pre-commissioning.

.3 Operating Test: Load elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding after a 5 second delay to the next. Record temperature rise of elevator machine during a 30-minute test period. Record failure to perform as required.

.4 NOTE: Advise Purchaser, Engineer, and authorities having jurisdiction two weeks in advance of dates and times tests are to be performed on elevators.

3.6 CLOSEOUT ACTIVITIES

.1 Training

.1 Engage factory-authorized service representative to train Purchaser's maintenance personnel to operate and perform general day to day inspection of elevators, including access to the elevator shaft(s) and use of emergency egress systems (as provided). The training provided shall not be less than one 10-hour day. Training manuals and documentation shall be provided for a minimum of five attendees. Training shall incorporate both a classroom component to review the manuals and documentation and a field component to instruct the attendees on the equipment.

.2 Demonstration

.1 Check operation of each elevator with Purchaser's personnel present and before date of issuance of the final Completion Certificate. Determine that operation systems and devices are functioning properly.

.2 Check operation of each elevator with Purchaser's personnel present not more than one month before end of Warranty Period. Determine that operation systems and devices are functioning properly.

3.7 MAINTENANCE SERVICE

.1 At issuance of the final Completion Certificate, provide training session to the Purchaser’s maintenance personnel by skilled employees of elevator Subcontractor. Training session to include monthly preventive maintenance schedule and repair or replacement of worn or defective components procedures, as required for proper elevator operation at rated speed and capacity.

.2 Continuing Maintenance Proposal: Provide a continuing maintenance proposal from Subcontractor to Purchaser, in the form of a standard 1 year maintenance agreement. State services, obligations, conditions, and terms for agreement period and for future renewal options.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, testing, flushing, marking, pre-commissioning and commissioning of the fire protection standpipe systems, including but not limited to the following:

.1 Piping.
.2 Primary electric motor driven fire water pump set and controller.
.3 Backup diesel engine driven fire water pump set and controller.
.4 Electric motor jockey pumps and controllers.
.5 Fire hose cabinets.
.6 Fire hose reels.
.7 Hydropneumatic tank.
.8 Wall hydrants.
.9 Fire department connections.

.2 Refer to Piping and Instrumentation Diagrams (P&IDs) in the Purchaser's Drawings for additional scope details.

.3 An independent fire protection standpipe system shall be provided for the spillway structure and equipment. Details of the system are to be determined and are not included in this Section of the Technical Specification.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 40 05 00 - Mechanical & Piping General Requirements.

.5 Section 21 13 00 - Fire Suppression Sprinkler System.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ASME B31.1 - Power Piping.
.2 CSA C22.2 No. 14 - Industrial Control Equipment.
.3 CSA W59 - Welded Steel Construction.

.4 CSA W47.1 - Certification of Companies for Fusion Welding of Steel.

.5 Manitoba Regulation M.R. 29/2003 - Trade of Sprinkler System Installer.

.6 Manitoba Workplace Safety and Health Act - Part 12 (Noise Criteria).

.7 Manitoba Conservation – Technical Bulletin PSF-100.

.8 NEMA MG 1 - Motors and Generators.

.9 NEMA ICS 1- Industrial Control and Systems: General Requirements.

.10 NFPA 14 - Standard for Installation of Standpipe.

.11 NFPA 20 - Stationary Pumps for Fire Protection.

.12 NFPA 851 - Recommended Practice for Fire Protection for Hydroelectric Generating Plants.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Equipment Items 21 12 00 (a)i to21 12 00 (a)ix will be based on the quantity shown in the applicable Purchaser's Drawings and Contractor's Documents.

.2 Measurement for the following Piping Items will be based on the length of pipe in metres shown in the applicable Purchaser's Drawings and Contractor's Documents, from fitting to fitting, excluding the fitting(s).

.1 21 12 00 (b)i to 21 12 00 (b)x - Exposed Piping.

.3 Measurement for the following Fitting and Valve Items will be based on the quantities shown in the applicable Purchaser's Drawings and Contractor's Documents.

.1 21 12 00 (c)i to 21 12 00 (c)xlvii - Exposed Fittings.

.2 21 12 00 (d)i to 21 12 00 (d)xvii - Valves.

.4 No separate measurement will be made for the following Items:

.1 21 12 00 (e) - Instrumentation.

.2 21 12 00 (f) - Testing, Flushing and Cleaning.

.3 21 12 00 (g) - Pre-commissioning.

.3 Unit Price

.1 The unit prices for Equipment Items 21 12 00 (a)i to 21 12 00 (a)ix in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein.

.2 The unit prices for the following Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein:

.1 21 12 00 (b)i to 21 12 00 (b)x - Exposed Piping.

.2 21 12 00 (c)i to 21 12 00 (c) xlvii - Exposed Fittings.

.3 21 12 00 (d)i to 21 12 00 (d)xvii - Valves.

.3 The Estimated Cost for Instrumentation Item 21 12 00 (e) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, Items such as pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment vendor. Include the costs for vendor supplied/installed instrumentation with the Equipment Item to which it applies.

.4 The Estimated Cost for testing, flushing and cleaning Item 21 12 00 (f) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system. Include costs for testing, flushing and cleaning Fire Suppression Sprinkler System Section 21 13 00.

.5 The Estimated Cost for Pre-Commissioning Item 21 12 00 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the system(s) as specified herein. Include costs for Pre-Commissioning Fire Suppression Sprinkler System Section 21 13 00.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including shop drawings, installation manual including installation and test plans, testing procedures, flushing procedures, marking procedures and pre-commissioning procedures.

.3 Submit piping drawings, product data, electrical schematics and calculations for Engineer's review in accordance with 21.7.9 Engineer's Review of the General Specification.

.4 Submit Fire Pump information including shop drawings, pump curves, pump capacity/ head, horsepower, efficiency and NPSH.

.5 Submit manufacturer's installation, operation and maintenance manuals to the Engineer.

.6 Include electrical schematic of circuits, written description of system design, drawings illustrating control logic and equipment location, and technical bulletins describing equipment.

.7 Provide list of recommended spare parts.

.8 Submit all test results and reports to the Engineer.

.9 The contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section.13 Project Quality Management of the General Specification.

.2 All fittings and equipment as required must have a Canadian Registration Number (CRN).

.3 All equipment and devices used shall be tested in accordance with Factory Mutual approval requirements.

.4 A registration number for the system shall be obtained from the Manitoba Labour's Mechanical and Engineering Branch.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All Items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Primary Electric Motor Driven Fire Water Pump Set and Controller: Tag No. 5750-PP-0001.

.1 Pump:

.1 Capacity - 315 L/s (5,000 USgpm).

.2 Rated Head - 71 m (695 kPa).

.3 The fire pump set shall be in accordance with the National Fire Protection Association Standard NFPA 20 and shall be ULC and UL listed, and FM approved, except the controller which can be UL listed, specifically for fire pump service.

.4 The pump assembly shall be mounted on a factory installed baseframe designed to be anchored to the concrete floor. A housekeeping pad shall be provided if required to raise the elevation.

.5 The pump shall be Aurora 10-481-18D, 400 HP, or Purchaser's approved equivalent.

.6 The pump shall be of horizontal split case construction.

.7 The suction supply to the fire pump shall have a maximum pressure of 500 kPa (73 psi) and a minimum pressure of -22 kPa (-3 psi).

.8 The pump shall deliver not less than 150% of rated capacity at a pressure not less than 65% of rated head.

.9 The shutoff pressure shall not exceed 120% of the total rated head.

.10 The pump shall operate in a clockwise direction as viewed from the drive motor end, at a maximum speed of 1,800 RPM.

.11 The pump casing shall be cast iron with 125 lb ANSI flat faced flange connections.

.12 Flanges and bearing supports shall be integrally cast with the lower casing.

.13 Removal of the upper casing shall allow removal of the rotating element without disconnecting the piping.

.14 The bearings shall be heavy-duty regreaseable ball bearings and shall be equipped with water slingers.

.15 The casing shall be fitted with renewable bronze wear rings.

.16 The impeller shall be bronze, double suction enclosed type, bronze sleeves securely locked in position to protect the shaft.

.17 The stuffing box shall be fitted with diagonally cut graphite fibre packing rings, lantern ring, and split packing glands.

.18 The pump shall be fitted with lifting lugs as required.

.19 The fire pumps shall be hydrostatic and performance tested at the factory to NFPA 20 requirements.

.2 Motor:

.1 The motor shall be a horizontal, foot mounted, totally enclosed fan cooled, ball bearing type, ac, induction, squirrel cage motor.

.2 The motor shall be wound for 575 V, 3-phase AC, 60 Hz.

.3 The motor shall meet the performance and test requirements of NEMA Standard MG1.

.4 The motor shall be capable of operating continuously with 15% overload without injurious stresses or excessive rise in temperature.

.5 Locked rotor current shall not exceed the values specified in NFPA 20. The motor shall be UL listed, as per NFPA 20.

.6 The motor shall be mounted on a steel base common to the pump and shall be connected to the pump with a flexible coupling protected by a suitable guard.

.7 The pump and motor shall be accurately aligned.

.8 The base plate shall be provided with a drip rim.

.3 Controller:

.1 The controller shall be in accordance with NFPA 20, Chapter 10.

.2 The controller shall be a combined automatic and non-automatic type.

.3 The starter shall be activated by a pressure switch, which responds to a low system pressure, a signal from the fire protection system, a signal from a panel mounted or remote manual electric control, or a manual mechanical control at the controller.

.4 The controller shall be designed for full voltage across-the-line type starting and rated for the horsepower of the fire pump motor.

.5 The motor shall operate continuously until shutdown manually at the controller.

.6 The controller shall be a floor mounted type with a drip-proof steel cabinet and shall be complete with the following:

.1 Auxiliary contact to show the electric fire pump motor is running.

.2 External handle for circuit breaker.

.3 Locked rotor overcurrent protection.

.4 Motor starter.

.5 Panel mounted alarm and signal device.

.6 Circuits and contacts for remote alarm and signal devices.

.7 Pressure switch set to cut in at 850 kPa.

.8 Provisions for measuring all line voltages and currents.

.9 Elapsed time meter.

.7 The controllers shall be completely assembled, wired, and tested before shipping.

.4 Protective Coating:

.1 Equipment shall be painted red (colour code per Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating) to manufacturer's factory standard coating system.

.5 Noise:

.1 The electric motor driven fire pump shall have a noise level not exceeding 85 dB(A) at a distance of 1 m.

.6 Accessories:

.1 The following fittings shall be supplied with the pump:

.1 Automatic air release valve.

.2 Circulation relief valve - bronze.

.3 Suction gauge, calibrated - 100 to +700 kPa (-14.5 to +100 psig) in accordance with Section 40 90 25.

.4 Discharge gauge, calibrated 0 to +2,000 kPa (0 to 290 psi) in accordance with Section 40 90 25.

.2 Provide any special Tools required for maintenance.

.2 Backup Diesel Engine Driven Fire Water Pump Set and Controller: Tag No. 5750-PP-0002.

.1 Pump:

.1 Capacity - 315 L/s (5,000 USgpm).

.2 Rated Head - 64 m (627 kPa).

.3 The fire pump set shall be in accordance with the National Fire Protection Association Standard NFPA 20 and shall be UL and ULC listed, and FM approved, listed specifically for fire pump service.

.4 The maximum and minimum operating temperatures are 40°C and 10°C, respectively.

.5 The diesel engine will be installed at an elevation of 152.1 m above sea level.

.6 The entire unit and associated equipment shall be painted red. The unit shall be mounted on a factory installed baseframe designed to be anchored to the concrete floor. A housekeeping pad shall be provided if required to raise the elevation.

.7 The pump shall be Aurora 10-481-18D, 460 HP, or Purchaser's approved equivalent.

.8 The pump shall be of horizontal split case construction.

.9 The suction supply to the fire pump will have a maximum pressure of 450 kPa (65 psi) and a minimum pressure of -21 kPa (-3 psi).

.10 The pump shall deliver not less than 150% of rated capacity at a pressure not less than 65% of rated head.

.11 The shutoff pressure shall not exceed 120% of the total rated head.

.12 The pump shall operate in a clockwise direction as viewed from the drive engine end, at a maximum governed speed of 1,800 RPM.

.13 The pump casing shall be cast iron with 125 lb ANSI flat faced flange connections.

.14 Flanges and bearing supports shall be integrally cast with the lower casing.

.15 Removal of the upper casing shall allow removal of the rotating element without disconnecting the piping.

.16 The bearings shall be heavy-duty regreaseable ball bearings and shall be equipped with water slingers.

.17 The casing shall be fitted with renewable bronze wear rings.

.18 The impeller shall be bronze, double suction enclosed type, keyed to the shaft.

.19 The shaft shall be steel with bronze sleeves securely locked in position to protect the shaft.

.20 The stuffing box shall be fitted with diagonally cut graphite fibre packing rings, lantern ring and split packing glands.

.21 The pump shall be fitted with lifting lugs as required.

.2 Diesel Engine:

.1 The driver shall be a reciprocating, compression ignition, four-cycle diesel engine with a minimum rating to suit service.

.2 The engine shall be built for heavy duty service and capable of operating continuously.

.3 Fuel: to ASTM D975 No. 2-D S15.

.4 The engine shall be of an in-line design with a nominal operating speed of 1800 RPM.

.5 The engine shall be mounted on a steel base common to the pump and shall be connected to the pump with a flexible coupling protected by a suitable guard.

.6 The pump and engine shall be accurately aligned.

.7 The base plate shall be provided with a drip rim.

.8 The engine shall be supplied with the following minimum accessories:

.9 Ability to allow monitoring of the control switch position (on, off or auto mode).

.10 Governor.

.11 Overspeed shutdown device.

.12 Instrument panel with tachometer, hour meter, oil pressure gauge, ammeter, and cooling water temperature gauge.

.13 Electric starter with suitable alternator (12 V, 40 Amp) and voltage regulator.

.14 Dual battery units, 12 V, with O gauge cables, and a battery box to provide acid spill containment.

.15 Mechanically operated main battery contactor.

.16 Force fed wet sump lubrication system.

.17 Air filter.

.18 Closed loop engine cooling system with water pump, heat exchanger, and jacket water temperature regulating device, (coolant shall be glycol-based antifreeze with anticorrosion additive).

.19 Exchanger water supply with strainers, pressure regulator, solenoid valve, isolation valves, bypass valves and pressure gauge. Shell shall be made of copper, with copper nickel tubes.

.20 Flexible connection for exhaust, between 400 and 600 mm long.

.21 Exhaust silencer, 12 gauge carbon steel, with flanged connections and protective barrier.

.22 Water jacket heater (block heater, comes with thermostatic control, 120 Vac).

.23 Fuel pump and injection system, with primary and secondary fuel filter.

.24 Flexible connections at termination of fuel lines.

.25 Pressurized recirculation lubricating oil system.

.26 Lifting lugs as required.

.3 Controller:

.1 The controller shall be in accordance with NFPA 20 Chapter 12.

.2 The controller shall be combined automatic and non-automatic type operated from battery voltage.

.3 The engine shall be activated by a pressure switch which responds to a low system pressure, a signal from the fire protection system, or a signal from a panel mounted or remote manual electric control.

.4 The engine shall operate continuously until shutdown manually at the controller.

.5 The controller shall be a floor-mounted type with a drip-proof steel cabinet, and shall be complete with:

.1 Dual battery charging systems (10 Amp).

.2 Panel mounted alarm and signal devices.

.3 Circuits and SPDT contacts for remote alarm and signal device.

.4 Weekly program timer.

.5 Pressure switch set to cut in at 750 kPa (109 psi).

.6 Sequence starting timer.

.7 Low room temperature alarm.

.8 Low fuel level alarm.

.9 High fuel level alarm.

.10 Electric pressure recorder.

.11 Selector switch for manual start on either battery bank 1 or 2, automatic start upon pressure drop, and off position and alarm reset.

.12 Manual crank push button.

.13 Engine stop button.

.14 Local alarm sound (bell/buzzer) for trouble annunciation.

.6 The controllers shall be completely assembled, wired, and tested before shipping.

.4 Protective Coating:

.1 Equipment shall be painted red (colour code per Appendix A of Section 09 90 00) to manufacturer's factory standard coating system 40 05 00.

.5 Noise:

.1 The diesel engine driven fire pump shall have a noise level not exceeding 110 dB(A) at a distance of 1 m.

.6 Accessories:

.1 The following fittings shall be supplied with the pump:

.1 Automatic air release.

.2 Relief valve, cast iron with brass trim.

.3 Enclosed cone.

.4 Suction gauge, calibrated -100 to +700 kPa (-14.5 to +100 psi) in accordance with Section 40 90 25.

.5 Discharge gauge, calibrated 0 to +2000 kPa (0 to 290 psi) in accordance with Section 40 90 25 Instrumentation for Piping Systems.

.3 Diesel Fire Pump Fuel Oil Storage Tank

.1 Fuel tank, single-wall, 2,200 L, complete with high level alarm switch, low level alarm switch, level gauge with local and remote indicator, and connections for fill, vent, supply, return and drain lines. The tank shall be for 50 KPa internal pressure provided with cradles and/or stand to vertically locate the tank to the diesel engine. The tank installation shall meet the requirements of NFPA 20, Manitoba Regulation 188/2001 for Storage and Handling of Petroleum Products and Allied Products, and Canadian Council of Ministries of the Environment (CCME) guidelines.

.2 Provide concrete spill containment volume of 110% around all fuel system components (fuel tank, valves, piping, etc).

.3 For details of Diesel Fuel Tank Level Transmitter, see Section 40 90 25 Instrumentation for Piping Systems.

.4 Electric Motor Jockey Pumps and Controllers: Tag Nos. 5750-PP-0003A and 5750-PP-0003B.

.1 Pump:

.1 Capacity - 0.63 L/s (10 GPM).

.2 Rated Head - 70 m (690 kPa).

.3 The jockey pumps shall be the Aurora Pump Model PVM2-90, (3 HP) or Purchaser's approved equivalent.

.4 The pump shall be of the multi-staged vertical type with direct-coupled electric motor driver.

.5 The suction supply to the pump will have a maximum pressure of 500/450 kPa (73/65 psi).

.6 The pump shall be vertical design.

.7 The casing, impeller, diffuser and shaft shall be made of 304 Stainless Steel.

.8 Flanges shall be 150 lbs.

.2 Motor:

.1 The motor shall be rated for 575 Vac, 3-phase, 60 Hz service.

.2 The motor speed shall not exceed 3,600 RPM.

.3 The motor shall meet the performance and test requirements of NEMA Standard MG1.

.4 The motor shall be capable of operating continuously with 15 % overload without injurious stresses or excessive rise in temperature.

.3 The controllers shall be completely assembled, wired, and tested before shipping.

.4 Protective Coating:

.1 Equipment shall be painted red (colour code per Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating) to manufacturer's factory standard coating system.

.5 Noise:

.1 The jockey fire pumps shall have a noise level not exceeding 85 dB(A) at a distance of 1 m.

.5 Fire Hose Cabinets

.1 The Fire Hose Cabinets shall be 30 in. long by 30 in. wide by 8 in. deep.

.2 The cabinets shall be constructed of 16 gauge steel tub with 14 gauge steel trim and an all metal door.

.3 The tub and door shall be finished with one coat of primer and red baked enamel. The cabinets shall be FM approved and UL and ULC listed.

.4 The cabinets shall be National Fire Equipment Ltd., Model Knight 200-2 or Purchaser's approved equivalent.

.5 The complete fire hose cabinet station shall consist of the following accessories:

.1 Angle valve, 2-1/2 in., 300 lb., complete with petcock, bronze body.

.2 Reducer, threaded, 2-1/2 in. x 1-1/2 in.

.3 Fire Hose, 1-1/2 in. x 30 m long latex lined, 100% synthetic, single jacket construction, complete with rocker lug couplings.

.4 Nozzle, 1-1/2 in., fog type rotary action operation to give complete shutoff to full stream, to saturation fog. Angus Fire DG66, Part No. 013979-1 or Purchaser's approved equivalent.

.5 Threads for 2-1/2 in. shall be 3-1/4 in. O.D. male, 6 threads per inch (i.e., Western Canada Fire Underwriters, Winnipeg Standards). Threads for 1-1/2 in. shall be 1-7/8 in. O.D. male, 11-1/2 threads per inch (i.e., Straight Iron Pipe Threads).

.6 All Items shall be FM approved, and UL and ULC listed.

.6 Fire Hose Reels

.1 Continuous Flow Fire Hose Reel.

.1 The continuous flow fire hose reel shall be installed in the spillway only.

.2 It shall be FM approved, and UL and ULC listed, and have a maximum allowable working pressure not less than 1,200 kPa (175 psi).

.3 The hose reel shall be National Fire Equipment Ltd., Model No. FD47-1-200 or Purchaser's approved equivalent.

.4 The complete continuous flow fire hose reel shall include the following accessories:

.1 Nozzle, 1 in., fog type rotary action operation to give complete shutoff to full stream, to saturation fog. Angus Fire DG66, Part No. 013979-1 or Purchaser's approved equivalent.

.2 Hard hose, rubber, non-collapsible, 1 in., 200 ft long.

.2 Standard Fire Hose Reel:

.1 The standard fire hose reel shall be complete with pipe mounting brackets to suit 2 in. schedule 40 pipe or wall as required.

.2 It shall be painted red, with baked enamel finish.

.3 The hose reel shall be FM approved and UL and ULC listed.

.4 The hose reel shall be National Fire Equipment Ltd.

.5 Style V Swinging Wall Reel, or Purchaser's approved equivalent.

.6 The complete standard fire hose reel station shall consist of the following accessories:

.1 Angle valve, 2-1/2 in., 300 lb., complete with petcock, bronze body.

.2 Reducer, threaded, 2-1/2 in. x 1-1/2 in.

.3 Fire hose, 1-1/2 in. x 30 m long latex lined, 100% synthetic, single jacket construction, complete with rocker lug couplings.

.4 Nozzle, 1-1/2 in. fog type rotary action operation to give complete shutoff to full stream, to saturation fog. Angus Fire DG66, Part No. 013979-1 or Purchaser's approved equivalent.

.5 Threads for 2-1/2 in. shall be 3-1/4 in. O.D. male, 6 threads per inch (i.e., Western Canada Fire Underwriters, Winnipeg Standards). Threads for 1-1/2 in. shall be 1-7/8 in. O.D. male, 11-1/2 threads per inch (i.e., Straight Iron Pipe threads).

.7 Hydropneumatic Tank: Tag No. 5750-PV-0004

.1 Capacity: 1600 L.

.2 Tank shall be a vertical carbon steel shell with a heavy duty replaceable bladder rated for a working pressure of 1,200 kPa(g).

.3 The tank shall have a 3 in. system connection and a charging valve.

.4 The accumulator shall be an AMTROL WX-456-C or Purchaser's approved equivalent.

.8 Wall Hydrants

.1 Wall hydrants shall be single 2-1/2 in. complete with control valve, extension stem, pipe sleeve with lock nut, control plate, shoulder adapter, and a cavity cap and chain; with hydrant plate, plain adapter, and cap and chain.

.9 Fire Department Connections

.1 Fire Department connection shall be 4 in. x 2-1/2 in. x 2-1/2 in. straight way body with an auto sprinkler standpipe plate, caps and chains.

.10 All equipment shall be provided with lifting lugs as required for general handling.

.11 Provide any special Tools required for operation and/or maintenance.

2.2 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc.) refer to P&IDs of the Purchaser's Drawings and applicable Pipe Class Material.

.2 Paint for piping: in accordance with Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating. Paint colour shall be red, per colour code indicated in Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating.

Part 3 Execution

3.1 GENERAL

.1 General execution of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, flushing, marking, testing, pre-commissioning, commissioning and Site quality control, shall be completed in accordance with Part 3 of

Section 40 05 00 Mechanical & Piping General Requirements, in addition to any specific requirements indicated below.

3.2 INSTALLATION

.1 Paint all pipe, fittings, and valves in accordance with Appendix A “Mechanical Coatings Standard” in Section 09 90 00 Painting and Coating.

.2 Electrical equipment installation: in accordance with Section 26 05 00 Electrical General Requirements.

.3 Primary electric motor driven fire water pump supply cable to be installed as per Canadian Electrical Code Section 32 requirements.

.4 Installation of the standpipe and hose reel systems shall be in accordance with NFPA 14.

3.3 TESTING AND FLUSHING

.1 Testing and Flushing shall be in accordance with NFPA 14.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein for the design, supply, transportation, handling, installation, testing, flushing, marking, pre-commissioning and commissioning of the fire suppression sprinkler systems, including but not limited to the following:

.1 Dry Deluge Sprinkler Systems.

.2 Wet Pipe Sprinkler Systems.

.3 Dry Pre-action Sprinkler Systems.

.2 Refer to Piping and Instrumentation Diagrams (P&IDs) in the Purchaser's Drawings for additional scope details.

.3 Fire suppression sprinkler systems shall be provided for the spillway structure and equipment. Details of the systems are to be determined and are not included in this Section of the Technical Specification.

1.2 CONTRACTOR COORDINATION

.1 The Work covered in this Section of the Technical Specification shall be done in conjunction with the Work covered in Section 28 31 00 Fire Detection and Alarm Systems and Section 21 12 00 Fire Protection Standpipe System. The Contractor shall ensure a completely unified and cohesive fire detection and suppression system is provided. If any aspect of the Work is undertaken by more than one Subcontractor, one shall be the lead for this Work. The Contractor shall take overall responsibility for all Work within these Sections.

1.3 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 21 12 00 - Fire Protection Standpipe System.

.4 Section 28 31 00 - Fire Detection and Alarm Systems.

.5 Section 40 05 00 - Mechanical & Piping General Requirements.

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ASME - American Society of Mechanical Engineers:
  .1 B16.5 - Pipe Flanges and Flanged Fittings.
  .2 B31.1 - Power Piping.
.2 ASTM - American Society for Testing and Materials.
.3 CSA CAN 3-Z299.3 - Quality Assurance Program, Category 3 - Canadian Standards Association.
.4 CSA W47.1, W48, W59 - Welding - Canadian Standards Association.
.5 CSA Z85 - Abbreviations for Scientific and Engineering Texts - Canadian Standards Association.
.6 FM - Factory Mutual.
.7 Manitoba Apprenticeship and Certification Act (C.C.S.M. c. A110).
  .1 Trade of Sprinkler System Installer Regulation 29/2003.
.8 Manitoba Electric Code.
.9 Manitoba Fire Code.
.10 National Fire Code.
.11 NFPA - National Fire Protection Association:
  .1 No. 13 - Standard for the Installation of Sprinkler Systems.
  .2 No. 15 - Standard for Water Spray Fixed Systems for Fire Protection.
  .3 No. 851 - Recommended Practice for Fire Protection for Hydroelectric Generating Plants.
  .4 No. 850 - Recommended Practice for Fire Protection for Electric Generating Plants and HVDC Converter Stations.
.12 UL - Underwriter Laboratories of the United States.
.13 ULC - Underwriter Laboratories of Canada.
.14 ULC-S527 - Underwriter Laboratories of Canada.
.15 ULC-S528 - Underwriter Laboratories of Canada.
.16 ULC-S530 - Underwriter Laboratories of Canada.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any

changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 No separate measurement will be made for the following Items:

.1 21 13 00 (a) - Dry Deluge Sprinkler systems.

.2 21 13 00 (b) - Wet Pipe Sprinkler systems.

.3 21 13 00 (c) - Dry-Pre-Action Sprinkler systems.

.3 Unit Price

.1 The Estimated Cost for Items 21 13 00 (a)i, (b)i, and (c)i in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the engineering design of the fire suppression systems, as follows:

.1 Item 21 13 00 (a)i - shall cover the design of the Dry Deluge Sprinkler system.

.2 Item 21 13 00 (b)i - shall cover the design of the Wet Pipe Sprinkler system.

.3 Item 21 13 00 (c)i - shall cover the design of the Dry Pre-action Sprinkler system.

.2 The Estimated Cost for Items 21 13 00 (a)ii, (b)ii, and (c)ii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling and identification, for all labour, equipment and materials for the sprinkler systems including piping, nozzles, deluge valves, valves, instrumentation and control devices and all Items required for the operation of these systems, as follows:

.1 Item 21 13 00 (a)ii - shall cover the Work associated with the Dry Deluge Sprinkler system.

.2 Item 21 13 00 (b)ii - shall cover the Work associated with the Wet Pipe Sprinkler system.

.3 Item 21 13 00 (c)ii – shall cover the Work associated with the Dry Pre-action Sprinkler system.

.3 Include costs for the testing, flushing, cleaning and pre-commissioning of the sprinkler systems in the unit prices set out in Section 21 12 00 Fire Protection Standpipe System.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including shop drawings, installation manual including installation and test plans, testing procedures, flushing procedures, marking procedures and pre-commissioning procedures.

.3 Submit piping drawings, product data, electrical schematics, and calculations for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.4 Submit manufacturer's installation, operation and maintenance manuals to the Engineer.

.5 Include electrical schematic of circuits, written description of system design, drawings illustrating control logic and equipment location, and technical bulletins describing equipment.

.6 Provide list of recommended spare parts.

.7 Submit all test results and reports to the Engineer.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Systems shall be designed by companies specializing in design of fire prevention and protection systems in the Province of Manitoba.

.3 All fittings and equipment as required must have a Canadian Registration Number (CRN).

.4 All equipment and devices used shall be tested as required in accordance with Factory Mutual approval requirements.

.5 Sprinkler installer shall be a registered apprentice or hold a certificate of qualifications as a sprinkler installer in the Province of Manitoba.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.9 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Dry Deluge Sprinkler Systems

.1 Operation of the Deluge Sprinkler Systems:

.1 The fire protection standpipe ring main serving the powerhouse and service bay shall provide water at a pressure of 600 kPa(g) to 950 kPa(g) to the deluge valves for each system.

.2 The actuation of each deluge system shall occur when the detection system activates the solenoid valve on the appropriate deluge valve and

allows the admission of water to the dry piping system in which are installed spray nozzles arranged to provide the spray coverage specified in Subsections 2.1.2, 2.1.3 and 2.1.4 of this Section of the Technical Specification.

.3 The deluge valve leading to the normally dry pipe spray system shall be maintained closed by the fire system water pressure applied through a branch line and orifice to the diaphragm chamber of the valve. The diaphragm chamber shall hold the valve clapper closed through a clapper latch. A solenoid valve on a vent line from the diaphragm chamber shall open when the detection system indicates a fire condition. The chamber pressure shall fall to below the trip ratio pressure and the deluge valve shall open admitting system pressure to the dry pipe system. The valve must be manually reset. The solenoid shall be rated for 24 Vdc.

.4 The supply line for each deluge sprinkler system shall include control and isolation valves and connection to the standpipe.

.2 Generator Step-Up Transformer Deluge System:

.1 Type of System - automatic, water spray, dry deluge system.

.2 Sprinkler Design - Special Hazard.

.3 System Design Pressure - 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).

.5 Ambient Conditions:

.1 Minimum temperature - -45°C.

.2 Maximum temperature - +40°C.

.3 Maximum wind velocity - 100 km/h.

.6 Minimum Average Density of Coverage - 0.17 L/s/m².

.7 Nozzle Type - open with dust caps, Mulsifyre, chrome plated, minimum orifice size 3 mm.

.8 Transformer Characteristics:

.1 Type - oil filled, force air cooling.

.2 Location - powerhouse tailrace deck.

.3 Approximate dimensions:

.1 Length - 11.5 m.

.2 Width - 4.9 m.

.3 Height - 8.2 m.

.4 Oil capacity per transformer - 39,000 L.

.5 Flash point of transformer oil - 150°C.

.3 Oil Storage Room Deluge System:

.1 Type of System - automatic, water spray, dry deluge system.

.2 Sprinkler Design - Special Hazard.

.3 System Design Pressure - maximum 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - minimum 600 kPa(g) (87 psig).

.5 Ambient conditions - indoor-heated.

.6 Minimum Average Density of Coverage - 0.25 L/s/m².

.7 Nozzle Type - open with dust caps, Mulsifyre, chrome plated, minimum orifice size 3 mm.

.8 Oil Storage Room Approximate Dimensions:

.1 Overall length - 14.6 m.

.2 Overall width - 12.9 m.

.3 Overall height - 4.3 m.

.9 Lubricating Oil Storage Tanks - four tanks each 9,000 L.

.10 Lubricating Oil Flash Point - 220°C.

.4 Powerhouse Downstream Wall Deluge System:

.1 Type of System - automatic, water spray, dry deluge system.

.2 Sprinkler Design - Special Hazard.

.3 System Design Pressure - 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).

.5 Ambient Conditions:

.1 Minimum temperature - -45°C.

.2 Maximum temperature - +40°C.

.3 Maximum wind velocity - 100 km/h.

.6 Minimum Average Density of Coverage - 0.17 L/s/m^2.

.7 Nozzle Type - open with dust caps, Mulsifyre, chrome plated, minimum orifice size 3 mm.

.2 Wet Pipe Sprinkler Systems

.1 Operation of Wet Pipe Sprinkler Systems:

.1 The fire protection standpipe ring main throughout the powerhouse and service bay shall provide the pressurized water supply for all the wet pipe sprinkler or spray systems.

.2 Each system shall be designed to NFPA 13 and NFPA 15 to provide the sprinkler coverage specified in Subsections 2.2.2 through 2.2.8 of this Section of the Technical Specification.

.3 Each system shall be a wet pipe arrangement with solder type or frangible bulb sprinklers, temperature rated for 74°C.

.4 The standpipes up to and including each system isolating valve, shall be supplied as per Section 21 12 00 Fire Protection Standpipe System.

.5 A water flow alarm switch shall be installed on each zone's supply pipe to detect the discharge of any one of the sprinklers in the system. A valved alarm test and drainpipe shall be provided at each switch for testing its operation. Each switch shall annunciate on the Purchaser's main fire alarm panel, remote annunciator panel and printer terminal to identify which sprinkler area has operated.

.6 The diesel fire pump and pump rooms shall be on one zone with annunciation from one water flow detection device.

.7 The Governor Oil Pumping systems shall each have a separate sprinkler system and flow detection device for each unit.

.8 The cable tray sprinkler system for the tailrace service gallery shall be zoned to be compatible with the maximum number of spray heads per zone.

.9 The system actuation shall be by a thermal link on each sprinkler head temperature rated for 74°C.

.2 Pump Room Sprinkler System:

.1 Type of System - automatic wet pipe sprinkler system.

.2 Sprinkler Design - Ordinary hazard Group 1.

.3 System Design Pressure - 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).

.5 Nozzles - Upright Sprinkler Equipped with Mechanical Guards.

.6 Ambient Conditions - Indoor heated.

.7 Minimum Average Density of Coverage - 0.10 L/s/m².

.8 Protection Area per Sprinkler - 12.1 m² maximum.

.3 Diesel Fire Pump Room Sprinkler System:

.1 Type of System - automatic wet pipe sprinkler system.

.2 Sprinkler Design - Extra Hazard Group 1.

.3 System Design Pressure - 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).

.5 Nozzles - Upright Sprinkler Equipped with Mechanical Guards.

.6 Ambient Conditions - Indoor heated.

.7 Minimum Average Density of Coverage - 0.20 L/s/m² (per Manitoba Hydro Manual).

.8 Protection Area per Sprinkler - 9.3 m² maximum.

.4 Compressor Room Sprinkler System:

.1 Type of System - automatic wet pipe sprinkler system.

.2 Sprinkler Design - Ordinary Hazard Group 1.

.3 System Design Pressure - 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).

.5 Nozzles - Upright Sprinkler Equipped with Mechanical Guards.

.6 Ambient Conditions - Indoor heated.

.7 Minimum Average Density of Coverage - 0.10 L/s/m² (per Manitoba Hydro Manual).

.8 Protection Area per Sprinkler - 12.1 m² maximum.

.5 Governor Oil Equipment Sprinkler System:

.1 Type of System - automatic wet pipe sprinkler system.

.2 Sprinkler Design - Ordinary Hazard Group 1.

.3 System Design Pressure - 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).

.5 Nozzles - Upright Sprinkler Equipped with Mechanical Guards.

.6 Ambient Conditions - Indoor heated.

.7 Minimum Average Density of Coverage - 0.15 L/s/m^2.
.8 Protection Area per Sprinkler - 12.1 m^2 maximum.
.9 Accumulator System:
.1 Width - 1,400 mm.
.2 Depth - 3,500 mm.
.3 Height - 3,400 mm.
.10 Oil Pressure System:
.1 Width - 1,420 mm.
.2 Depth - 3,400 mm.
.3 Height - 2,600 mm.
.11 Flash Point of Oil - 220°C.

.6 Stores Areas Sprinkler System:
.1 Type of System - automatic wet pipe sprinkler system.
.2 Sprinkler Design - Ordinary Hazard Group 1.
.3 System Design Pressure - 1,200 kPa(g) (175 psig).
.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).
.5 Nozzles - Upright Sprinkler Equipped with Mechanical Guards.
.6 Ambient Conditions - Indoor heated.
.7 Minimum Average Density of Coverage - 0.15 L/s/m^2.
.8 Protection Area per Sprinkler - 12.1 m^2 maximum.

.7 Cable Tray Sprinkler System:
.1 Type of System - automatic wet pipe sprinkler system.
.2 Sprinkler Design - Ordinary hazard Group 1.
.3 System Design Pressure - 1,200 kPa(g) (175 psig).
.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).
.5 Nozzles - Upright Sprinkler Equipped with Mechanical Guards.
.6 Ambient Conditions - Indoor heated.
.7 Minimum Average Density of Coverage - 0.20 L/s/ m^2.

.8 Standby Diesel Generator Sprinkler System:
.1 Type of System - automatic wet pipe sprinkler system.
.2 Sprinkler Design - Extra hazard Group 1.
.3 System Design Pressure - 1,200 kPa(g) (175 psig).
.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).
.5 Nozzles - Upright Sprinkler Equipped with Mechanical Guards.
.6 Ambient Conditions - Indoor heated.
.7 Minimum Average Density of Coverage - 0.20 L/s/ m^2.
.8 Protection Area per Sprinkler - 9.3 m^2 maximum.

.3 Dry Pre-Action Sprinkler Systems

.1 For the purpose of this Section of the Technical Specification, the following terms shall be defined:

.1 Double Interlock - Refers to a system that will only release water if there is a loss of pressure in pipe, plus an activation of an electrical fire alarm.

.2 Single Zoned - Refers to a system where only one detector must be activated to trigger an electrical alarm signal.

.3 Cross Zoned - Refers to a system where two different types of detectors on two different electrical circuits must be activated in order to trigger an electrical alarm signal.

.2 Operation of the Dry Pre-Action Sprinkler System:

.1 The fire protection ring main serving the powerhouse and service bay shall provide water at a pressure of 600 kPa(g) to 950 kPa(g) to the deluge valves for each system.

.2 The supply line for each dry pre-action sprinkler system shall include the following components:

.1 Isolation valve.

.2 Deluge valve

.3 Pressure reducing type air maintenance device.

.3 Downstream of the deluge valve, the sprinkler piping shall be kept dry, and filled with compressed air from the service air system. The pressure reducing type air maintenance device shall maintain a pressure of approximately 275 kPa (40 psig) in the dry piping, to make up for minor losses. Plant air at a nominal pressure of 700 kPa(g) (100 psig) must be available. The low air pressure alarm switch shall monitor the dry pipe portion of the system, and initiate a trouble signal to the main fire alarm panel on loss of pressure. When the ambient temperature reaches the operating temperature of the sprinklers, the sprinklers shall open, releasing the air.

.4 The deluge valve shall only open when two independent events occur; an electric fire detection device (one for Spillway or two in cross-zoned electrical equipment rooms) must be activated, and the low air pressure alarm switch must be activated. When these two events occur, the solenoid valve shall be opened, which shall activate the deluge valve. The water supply pressure then forces the diaphragm open, permitting water to flow into the system piping. The water also flows through the Pressure Flow Switch, providing a signal to the main fire alarm panel.

.3 Deluge Valve Control:

.1 The double-interlocked deluge valve is a diaphragm style valve, which depends upon water pressure in the diaphragm chamber to hold the diaphragm closed against the water supply pressure. The deluge valve leading to the normally dry pipe spray system shall be maintained closed by the fire water pressure applied through a branch line and orifice to the diaphragm chamber of the valve. The diaphragm chamber shall hold the valve clapper closed through a clapper latch. A solenoid valve on a vent line from the diaphragm chamber shall open when the detection system indicates a fire condition. This shall vent the diaphragm chamber faster than the orifice will allow the fire water pressure to restore the pressure in the chamber. The chamber pressure shall fall to below the trip ratio pressure and the deluge valve shall open admitting system pressure to the

dry pipe system. The valve must be manually reset. The solenoid shall be rated for 24 Vdc.

.4 Electrical Equipment Rooms (service bay MCCs at El. 141, control room, UCMS room, and communications room).

.1 The electrical equipment room sprinkler systems shall be of the dry, pre-action, double interlock type, connected to the station fire suppression header, and shall be provided with automatic sprinkler heads and a deluge valve activated by a cross-zoned detection system.

.1 Type of System - dry, pre-action, double interlock type.

.2 Sprinkler Design - Ordinary Hazard Group 2.

.3 System Design Pressure - 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).

.5 Nozzles - Pendant/Upright Sprinkler Equipped with Mechanical Guards.

.6 Ambient Conditions - Indoor heated.

.7 Minimum Average Density of Coverage - 0.17 L/s/m^2.

.8 Protection Area per Sprinkler - 12.1 m^2 maximum.

.5 Intake Hoist Housing Sprinkler System:

.1 The intake hoist housing sprinkler system shall be of the dry, pre-action, double interlock type, connected to the station fire protection standpipe and shall be provided with automatic sprinkler heads and a deluge valve activated by a single-zoned detection system.

.1 Type of System - dry, pre-action, double interlock type.

.2 Sprinkler Design - Light Hazard.

.3 System Design Pressure - 1,200 kPa(g) (175 psig).

.4 Minimum Operating Pressure - 600 kPa(g) (87 psig).

.5 Nozzles - Upright Sprinklers Equipped with Mechanical Guards.

.6 Ambient Conditions - Indoor heated.

.7 Minimum Average Density of Coverage - 0.15 L/s/m^2.

.8 Protection Area per Sprinkler - 20 m^2 maximum.

2.2 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc.) refer to P&IDs in the Purchaser's Drawings and applicable Pipe Class Material.

.2 Paint for piping: in accordance with Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating. Paint colour shall be red, per colour code indicated in Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating.

2.3 COMPONENTS

.1 Dry Deluge System Nozzles

.1 The nozzles used in the dry deluge systems shall be open nozzle, high velocity, directional water spray type with dust caps. The caps shall be pressure activated,

with a non-metallic retaining wire. The nozzles shall be FM approved, and UL and ULC listed as to orifice size and finish. The nozzles shall be fixed type, brass/bronze. Nozzles shall be chrome plated "Mulsifyre" nozzles (no substitution permitted), Model F822 through F834, or Purchaser's approved equivalent.

.2 Water passages in the nozzles and orifices used to equalize flow shall be not less than 3 mm in their smallest dimension.

.3 The nozzles shall be suitable for outdoor operation at a maximum design wind velocity of 100 km/h.

.2 Deluge Valves

.1 The Deluge Valve shall be of the diaphragm type; rated for 1,200 kPa(g) (175 psig). The Deluge Valve shall come complete with the following trim:

.1 Water Supply Pressure Gauge.

.2 Diaphragm Chamber Pressure Gauge.

.3 Manual Control Station.

.4 Main Drain Valve.

.5 Automatic Drain Valve.

.6 System Air Pressure Gauge.

.7 Low Air Pressure Alarm Switch - located in the dry pipe portion to sense a loss in pressure, indicating a leak, and initiating a trouble signal.

.8 Waterflow Pressure Alarm Switch- provides a system activated signal to the main fire alarm panel when deluge valve is activated.

.9 Pressure reducing air maintenance device.

.10 The Deluge Valve shall be a Viking Model, or Purchaser's approved equivalent.

.2 FM approved, UL and ULC listed deluge valve of flanged, iron body, brass trim construction and Class 175 rating shall be supplied for each dry deluge system. The deluge valves shall be of the quick-opening, electro-mechanically initiated type, arranged for automatic operation by the detection system, or by a manual pull control station at the valve. All electrical devices shall return to the ready position when the deluge valve and detection system are reset. The solenoid valve coils shall be encapsulated and be capable of being electrically supervised by the fire alarm panel. A pressure switch shall confirm system activation.

.3 The deluge valves shall be drip-tight under all pressures between 70 kPa(g) and 1380 kPa(g). Each deluge valve shall be equipped with manual drain valves and a trim package including pressure gauges, solenoid valve, pressure switches and emergency trip valve. Each valve shall have a self-draining feature to remove water completely from the system and to keep the system dry when not in use.

.4 The deluge valves shall be Viking Model, or Purchaser's approved equivalent.

.3 Electric Actuated Solenoid Valve

.1 The solenoid valve shall be rated for 24 Vdc, and shall have a NEMA 4 rating. The maximum working pressure shall be no less than 1,200 kPa(g) (175 psig).

.4 Air Maintenance Device

.1 The air maintenance device shall be of the adjustable pressure-reducing type. The device shall have an adjustable outlet pressure range between 70 - 410 kPa(g) (10 - 60 psig). The device shall be rated for an inlet pressure of at least 1,200 kPa(g) (174 psig). The device shall come with a by-pass valve to allow fast fill of the system during initial pressurization.

.5 Pressure Switches

.1 One pressure switch, initiated by the water pressure when the deluge valve opens, shall be provided with each deluge valve. The switch shall be suitable for use where there is shock and vibration and shall have adjustable range 70 - 1,400 kPa(g), single pole double throw contacts rated 15 A 120/240 Vac, proof pressure of 2,070 kPa(g), and be UL and ULC listed and FM approved.

2.4 INSTRUMENTATION

.1 For Instrumentation refer to Section 40 90 25 Instrumentation for Piping Systems.

Part 3 Execution

3.1 GENERAL

.1 General execution of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, testing, flushing, marking, pre-commissioning, commissioning and Site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements, in addition to any specific requirements indicated below.

3.2 EXAMINATION

.1 After each fire suppression system is installed, the Contractor shall completely clean the piping, supply and install the necessary plugs and blind flanges, and subject the completed system to a hydraulic pressure test of 1,400 kPa(g) (200 PSI) in accordance with NFPA 13 Standard for Installation of Sprinkler Systems. The test pressure shall be maintained for a minimum period of two hours, plus the length of time required to inspect the system. Any defects found during testing shall be corrected and the pressure test repeated.

.2 Upon successful completion of the pressure test, the Contractor shall thoroughly flush each system. Flushing shall be done without the deluge and nozzles in the circuit. Flushing shall continue until cleanliness of the system is obtained to the satisfaction of the Engineer. The Contractor shall supply all hoses, equipment, and personnel required to carry out this aspect of the Work and to protect the Purchaser's equipment from damage.

.3 If deemed necessary by the Engineer, the deluge, pre-action and/or wet pipe systems may be subjected to a full or partial flow test by the Contractor to ensure each hazard group is fully protected and the nozzles are adjusted to give efficient and uniform coverage. If deemed necessary after the tests, orifice plate to equalize flow or reduce pressure and/or larger pipes to increase flow or raise pressure shall be installed by the Contractor at no extra cost to the Purchaser.

3.3 PREPARATION

.1 All components of the suppression systems shall be inspected and tested for proper installation and operation to the satisfaction of the Engineer, prior to acceptance by the Purchaser.

.2 Materials required for the installation of this aspect of the Work may be supplied, pre-assembled and prefabricated to avoid the necessity for field welding. The pipework shall be supplied in spool pieces of convenient length and shape for economical shipment to Site. Where galvanized material is specified, galvanizing shall be done after welding. Provision for the repair of galvanized surfaces or threads shall be made by supplying Meadows "Galvafroid" No. 9911 or Purchaser's approved equivalent.

.3 Extreme care shall be taken, particularly with the galvanized piping to avoid distortion during galvanizing.

.4 Threaded components in the assembly of spool pieces shall be minimized.

3.4 INSTALLATION

.1 The fire protection standpipe shall terminate at, and include, the isolation valve leading to each system. The installation of the dry deluge piping shall ensure uniform water distribution throughout each system. The design shall be such that during operation, the water spray shall also protect the deluge system piping as well as the protected equipment, and the positioning of all parts of the system shall be such that they shall have a maximum protection against effects of fire or explosion.

.2 All piping shall be installed with sufficient flanged/grooved joints or screwed unions to permit easy dismantling of the piping system for removal of the protected equipment. The arrangement shall be such that dismantling of the piping is kept to a minimum and that any piping left standing or hanging is adequately supported and does not require additional bracing during removal of the protected equipment.

.3 All piping shall be installed to be supported free from the protected equipment and securely anchored to resist all hydraulic thrust when the system operates.

.4 All headers shall be sloped to drain back to the deluge valves or nozzles.

.5 The piping systems shall be supplied free from distortions, which could result in misalignment of nozzles after assembly at Site. Shop assemblies shall be galvanized after fabrication.

.6 Dry Deluge System nozzles shall be so placed that all exposed exterior surfaces of the protected equipment are subject to direct spray from one or more nozzles. Nozzles shall be so directed that the centre of their discharge is downward so that the spray is generally opposed to the expected updraft from a fire.

.7 The following requirements apply specifically to the nozzles used in the transformer dry deluge systems.

.1 The nozzles shall be arranged in not less than two horizontal ring headers at each transformer.

.2 The nozzles shall be located and the system designed so that accidental operation of the transformer deluge system when the transformer is energized shall not fault the transformer by causing a flashover either to ground or to adjacent phases and buswork.

.3 Nozzles shall be installed in accordance with the requirements of NFPA No. 15, Section 6.1.2.2 “Clearance from Water Spray Equipment to Live Uninsulated Electrical Components” and shall be suitably grounded.

.4 All vertical channels and other supports between the transformer coolers and radiators shall be protected by direct discharge from one or more nozzles.

.8 Paint all pipe, fittings, and valves in accordance with Appendix A “Mechanical Coatings Standard” of Section 09 90 00 Painting and Coating.

.9 The Contractor shall provide suitable identification signs at each control valve, deluge valve and manual operation station. The signs at each deluge valve shall be hung with a chain and have the following typical information:

.1 AUTOMATIC DELUGE SPRINKLER SYSTEM
(equipment name here)
TO ACTIVATE SYSTEM
PULL “MANUAL STATION”

.2 Brief operation and maintenance instructions as required.

.3 Manufacturer’s name and reference numbers.

.4 The identification signs shall be made of engraved red laminated plastic with white lettering 13 mm high or Purchaser’s approved equivalent and shall not be less than 300 mm x 200 mm in size.

3.5 SITE QUALITY CONTROL

.1 After each fire suppression system is installed, the Contractor shall completely clean the piping, supply and install the necessary plugs and blind flanges, and subject the completed system to a hydraulic pressure test of 1,200 kPa(g) in accordance with NFPA 13 Standard for Installation of Sprinkler Systems. The test pressure shall be maintained for a minimum period of 2 hours, plus the length of time required to inspect the system. Any defects found during testing shall be corrected and the pressure test repeated.

.2 Upon successful completion of the pressure test, the Contractor shall thoroughly flush each system. Flushing shall be done without the deluge and nozzles in the circuit. Flushing shall continue until cleanliness of the system is obtained to the satisfaction of the Engineer. The Contractor shall supply all hoses, equipment, and personnel required to carry out this Work and to protect the Purchaser’s equipment from damage.

.3 If deemed necessary by the Engineer, the deluge, pre-action and/or wet pipe systems may be subjected to a full or partial flow test by the Contractor to ensure each hazard group is fully protected and the nozzles are adjusted to give efficient and uniform coverage. If deemed necessary after the tests, orifice plate to equalize flow or reduce pressure and/or larger pipes to increase flow or raise pressure shall be installed by the Contractor at no extra cost to the Purchaser.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary as shown on the applicable Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, testing, pre-commissioning, and commissioning of the Domestic Water System (except the Water Treatment Plant specified in Section 46 07 13 Domestic Water Treatment Plant).

.2 Refer to Piping and Instrumentation Diagrams (P&IDs) in the Purchaser's Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 40 05 00 - Mechanical & Piping General Requirements.

.4 Section 46 07 13 - Domestic Water Treatment Plant.

.5 Section 09 90 00 - Painting and Coating.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ASME B31.1 - Power Piping.

.2 ANSI 358.1 - American National Standard for Emergency Eyewash and Shower Equipment.

.3 CSA B51 - Boiler, Pressure Vessel, and Pressure Piping Code.

.4 Manitoba Building Code.

.5 National Plumbing Code of Canada.

.6 Plumbing and Drainage Institute WH 201 - Water Hammer Arresters.

.7 AWWA Specifications C651 - Disinfecting Water Mains.

.8 AWWA Specifications C652 - Disinfection of Water-Storage Facilities

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Equipment Items 22 11 00 (a)i to 22 11 00 (a)xiv will be based on the quantities shown on the applicable Purchaser's Drawings and Contractor's Documents.

.2 Measurement for the following Piping Items will be based on the length of pipe in metres shown on the applicable Purchaser's Drawings and Contractor's Documents, from fitting to fitting, excluding the fitting(s).

.1 22 11 00 (b)i to22 11 00 (b)vi - Exposed Piping.

.3 Measurement for the following Fitting and Valve Items will be based on the quantities shown on the applicable Purchaser's Drawings and Contractor's Documents.

.1 22 11 00 (c)i to 22 11 00 (c)xxiv - Exposed Fittings.

.2 22 11 00 (d)i to 22 11 00 (d)vii - Valves

.4 Measurement for Components, Items 22 11 00 (e)i to 22 11 00 (e)iii will be based on the quantities shown on the applicable Purchaser's Drawings and Contractor's Documents.

.5 No separate measurement will be made for the following Items:

.1 22 11 00 (f) - Insulation.

.2 22 11 00 (g) - Instrumentation

.3 22 11 00 (h) - Testing, Flushing and Cleaning.

.4 22 11 00 (i) - Pre-commissioning.

.3 Unit Price

.1 The unit prices for equipment Items 22 11 00 (a)i to 22 11 00 (a)xiv inclusive, in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein. Item 22 11 00 (a)i is specified in Section 46 07 13 Domestic Water Treatment Plant.

.2 The unit prices for the following exposed piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission

shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein.

.1 22 11 00 (b)i to 22 11 00 (b)vi - Exposed Piping.

.2 22 11 00 (c)i to 22 11 00 (c)xxiv - Exposed Fittings.

.3 22 11 00 (d) i to 22 11 00 (d)vii - Valves.

.3 The unit prices for Component Items 22 11 00 (e)i to 22 11 00 (e)iii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, final connections of the equipment specified herein.

.4 The Estimated Cost for Insulation Item 22 11 00 Item (f) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading and handling of insulation material as specified herein.

.5 The Estimated Cost for Instrumentation Item 22 11 00 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, Items such as pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment vendor. Include the costs for vendor supplied/installed instrumentation with the Equipment Item to which it applies.

.6 The Estimated Cost for Testing, Flushing and Cleaning Item 22 11 00 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system. Include costs for testing, flushing and cleaning Domestic Water Treatment Plant (Section 46 07 13).

.7 The Estimated Cost for Pre-Commissioning Item 22 11 00 (i) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the system as specified herein. Include costs for pre-commissioning Domestic Water Treatment Plant (Section 46 07 13).

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit drawings, product data, and required documentation to authority having jurisdiction in the Province of Manitoba for System Registration, as required.

.3 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data, installation manual including installation and test plans, testing procedures, flushing

procedures, marking procedures, pre-commissioning procedures, and operation and maintenance manuals.

.4 Provide list of recommended spare parts.

.5 Submit all test results and reports to the Engineer.

.6 The contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All fittings require a Canadian Registration Number.

.4 Plumbing fixtures shall be tested, certified and labelled in accordance with a certification program accredited by the Standards Council of Canada. Where a product is not so labelled, provide written approval by the authority having jurisdiction.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All Items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements set out in Section 25 Warranty of the General Specification.

Part 2 Products

2.1 PLUMBING FIXTURES AND EQUIPMENT

.1 Boundary of domestic water piping and water treatment plant are the isolation valves installed on water treatment plant outlets as indicated on P&ID.

.2 All fixtures including trim shall be CSA approved, free from flaws or blemishes and subject to Engineer's review in accordance with Section 21.7.9 Engineer's Review of the General Specification. All finished surfaces shall be clear, smooth and bright, and guaranteed not to craze, discolour or scale.

.3 All visible parts of trimmings of all fixtures, including faucets, showerheads, piping, escutcheons, wastes, strainers, traps, tailpieces, supplies, stops, etc. shall be heavily chrome-plated (industrial thick chrome-plated) and/or covered.

.4 Water Closet

.1 Caroma Caravelle 270 1.6/0.8 GPF water saving dual flush high efficiency combination toilet, two piece ultra low flush vitreous china, floor mount, elongated rim, wash down, bolt caps, white, 4” trapway.

.2 Olsonite 10 CC open front seat less cover, self- sustaining concealed check hinge, colour white, stainless steel hinge posts, washers and nuts.

.3 Speedway chrome plated flexible supply with screwdriver angle stop, inlet extension tube, chrome plated escutcheon plate.

.4 Wax seal, brass back bolts, nut and washers.

.5 Urinal

.1 Crane 7397 Cromwell, vitreous china, washout, wall hung, stainless steel strainer, top spud, concealed wall hanger. (bolt through block wall).

.2 Delta Commercial 81T231 3/4” manual exposed diaphragm flush valve, polished chrome, vacuum breaker, 0.7 GPF.

.6 Lavatory

.1 Kindred KSOV1821/7 stainless steel countertop lavatory, 4" centers, self rimming, undercoated, integral overflow.

.2 Delta Commercial 22C151 lavatory faucet, 0.5 GPM aerator, 4” center single lever, ceramic cartridge, colour coded hot/cold identification.

.3 Delta Commercial 33T311 cast brass adjustable 'P' trap with cleanout plug.

.4 Delta Commercial 33T260 cast waste open grid strainer.

.5 Speedway chrome plated flexible supplies with screwdriver angle stops, inlet extension tubes, chrome plated escutcheon plates.

.7 Slop Sink

.1 Franke WSS6713 Wall Mounted Service Sink, concealed hanger, 3-1/2" crumb cup waste, polished satin finish, 14 gauge, no hole drilling.

.2 Delta Commercial 28C2383, 8" wall mounted sink faucet, bottom brace, 10-1/2" spout with vacuum breaker, garden hose end, polished chrome, 3 blade handles with sanitary hood, integral stops.

.3 Fiat #832-AA hose and hose bracket, 30" (750 mm) long flexible heavy-duty rubber hose with brass hose coupling one end, Type 302 stainless steel hose bracket with rubber gripper.

.4 Fiat #889CC mop hanger.

.8 Kitchen Sink

.1 Franke LBD6407-1 two compartment with backledge, stainless steel sink, self-rimming, 2 bowls @ 16" x 14" x 7" deep I.D., 3 hole drilling, 8" centers, 3-1/2" basket strainer and tailpiece assembly, baked-on undercoating, under deck clamps.

.2 Delta 335-WFTP Kitchen Faucet, vegetable sprayer hose, single handle deckmount, 8" centerset, 9" tubular swing spout, aerator.

.3 Cast brass 'P' trap with cleanout plug.

.4 Speedway chrome plated flexible supplies with screwdriver angle stops, inlet extension tubes, chrome plated escutcheon plates.

.9 Laboratory Sink (Water Treatment Plant Room and Wastewater Treatment Plant Room)

.1 Made of 304 stainless steel, free standing sink with drain board, Franke Model SSS1827SDSR.

.10 Shower

.1 HYTEC Torrero AC36, one piece acrylic, white, moulded-in floor pattern, 2 toiletry shelves, grip rail, 6” high threshold.

.2 Delta Commercial T13H183 multichoice universal pressure balancing shower mix valve, polished chrome plated finish, integral checks, lever handle.

.3 Rough-in valve R10000-UNWS.

.4 Shower Head Kohler K-10240-CP @ 1.75 GPM, three function spray, sprayface resists hard water buildup, chromed arm and flange.

.5 Shower Waterproof Dome Light, all wiring by Electrical Contractor.

.11 Wash Fountain

.1 WF1 Bradley.

.2 WF2704 Stainless Steel classic semi-circular 36” wash fountain with foot control.

.12 Self-contained Eyewash Unit

.1 Portable gravity operated eyewash shall include a FDA approved polyethylene 16 gallon tank with 0.4 gpm flow rate over 15 minutes and shall meet ANSI Z358.1 standard. Haws model 7,500 portable eyewash unit or Purchaser’s approved equivalent.

.13 Hot Water Tank (Service Bay)

.1 A.O. Smith DSE-80 Dura-Power supreme commercial electric heater, 80-gallon capacity, 30 KW, two immersion heaters, 15,000 watts, glass-lined, anode rod, drain valve, T and P relief valve.

.14 Hot Water Tank (Unit 5)

.15 A.O. Smith Dura-Power supreme commercial electric heater 6 gallon capacity, 3 KW, 1 immersion heater, 3,000 watts, glass-lined anode rod, drain valve, T and P relief valve. Recirculation Pump - Tag No. 5750-PP-0015

.1 In-line 1/2” centrifugal, Bronze, single stage, constructed to prevent contact of water with metal other than nonferrous. Pump shall be suitable for potable water.

.2 115/60/1, 1/40 HP motor shall be equipped with thermal overload protection.

.3 Pump shall operate continuously with "on-off" switch for shut down, Taco Circulator Model 003B or Purchaser’s approved equivalent.

.16 Hydropneumatic Tank - Tag No. 5750-PV-0001

.1 One 1,067 mm (3’-6”) diameter x 1,524 mm (5’-0”) side shell horizontal hydropneumatic tank, carbon steel construction, rated for a total capacity of 1,685 L (445 USgal), designed in accordance with ASME and bearing the ASME stamp. Tank to weigh approximately 454 kg (1,000 lbs). Including:

.1 Structural support saddle.

.2 Duplex compressed air system shall consist of two compressor pumps with two 2 hp, 575 V, 3 phase motors, mounted on a 227 l (60 USgal.) ASME code horizontal receiver tank. System requires a 115-volt receptacle (by Division 26).

.17 Domestic Water Pumps – Tag Nos. 5750-PP-0013A & B

.1 Two cast iron centrifugal pumps, 7.5 HP, 3,600 RPM, 575 Vac; 4.1 L/s (65 gpm) @ 551 kPa (80 psi), as specified.

2.2 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc) refer to P&IDs in the applicable Purchaser's Drawings and applicable Pipe Class Material Specification.

.2 Water Pipe Sizes to Fixtures

	Cold	Hot
Lavatory Basins	1/2 in.	1/2 in.
W.C. Flush Tanks	1/2 in.	
Sinks	1/2 in.	1/2 in.
Drinking Fountain	1/2 in.	
Showers	1/2 in.	1/2 in.
Urinal	3/4 in.	

.3 Flanged joints must have suitable gasket and bolts. Use brass nipples between copper piping and flush valves or chrome plated brass goods. Where alternate piping materials or jointing are specified a uniform type of pipe and fittings shall be used throughout each system.

.4 Silicone to be mildew-resistant, translucent white silicone, General Electric Sanitary Silicone Sealant #SCS 1752.

.5 Refer to Part 2 of Section 40 05 00 Mechanical & Piping General Requirements for additional material requirements.

2.3 COMPONENTS

.1 Expansion Joints

.1 Metraflex METRALOOP, copper, sweat end expansion loop or Purchaser's approved equivalent, shall be provided on water systems.

.2 Trap Primers

.1 Provide approved Zurn trap primers. Locations to be shown on detailed design drawings (to be completed during detailed design) or as required by Plumbing Code, to maintain trap seals.

.3 Shock Absorbers

.1 Supply and install shock absorbers on hot and cold water lines at each group of fixtures, each isolated fixture, and where noted on the Purchaser's Drawings and Contractor's Documents. Sizes shall be as noted or in accordance with Plumbing and Drainage Institute Standard
WH-201 "Water Hammer Arresters".

.2 Provide shock absorber upstream of every solenoid valve or quick closing valve.

.3 Review proposed location and type of shock absorbers with the Engineer prior to installation.

.4 Provide approved backflow preventers on all potable water supplies as noted on the Purchaser's Drawings and Contractor's Documents, specified herein, or as required by provincial/municipal authorities.

Part 3 Execution

3.1 GENERAL

.1 General execution of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, flushing, testing, pre-commissioning, marking, commissioning and Site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements, in addition to any specific requirements indicated below.

3.2 INSTALLATION

.1 Paint all pipe, fittings, and valves in accordance with Appendix A "Mechanical Coatings Standard" of Section 09 90 00 Painting and Coating.

.2 Domestic water pipes shall be disinfected in accordance with AWWA Specifications C651, and C652.

.3 Be responsible for protection of all fixtures until building is accepted by the Purchaser.

.4 All fixtures shall be completely installed and connected to drain, vent, hot and cold water supply piping in approved manner.

.5 Except where specifically noted otherwise, supply and install screwdriver stop (isolation) valve on hot and cold water supply to every fixture on project, in addition to valve or faucets on fixture itself.

.6 Provide adequate supports for all fixtures. Have these built into walls with back-up plates where required.

.7 Provide traps for all fixtures and equipment.

.8 Provide domestic water, vent and waste connections to all equipment requiring plumbing services.

.9 Confirm mounting heights for all fixtures before roughing in water, waste and vent piping.

.10 Provide silicone sealing of fixtures as follows:

.1 Silicone seal perimeter edges of fixtures as specified herein.

.2 Provide silicone sealing of following fixtures: drinking fountains, urinals, water closets, sinks (all types), and lavatories.

.3 Application of sealant shall be by experienced applicators, regularly employed for sealant application.

.4 Properly adjust and align fixtures prior to sealant application.

.5 Sealant bead to be smooth and neat, with proper proportions.

.6 Apply sealant in strict accordance with manufacturer's published data.

.7 For wall hung fixtures, seal only three edges; top and both sides, not bottom.

.8 For lavatories, seal perimeter edge between countertop and lavatory.

.9 Do not apply silicone sealant onto stainless steel fixtures, unless noted otherwise.

.11 Insulation shall be installed on all hot domestic water piping per thermal insulation system specification in Section 40 42 00 Piping Insulation.

.12 Grade horizontal runs of piping to drain through risers, and slope all horizontal runs.

.13 Install shut off valves at hot water heaters, at all connections to major pieces of equipment, in all branches to fixtures or groups of fixtures.

.14 Install dielectric insulating unions between all pipes or apparatus constructed of dissimilar metals. Use brass nipples at flush valves, etc.

.15 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein for the supply, transportation, handling, installation, testing, flushing, marking, pre-commissioning, and commissioning of the sanitary system (except the wastewater treatment plant specified in Section 46 07 53 Wastewater Treatment Plant). The sanitary system shall interface with the wastewater treatment plant at a flanged connection on the wastewater treatment plant.

.2 Refer to the Purchaser's Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 22 11 00 - Domestic Water System.

.4 Section 26 05 00 - Electrical General Requirements.

.5 Section 40 05 00 - Mechanical & Piping General Requirements.

.6 Section 46 07 53 - Wastewater Treatment Plant.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 National Plumbing Code of Canada.

.2 Manitoba Plumbing Code.

.3 Manitoba Regulations.

.4 Manitoba Public Health Act.

.5 The Clean Environment Act.

.6 Ministerial Approval - Clean Environment Commission.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill

of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Equipment Items 22 13 00 (a)i to 22 13 00 (a)ii will be based on the quantities shown in the Purchaser's Drawings and Contractor's Documents.

.2 Measurement for the following Piping Items will be based on the length of pipe in metres shown in the Purchaser's Drawings and Contractor's Documents, from fitting to fitting, excluding the fitting(s).

.1 22 13 00 (b)i to 22 13 00 (b)iii - Exposed Piping.

.3 Measurement for the following Fitting and Valve Items will be based on the quantities shown in the Purchaser's Drawings and Contractor's Documents.

.1 22 13 00 (c)i to 22 13 00 (c)viii - Exposed Fittings.

.2 22 13 00 (d)i to 22 13 00 (d)ii – Valves.

.4 Measurement for Component Item 22 13 00 (e)i will be based on the quantities shown in the Purchaser's Drawings and Contractor's Documents.

.5 No separate measurement will be made for the following Items:

.1 22 13 00 (f) – Instrumentation.

.2 22 13 00 (g) – Testing, Flushing and Cleaning.

.3 22 13 00 (h) – Pre-commissioning.

.3 Unit Price

.1 The unit prices proposed for Equipment Items 22 13 00 (a)i to 22 13 00 (a)ii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein. Item 22 13 00 (a)i is specified in Section 46 07 53 – Wastewater Treatment Plant.

.2 The unit prices proposed for the following Exposed Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein.

.1 22 13 00 (b)i to 22 13 00 (b)iii - Exposed Piping.

.2 22 13 00 (c)i to 22 13 00 (c)viii - Exposed Fittings.

.3 22 13 00 (d)i to 22 13 00 (d)ii – Valves.

.3 The unit price proposed for Component Item 22 13 00 (e)i in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling,

touch-up painting, identification, final connections of the equipment specified herein.

.4 The Estimated Cost proposed for Instrumentation Item 22 13 00 (f) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, Items such as pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment Vendor. Include the costs for Vendor supplied/installed instrumentation with the Equipment Item to which it applies.

.5 The Estimated Cost proposed for Testing, Flushing and Cleaning Item 22 13 00 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system. Include costs for Testing, Flushing and Cleaning in Section 46 07 53 Waste Water Treatment Plant.

.6 The Estimated Cost proposed for Pre-Commissioning Item 22 13 00 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the system as specified herein. Include costs for Pre-commissioning in Section 46 07 53Waste Water Treatment Plant.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor’s Documents of the General Specification.

.2 Submit the necessary information to the authority having jurisdiction in the Province of Manitoba to obtain any Certificates, if required.

.3 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification, all applicable Contractor’s Documents including product installation manual including installation and test plans, testing procedures, flushing procedures, marking procedures and pre-commissioning procedures.

.4 Wastewater treatment room sump pump information shall include typical pump curves, pump capacity/head, horsepower, efficiency and NPSH.

.5 Submit all test results and reports to the Engineer.

.6 The contractor shall provide a simplified 3D Model of the equipment in accordance Subsection 21.7.7 3D Model Standards. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor’s Quality Management Plan.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Wastewater Treatment Plant (WWTP) Room Sump Pump.

.1 One pump will be installed to pump water from the sewage treatment plant room sump. The pump shall have a capacity of 2 L/s (32 GPM) at a total dynamic head of 3 m (10 ft). The pump shall be of centrifugal, vertical shaft, submersible design. The pump shall have an integral electric motor.

.1 The pump shall be Flygt Model Ready 4, 2 in. NPS, 0.6 HP, or Purchaser's approved equivalent.

.2 The submersible pump shall be enclosed in a cast iron housing. The pump shall be capable of handling unscreened drainage water. It shall be driven by a vertical axis motor through a stainless steel shaft, supported by anti-friction bearings. The impeller shall be erosion resistant cast iron which is keyed to the shaft. A double mechanical seal shall separate the motor from the pump. The pump housing bottom and the impeller shall be equipped with replaceable wear rings. The pump shall be designed for continuous operation at water inlet temperatures of 0^{o}C to 28^{o}C and be capable of running indefinitely in a dry sump. The direction of pump rotation shall be clearly marked on the exterior of each unit.

.3 The pump motor shall be a squirrel cage induction type, continuously rated at 120 V, single-phase, 60 Hz, capable of operating in an external environment of 0^{o}C to 28^{o}C. The motor shall meet the performance and test requirements of NEMA Standard MG1. The motors shall have Class F or better insulation made of non-hygroscopic and moisture resistant materials. Each phase of the motor windings shall have a temperature sensing device. The devices shall be connected in series so that a temperature rise in any phase above the set value will shut down the motor. The set value shall be determined by the motor insulation rating and will prevent damage to the motor from overheating. The sensors shall automatically reset once the stator temperature returns to normal. The motor shall be enclosed in a watertight casing capable of withstanding a minimum of 13.5 m continuous submergence.

.4 The pump shall require two liquid level regulators with mechanical switches and No. 14 AWG Type SOW or Purchaser's approved equivalent factory sealed control cable on each regulator for pump control. The level regulators shall be rated for 120 V ac, 60 Hz and 5 A. A hanger shall be supplied to support the liquid level regulators. The type of regulators shall be Flygt ENM10 or Purchaser's approved equivalent.

.5 The exterior of the pump unit shall be painted green (colour code Appendix A of Section 09 90 00 Painting and Coating). Equipment shall be painted as per manufacturer's factory standard coating system.

.6 Each pump shall be hydrostatic and performance tested at the factory. The Purchaser reserves the right to inspect the pumps prior to shipment.

.2 Protective Coatings.

.1 All equipment and associated devices shall be painted to manufacturer's factory standard coating.

2.2 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc) refer to the Purchaser's Drawings and applicable Pipe Class Material Specification.

.2 Flanged joints must have suitable gasket and bolts. Use brass nipples between copper piping and flush valves or chrome plated brass goods. Where alternate piping materials or jointing are specified, a uniform type of pipe and fittings shall be used throughout each system.

.3 Cleanouts.

.1 Cleanouts in copper drainage: Brass screwed plugs with raised head. Exposed C.O. caps shall be chrome plated in finished areas.

.4 Refer to Part 2 of Section 40 05 00 Mechanical & Piping General Requirements for additional material requirements.

2.3 COMPONENTS

.1 Expansion Joints (as required).

.1 Flexicraft Industries, or Purchaser's approved equivalent copper, sweat end, sanitary metal bellows with integral silicone liner for food service for sanitary systems, and Flexicraft Industries, Model 3S or Purchaser's approved equivalent expansion compensator with copper sweat ends for sanitary vents.

Part 3 Execution

3.1 GENERAL

.1 General execution of this aspect of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, testing, flushing, marking, pre-commissioning, commissioning and Site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements, in addition to any specific requirements indicated in Paragraph 3.2 below.

3.2 INSTALLATION

.1 Install cleanouts on sanitary pipe at all changes of direction, at intervals of not over 15 m in horizontal runs, at all points where obstructions might be formed and at points required by plumbing regulations or shown on the Purchaser's Drawings and Contractor's Documents.

.2 Cleanouts on sink waste and vent pipes shall have a chrome-plated cap installed tight to wall. Cleanouts behind walls shall have access panel. Cooperate in locating cleanouts adjacent to access panels, etc. Check all cleanouts immediately prior to turning the job over to the Purchaser. Remove plugs, re-lubricate with graphite and oil, and re-install using only enough force to insure permanent joint, depending on location.

.3 Grade horizontal runs of piping to drain through risers, and slope all horizontal runs.

.4 Install dielectric insulating unions between all pipes or apparatus constructed of dissimilar metals. Use brass nipples at flush valves, etc.

.5 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, flushing, marking, testing, pre-commissioning and commissioning of the Clearwater Drainage Systems, including but not limited to the following:

- .1 Gravity drainage system including:
  - .1 Gravity drainage piping and fittings.
  - .2 Roof, floor, trench, and equipment drains.
- .2 Pumped drainage system including:
  - .1 Clearwater drainage pumps.
  - .2 Elevator sump pumps.
  - .3 Pumped drainage system piping, valves and fittings.

.2 Refer to Piping & Instrumentation Diagram (P&ID) in the Purchaser's Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 26 29 10 - Motor Starters and Control Stations.

.5 Section 40 05 00 - Mechanical & Piping General Requirements.

.6 Section 46 25 00 - Oil-Water Separation Facility.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Works shall be performed in accordance with:

- .1 ASME B31.1 - Power Piping.
- .2 CSA C22.2 No. 14 - Industrial Control Equipment.
- .3 NEMA MG 1 - Motors and Generators.
- .4 NEMA ICS 1- Industrial Control and Systems: General Requirements.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work andn Adjustments the General Specification.

.2 Measurement

.1 Measurement for Equipment Items 22 14 00 (a)i to 22 14 00 (a)ix will be based on the quantities shown in the Purchaser's Drawings and Contractor's Documents.

.2 Measurement for the following Piping Items will be based on the length of pipe in metres shown in the Purchaser's Drawings and Contractor's Documents, from fitting to fitting, excluding the fitting(s).

.1 22 14 00 (b)i to 22 14 00 (b)vii - Exposed Piping.

.2 22 14 00 (e)i to 22 14 00 (e)ix - Embedded Piping

.3 Measurement for the following Fitting and Valve Items will be based on the quantities shown in the Purchaser's Drawings and Contractor's Documents.

.1 22 14 00 (c)i to 22 14 00 (c)xxi - Exposed Fittings.

.2 22 14 00 (d)i to 22 14 00 (d)xiii - Valves

.3 22 14 00 (f)i to 22 14 00 (f)xxix - Embedded Fittings.

.4 Measurement for Components, Items 22 14 00 (h)i to 22 14 00 (h)vi will be based on the quantities shown in the Purchaser's Drawings and Contractor's Documents.

.5 No separate measurement will be made for the following Items:

.1 22 14 00 (g) - Insulation .

.2 22 14 00 (i) - Instrumentation

.3 22 14 00 (j) - Testing, Flushing and Cleaning.

.4 22 14 00 (k) - Pre-commissioning.

.3 Unit Price

.1 The unit prices for Equipment Items 22 14 00 (a)i to 22 14 00 (a)ix in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the Items for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein. Items 22 14 00 (a)iii to 22 14 00 (a)ix specified in Section 46 25 00 Oil Water Separation Facility.

.2 The unit prices for the following Exposed Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein.

.1 22 14 00 (b)i to 22 14 00 (b)vii - Exposed Piping.

.2 22 14 00 (c)i to 22 14 00 (c)xxi - Exposed Fittings.

.3 22 14 00 (d) i to 22 14 00 (d)xiii - Valves.

.3 The unit prices for the following Embedded Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, non-destructive testing, examination, pressure testing and flushing of the embedded piping segments to be installed, as specified herein.

.1 22 14 00 (e)i to 22 14 00 (e)ix - Embedded Piping.

.2 22 14 00 (f)i to 22 14 00 (f)xxix - Embedded Fittings.

.4 The Estimated Cost for Insulation Item 22 14 00 Item (g) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading and handling of insulation material as specified herein.

.5 The unit prices for Component Items 22 14 00 (h)i to 22 14 00 (h)vi in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, final connections of the equipment specified herein. Items 22 14 00 (h)v to 22 14 00 (h)vi are specified in Section 46 25 00 Oil Water Separation Facility.

.6 The Estimated Cost for Instrumentation Item 22 14 00 (i) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, Items such as pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment vendor. Include the costs for vendor supplied/installed instrumentation with the Equipment Item to which it applies.

.7 The Estimated Cost for Testing, Flushing and Cleaning Item 22 14 00 (j) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system. Include costs for testing, flushing and cleaning of the Oil Water Separation Facility (Section 46 25 00).

.8 The Estimated Cost for Pre-Commissioning Item 22 14 00 (k) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all Materials, supplies and equipment necessary for pre-commissioning and putting into service of the system as specified herein. Include costs for Pre-commissioning of the Oil Water Separation Facility (Section 46 25 00).

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data shop drawings, installation manuals including installation and test plans, testing procedures, flushing procedures, marking procedures, pre-commissioning procedures and operation and maintenance manuals.

.3 For all drainage pumps, submit shop drawings including performance curves showing operating point (capacity/head, horsepower, efficiency and NPSH) and dimensional drawing(s) of pump and accessories.

.4 Provide list of recommended spare parts.

.5 Submit all test results and reports to the Engineer.

.6 The contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All fittings require a Canadian Registration Number.

.4 Obtain a registration number for the pumped drainage system from the Province of Manitoba Department of Labour.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Equipment and Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Equipment and Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All Items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Unit Clearwater Drainage Sump Pumps - Tag Nos. 5750-PP-2003A & B and 5750-PP-5003A & B.

.1 Performance/Design Criteria:

.1 Rated capacity - 45 L/s (713 USgpm).

.2 Rated head - 45.7 m (150 ft) total dynamic head.

.2 Description:

.1 Centrifugal, vertical shaft, submersible, rail-mounted with automatic discharge connection, heavy-duty type, integral electric motor, terminal box and five liquid level regulators per pair of pumps.

.3 Accessories:

.1 Water leakage detector.

.2 17 m of lifting chain.

.3 Chain hook.

.4 17.0 m power cable, SOW-A, extra heavy duty, submersible.

.5 Three intermediate guide rails supports.

.4 Acceptable material: Flygt Model NP3202.180HT-6 in. NPS, 70 HP, or Purchaser's approved equivalent.

.5 The pump shall be lifted out of the sump using a chain block hoist, to be supplied by the Purchaser.

.6 Pump:

.1 Submersible pump shall be enclosed in a cast iron housing.

.2 Pump shall be capable of handling unscreened drainage water from the Powerhouse floor drains.

.3 Pump shall be driven by a vertical axis motor through a stainless steel shaft, supported by anti-friction bearings.

.4 The impeller shall be erosion resistant cast iron which is keyed to the shaft.

.5 A double mechanical seal shall separate the motor from the pump.

.6 The pump housing bottom and the impeller shall be equipped with replaceable wear rings.

.7 The pump shall be guided onto the discharge base by galvanized steel guide rails supplied by the Contractor.

.8 Guide rail supports shall include an upper bracket and three intermediate brackets made of galvanized steel.

.9 The lower bracket shall be integral with the discharge base.

.10 The pump shall be designed for continuous operation at water inlet temperatures of 0^{o}C to 28^{o}C and be capable of running indefinitely in a dry sump.

.11 The direction of pump rotation shall be clearly marked on the exterior of each unit.

.7 Motor:

.1 The pump motor shall be a squirrel cage induction type, continuously rated at 600 V, 3-phase, 60 Hz, capable of operating in an external environment of 0^{o}C to 28^{o}C.

.2 The motor shall meet the performance and test requirements of NEMA Standard MG1.

.3 The motors shall have Class F or better insulation made of non-hygroscopic and moisture resistant materials.

.4 17 m of 4-conductor SOW, submersible factory sealed power cable shall be supplied with the pump.

.5 Each phase of the motor windings shall have a temperature-sensing device.

.6 The devices shall be connected in series so that a temperature rise in any phase above the set value will shut down the motor.

.7 The set value shall be determined by the motor insulation rating and will prevent damage to the motor from overheating.

.8 The sensors shall automatically reset once the stator temperature returns to normal.

.9 The sensors shall be supplied with 17.0 m of No. 14 AWG Type SOW or Purchaser's approved equivalent factory sealed submersible control cable with watertight connection at pump.

.10 The motor shall be enclosed in a watertight casing capable of withstanding a minimum of 13.5 m continuous submergence.

.11 A leakage detector shall shut down the motor when water or oil is sensed in the stator.

.12 The moisture detector shall include moisture sensor, cable and panel complete with alarm and shutdown contacts.

.8 Liquid Level Regulators:

.1 For Liquid Level Regulators refer to Section 40 90 25.

.9 Protective Coating:

.1 The exterior of the pump unit shall be painted to manufacturer's factory standard coating system.

.10 Testing:

.1 Each pump shall be hydrostatic and performance tested at the factory.

.2 The Purchaser reserves the right to inspect the pumps prior to shipment.

.2 Elevator Shaft Drainage Pumps - Tag Nos. 5750-PP-0011, 0012 and 0034.

.1 Performance/Design Criteria:

.1 Rated capacity: 2 L/s (32 USgpm).

.2 Rated head: 7.9 m (26 ft) total dynamic head.

.2 Description:

.1 Centrifugal, vertical shaft, submersible design, with integral electric motor.

.3 Acceptable material: Flygt Model Ready 4, Product Code BS2004.211 MT, 2 in. NPS, 0.6 HP, or Purchaser's approved equivalent.

.4 Pump:

.1 Submersible pump shall be enclosed in a cast iron housing.

.2 Pump shall be capable of handling unscreened drainage water.

.3 Driven by a vertical axis motor through a stainless steel shaft, supported by anti-friction bearings.

.4 The impeller shall be erosion resistant cast iron which is keyed to the shaft.

.5 A double mechanical seal shall separate the motor from the pump.

.6 The pump housing bottom and the impeller shall be equipped with replaceable wear rings.

.7 The pump shall be designed for continuous operation at water inlet temperatures of 0°C to 28°C and be capable of running indefinitely in a dry sump.

.8 The direction of pump rotation shall be clearly marked on the exterior of each unit.

.5 Motor:

.1 The pump motor shall be a squirrel cage induction type, continuously rated at 120 V, single-phase, 60 Hz, capable of operating in an external environment of 0°C to 28°C.

.2 The motor shall meet the performance and test requirements of NEMA Standard MG1.

.3 The motors shall have Class F or better insulation made of non-hygroscopic and moisture resistant materials.

.4 Each phase of the motor windings shall have a temperature sensing device.

.5 The devices shall be connected in series so that a temperature rise in any phase above the set value will shut down the motor.

.6 The set value shall be determined by the motor insulation rating and will prevent damage to the motor from overheating.

.7 The sensors shall automatically reset once the stator temperature returns to normal.

.8 The motor shall be enclosed in a watertight casing capable of withstanding a minimum of 13.5 m continuous submergence.

.6 Pump Control: refer to Section 40 90 25.

.7 Protective Coating:

.1 The exterior of the pump unit shall be painted to manufacturer's factory standard coating system.

.8 Testing:

.1 Each pump shall be hydrostatic and performance tested at the factory.

.2 The Purchaser reserves the right to inspect the pumps prior to shipment.

.3 Oil Water Separation Facility: refer to Section 46 25 00 Oil Water Separation Facility.

.4 Drainage Sump Level Transmitter: refer to Section 40 90 25 Instrumentation for Piping Systems.

2.2 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc) refer to P&ID in the Purchaser's Drawings and applicable Pipe Class Material Specification.

.2 Paint for piping: in accordance with Appendix A "Mechanical Coatings Standard" of Section 09 90 00 Painting and Coating. Paint colour shall be green, per colour code indicated in Appendix A "Mechanical Coatings Standard" of Section 09 90 00 Painting and Coating.

.3 Insulation shall comply with the specifications listed in Section 40 42 00 Piping Insulation.

.4 Refer to Part 2 of Section 40 05 00 Mechanical & Piping General Requirements for additional Material requirements.

2.3 COMPONENTS

.1 Instrumentation

.1 Pressure gauges: as indicated in Part 2 of Section 40 90 25 Instrumentation for Piping Systems.

.2 Drains:

.1 Floor drains:

.1 300 mm (12 in.) diameter floor drains shall be heavy duty, dura coated cast iron body, heavy duty slotted grate with suspended sediment bucket, threaded type outlet, Zurn Model Z-541-IP or Purchaser approved equivalent.

.2 125 mm (5 in.) diameter floor drains shall be heavy duty, dura coated cast iron body, Type "A" heavy duty polished nickel bronze grate, threaded type outlet, Zurn Model Z-451-A5-IP or Purchaser's approved equivalent.

.2 Equipment drains shall be 90 mm x 230 mm (3-1/2 in. x 9 in.) funnel, dura coated cast iron body, Type "F" dura coated cast iron oval funnel, threaded type outlet, Zurn
Model Z-415-BF-IP or Purchaser's approved equivalent.

.3 Trench drains shall be 180 mm x 380 mm (7 in. x 15 in.), medium duty, dura coated cast iron body, medium duty cast iron slotted grate, threaded type outlet, Zurn Model Z-576-IP or Purchaser's approved equivalent.

.4 Roof Drains:

.1 380 mm (15 in.) diameter roof drain.

.2 150 mm (6 in.) female threaded pipe outlet.

.3 Dura-Coated cast iron body with combination membrane flashing clamp/gravel guard, static extension, top-set deck plate, and low silhouette Poly-Dome.

.4 Acceptable material: Zurn Model Z100-DP-E, or the Purchaser's approved equivalent.

Part 3 Execution

3.1 GENERAL

.1 General execution of this aspect of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, flushing, marking, testing, pre-commissioning, marking, commissioning and Site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements, in addition to any specific requirements indicated below.

3.2 INSTALLATION

.1 Paint all pipe, fittings, and valves in accordance with Appendix A “Mechanical Coatings Standard” of Section 09 90 00 Painting and Coating.

.2 The first 3 m of all roof drain piping shall be insulated. Insulation system shall be as indicated on the P&ID.

.3 Installation of insulation shall be per Section 40 42 00 Piping Insulation.

.4 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, flushing, marking, testing, pre-commissioning and commissioning of the service and brake air systems, including but not limited to the following:

- .1 Brake and service air compressors.
- .2 Service air receivers.
- .3 Brake air receiver.
- .4 Compressed air piping, valves and fittings.

.2 Refer to the Piping and Instrumentation Diagrams (P&IDs) in the Purchaser's Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 26 05 21 - Wire and Cable Systems.

.5 Section 26 29 10 - Motor Starters and Control Stations.

.6 Section 40 05 00 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

- .1 Canadian Standards Association (CSA):
  - .1 C22.1 - Canadian Electrical Code Part 1, Safety Standard for Electrical Installations.
  - .2 C22.2 No. 14 - Industrial Control Equipment.
  - .3 CSA C22.2 No. 0.4 - Grounding.
  - .4 CSA C22.2 No. 0.12 - Wire Bending Space.
- .2 NEMA:
  - .1 NEMA ICS 1 - Industrial Controls and Systems.
  - .2 NEMA ICS 2 - Starters, Contactors, Overload Relays.

.3 NEMA 250 - Enclosures.

.4 NEMA MG 1 - Motors and Generators.

.3 Purchaser's Drawings.

.4 ASME B31.1 - Power Piping.

.5 ASME Section VIII - Pressure Vessels.

.6 CSA B51 - Boilers, Pressure Vessels and Pressure Piping.

.7 CSA C22.2 No. 14 - Industrial Control Equipment.

.8 Province of Manitoba – The Steam and Pressure Plants Act S210.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Equipment Items 22 15 00 (a)i to 22 15 00 (a)iv will be based on the quantity shown in the Purchaser's Drawings and Contractor's Documents.

.2 Measurement for the following Piping Items will be based on the length of pipe in metres shown in the Purchaser's Drawings and Contractor's Documents, from fitting to fitting, excluding the fitting(s).

.1 22 15 00 (b)i to 22 15 00 (b)vi - Service Air - Exposed Piping.

.2 22 15 00 (e)i - Brake Air - Exposed Piping.

.3 Measurement for the following Fitting and Valve Items will be based on the quantities shown in the Purchaser's Drawings and Contractor's Documents.

.1 22 15 00 (c)i to 22 15 00 (c)ix - Service Air - Exposed Fittings.

.2 22 15 00 (d)i to 22 15 00 (d)vii - Service Air Valves

.3 22 15 00 (f)i to 22 15 00 (f)v - Brake Air - Exposed Fittings.

.4 22 15 00 (g)i to 22 15 00 (g)iv - Brake Air Valves

.4 Measurement for Components, Items 22 15 00 (h)i to (h)iii will be based on the quantity shown in the Purchaser's Drawings and Contractor's Documents.

.5 No separate measurement will be made for the following Items:

.1 22 15 00 (i) - Instrumentation.

.2 22 15 00 (j) - Testing, Flushing and Cleaning.

.3 22 15 00 (k) - Pre-commissioning.

.3 Unit Price

.1 The unit prices for Equipment Items 22 15 00 (a)i to (a)iv in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein.

.2 The unit prices for the following Exposed Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein.

.1 22 15 00 (b)i to (b)vi - Service Air - Exposed Piping.

.2 22 15 00 (c)i to (c)ix - Service Air - Exposed Fittings.

.3 22 15 00 (d)i to (d)vii - Service Air - Valves.

.4 22 15 00 (e)i - Brake Air - Exposed Piping.

.5 22 15 00 (f)i to (f)v - Brake Air - Exposed Fittings.

.6 22 15 00 (g)i to (g)iv - Brake Air - Valves.

.3 The unit prices for Component Items 22 15 00 (h)i to (h)iii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, final connections of the equipment specified herein.

.4 The Estimated Cost for Instrumentation Item 22 15 00 (i) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, items such as pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment vendor. Include the costs for vendor supplied/installed instrumentation with the Equipment Item to which it applies.

.5 The Estimated Cost for testing, flushing and cleaning Item 22 15 00 (j) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system.

.6 The Estimated Cost for Pre-Commissioning Item 22 15 00 (k) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the system(s) as specified herein.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data, installation manual including installation and test plans, testing procedures, flushing procedures, marking procedures and pre-commissioning procedures.

.3 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including shop drawings indicating detailed layout of compressors, locating each component. Include control diagrams, wiring diagrams as required and written sequence of operation.

.4 Submit manufacturer's installation, operation and maintenance manuals to the Engineer. Include electrical schematic of circuits, written description of system design, drawings illustrating control logic and equipment location, and technical bulletins describing equipment.

.5 Provide list of recommended spare parts for the system.

.6 Submit all test results and reports to the Engineer.

.7 The contractor shall provide a simplified 3D Model of the equipment in accordance with Subsection 21.7.7 3D Model Standards of the General Specification. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All fittings and equipment as required must have a Canadian Registration Number (CRN).

.4 Obtain a registration number for the compressed air systems from the Province of Manitoba Department of Labour.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Brake and Service Air Compressors: Tag Nos. 5750-CP-0001A and 5750-CP-0001B.

.1 Requirements:

.1 Rated Capacity (each) - 59 L/s (125 cfm).

.2 Rated Discharge Pressure - 862 kPa(g) (125 psig).

.3 Type - Screw, Air Cooled.

.4 The compressor unit shall be complete with compression unit, electric motor, inlet air filter/silencer, oil separator, aftercooler and moisture separator with automatic drain trap, controls and ancillary equipment; all mounted on a common structural steel frame and provided with an easy access enclosure. The following manufacturers shall be considered acceptable: Atlas-Copo, Ingersoll-Rand, Kaeser, Quincy or Sullair.

.2 Compression Unit:

.1 The compression unit shall be a single stage air-cooled gear driven oil flooded rotary screw type capable of operating continuously. The rotor shall operate in a flood of lubricating/cooling oil injected under pressure through a full flow filter. An oil separator/receiver shall minimize the oil carryover and the oil cooler shall be air-cooled. A safety valve and a pressure gauge shall be provided on the discharge. The aftercooler shall be provided with a moisture separator and automatic drain trap.

.3 Accessories:

.1 The compression unit shall, as a minimum, be complete with the following:

.1 A combined intake silencer and a 7-10 micron dry type air filter with a condition indicator.

.2 Air temperature gauge and adjustable high temperature shutdown switch mounted in the discharge line.

.3 Flexible connector on the discharge shall have the same pressure rating of the system.

.4 Motor:

.1 The motor shall be horizontal regreaseable antifriction bearing induction motor rated to suit service, with an open drip-proof NEMA enclosure for operation on 600 Vac, 3-phase, 60 Hz service. The motor shall be capable of operating continuously with a 15% overload without injurious stresses or excessive rise in temperature. The motor shall meet the performance and test requirements of NEMA Standard MG1.

.2 The motor shall be mounted on a steel base common to the compression unit. Drive shall be provided by direct coupling. V-belt drives shall be

rated for 2.0 times the nameplate rating on the motor. Drives shall be protected by a suitable totally enclosed guard. The base shall be provided with jacking bolts, and rubber-in-shear vibration isolators at each mounting point.

.5 Instrument and Control Panels:

.1 All gauges shall be mounted in a panel. A centralized NEMA Type 12 control panel shall be provided. The controls shall include all devices necessary for safe operation of the unit.

.2 Wiring and terminations shall be in accordance with Section 26 05 00 Electrical General Requirements and Section 26 05 21 Wire and Cable Systems.

.3 Control devices and wiring shall conform to the applicable CSA Standards.

.4 All wires shall be identified at both ends according to the accepted schematic and wiring diagrams. Any specific wiring designations required by the Engineer shall be marked on the supplier's schematics and wiring diagrams when they are submitted for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.5 The control conductors shall be single conductor stranded copper minimum size No. 14 AWG or the Purchaser's approved equivalent.

.6 Control fuses shall be HRC Form II Type C with dead front fuse holders.

.7 Terminal blocks shall be Screw clamp Entrelec Type M10/10 or the Purchaser's approved equivalent.

.8 All devices shall be clearly identified with lamacoid engraved nameplates.

.9 The controls shall include, as a minimum, the following functions and devices:

.1 Control power indicator light.

.2 Dual control for constant running and automatic start/stop, with adjustable minimum run timer.

.3 Manual (constant running) - off - auto (start/stop) selector switch.

.4 Automatic unloading shall be provided for "no-load" starting. The unloader shall also unload at 862 KPa(g) and reload at 800 KPa(g) when operating in the constant running mode or during the minimum run cycle in the start/stop mode. The settings shall be adjustable.

.5 High discharge air temperature shutdown.

.6 Annunciator panel with indicator lights for each point, and test and reset means.

.7 Service indicators for air filter, oil filter and separator filter.

.8 Dry contacts for remote alarm and indication of all alarm points and indication lights. The contacts shall be independent of the annunciator panel. Repeat contacts from the annunciator panel will not be used. The contacts shall be rated for 1A at 24 Vdc.

.9 The compressor control panel shall be equipped with Modbus TCP/IP or Modbus serial communications, if this feature is an available option. This will enable connection to the station UCMS for remote monitoring.

.10 The control relays, if used, shall be of heavy duty industrial quality. The time delay relays shall be of the solid-state type and have adjustable timing ranges. Acceptable relays are by Potter & Brumfield, Omron or Purchaser's approved equivalent.

.11 One Lot of terminals, Entrelec Type M10/RS10, assume 30 terminals.

.6 Design Conditions:

.1 The compressor shall be installed indoors at an elevation of 146.6 m ASL. The ambient air temperatures within the room may vary between 10^{o}C and 40^{o}C.

.2 The equipment provided shall be designed and constructed so that the maximum noise level under the worst operating conditions shall not exceed a level of 80 dBA measured at a distance of 1 m from the equipment involved.

.3 Oil carryover from the equipment shall be limited to 5 ppm maximum.

.7 Protective Coating:

.1 Paint shall be applied prior to shipment and shall be per manufacturer's factory standard paint system.

.2 Service Air Receivers: Tag Nos. 5750-PV-0002A and 5750-PV-0002B

.1 Requirements:

.1 Capacity (each) - 5 m^3.

.2 Diameter - mm (by Supplier).

.3 Height - mm (by Supplier).

.4 Design Pressure - 1,100 KPa(g) (160 psig).

.5 Design Temperature - 65°C (149°F).

.6 Code of Construction - ASME Boiler and Pressure Vessel Code, Section VIII.

.7 The Service Air receiver shall be a vertical type, with welded steel construction, complete with appurtenances.

.2 Lifting Lugs:

.1 The tank shall be provided with lifting lugs of adequate size and strength, properly located for lifting the tank during shipping and installation.

.3 Protective Coating:

.1 The exterior shall be cleaned and coated per System S-1, Appendix A, "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating, or Purchaser's approved equivalent.

.2 Exterior finish coat shall be blue (see colour codes in Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating).

.3 Interior finish coat shall be white (see colour codes in Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating).

.3 Brake Air Receiver: Tag No. 5750-PV-0003

.1 The Brake Air receiver shall be designed to meet the following requirements:

.1 Capacity - 5 m^3.

.2 Diameter - mm (by Supplier).

.3 Height - mm (by Supplier).

.4 Design Pressure - 1,100 KPa(g) (160 psig).

.5 Design Temperature 65°C (149°F).

.6 Code of Construction - ASME Boiler and Pressure Vessel Code, Section VIII.

.7 The Brake Air receiver shall be a vertical type, with welded steel construction, complete with appurtenances.

.2 Lifting Lugs:

.1 The tank shall be provided with lifting lugs of adequate size and strength, properly located for lifting the tank during shipping and installation.

.3 Protective Coating:

.1 The exterior and interior shall be cleaned and coated per System S-1, Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating.

.2 Exterior coat shall be blue (see colour codes in Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating).

.3 Interior finish coat shall be white (see colour codes in Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating).

.4 Compressed Air Oil-Water Separator

.1 All condensate drains on the compressed air system shall drain into an oil-water separator.

.2 The oil-water separator shall be BEKO Model OWAMAT 6, or Purchaser's approved equivalent.

2.2 COMPONENTS

.1 Condensate Drains

.1 Condensate drains shall be installed on the service air and brake air compressors and receivers.

.2 The automatic drain valves shall have stainless steel body.

.3 The automatic drain valve shall be capable of automatic discharge of collected condensate.

.4 The drains shall have a maximum allowable working pressure not less than system rating pressure.

.5 The condensate drains shall be BEKO Model BEKOMAT 13 or Purchaser's approved equivalent.

.2 Flexible pipe connectors installed on compressor discharge lines shall be stainless steel hose flexible connectors of corrugated, stainless steel tubing with stainless steel wire braid covering and ends welded to inner tubing. The stainless steel hose connectors rating and ends shall match the system rating and pipe class material specifications.

.3 Safety valves/pressure relief valves shall be constructed according to the ASME Boiler and Pressure Code, Section VIII "Pressure Vessels" and shall be listed for compressed air service.

2.3 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc) refer to P&IDs in the Purchaser's Drawings and applicable Pipe Class Specification.

.2 Paint for piping: in accordance with System S-1 Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating. Paint colour shall be blue, per colour code indicated in Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating.

2.4 SOURCE QUALITY MANAGEMENT

.1 The air compressors shall be fully assembled in the manufacturer's shop and operating tests performed to demonstrate that all parts of the compressors are in satisfactory operating condition.

.2 Prior to painting, the receiver tanks shall be hydrostatically tested to at least 1.5 times the design pressure at the manufacturer's facility. It shall be fully inspected by the Department of Labour of the Province of Manitoba, and marked with an approval stamp in accordance with ASME requirements. The manufacturer shall obtain a Canadian Registration Number (CRN) for the receiver.

Part 3 Execution

3.1 GENERAL

.1 General execution of this aspect of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, testing, flushing, marking, pre-commissioning, commissioning, and Site quality control, shall be completed in

accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements, in addition to any specific requirements indicated below.

3.2 INSTALLATION

.1 Compressors and all equipment shall be installed per the Purchaser's Drawings, manufacturers' instruction/drawing and Manitoba Hydro standards and procedures.

.2 Piping installed adjacent to compressors shall be located such that it allows for the required service clearances.

.3 Compressed air and drain piping shall be installed with downward slope in direction of flow.

.4 Only eccentric reducers shall be installed where compressed air piping is reduced in direction of flow, with bottoms of both pipes and reducers fitting flush.

.5 Branch connections shall be installed from the top of the main compressed air line. Drain legs and drain trap shall be installed at the end of each main and branch and at all low points in the system.

.6 Electrical and control equipment shall be installed as per Section 26 05 00 Electrical General Requirements.

.7 Paint all pipe, fittings, and valves in accordance with Appendix A "Mechanical Coatings Standard" in Section 09 90 00 Painting and Coating.

3.3 TESTING AND PRE-COMMISSIONING

.1 Contractor shall provide all services necessary to start-up, test and pre-commission the compressors as per the manufacturer's instructions, under the direction of the manufacturer's pre-commissioning personnel on Site.

3.4 COMMISSIONING

.1 Commissioning will be performed by the Purchaser, as per Section 40 05 00 Mechanical & Piping General Requirements.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer, and as specified herein for the supply, transportation, handling, and installation of the following:

.1 Insulation for Powerhouse and Control Building Heating, Ventilation and Air Conditioning (HVAC) Ducts.

.2 Refer to HVAC Flow Diagrams in the Purchaser's Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification set out below.

.2 Section 23 30 00 - Heating Ventilation and Air Conditioning System.

.3 Section 40 05 00 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 Standards

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 Alternative standards and codes at least equivalent to those referred to in this Section of the Technical Specification may be substituted for the standards and codes specified herein upon authorization by the Engineer.

.4 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 Regulations:

.1 Manitoba Building Code.

.2 National Building Code.

.3 Local Regulations and By-Laws.

.2 Standards:

.1 Recommended Practices by the Sheet Metal and Air Conditioning Contractors' National Association Inc. (SMACNA) Standards.

.2 Recommended Practices by American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Standards.

.3 Manitoba Hydro Guideline - Power Smart Design Standards.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 The Contractor shall include costs for the HVAC duct insulation associated with the HVAC System in the Target Prices proposed in Section 23 30 00 Heating Ventilation and Air Conditioning System of the Technical Specification.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data and installation manual for the equipment.

.3 Submit proof to the Engineer that the Contractor has the necessary systems and procedures in force for proper control of the quality of its Work.

.4 Submit Manufacturer's maintenance manual to Engineer.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be delivered, handled and stored with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Duct Insulation for Control Building

.1 Outdoor air and exhaust air ductwork in the mechanical room shall be 50 mm TIAC Code C-1 (Rigid mineral fibre board) external with canvas jacketing.

.2 Rectangular supply air ductwork shall be internally lined with 25 mm C-1 insulation.

.3 Round supply ductwork shall be externally lined with 25 mm C-2 (Mineral fibre blanket with FRK jacket).

Part 3 Execution

3.1 GENERAL

.1 General execution of this aspect of the Work, including but not limited to Site fabrication, installation, examination, preparation, cleaning and Site quality control, shall be completed in accordance with Section 40 05 00 Mechanical & Piping General Requirements, in addition to any specific requirements contained in this Section.

3.2 PREPARATION

.1 All ductwork dimensions shown on the Purchaser's Drawings refer to the inside dimensions. For ducts requiring internal acoustical or thermal insulation, the dimensions shall be increased to allow for the thickness of the lining.

.1 Insulation in contact with hangers and supports shall be protected with approved metal shields.

3.3 INSTALLATION

.1 Maintain clearances for the operation of dampers, maintenance of filters and installation and maintenance of controls.

.2 Carry full insulation thickness over duct surfaces and standing seams.

.3 Do not insulate flexible connections.

3.4 SITE QUALITY CONTROL

.1 The Purchaser reserves the right to audit the Contractor's Quality Verification Program at any time during the performance of the Work.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary as shown on the Purchaser's Drawings and Contractor's Documents, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, testing and commissioning of the following:

.1 Powerhouse and Control Building HVAC Control System.

.2 Powerhouse and Control Building HVAC Instrumentation.

.2 Refer to HVAC Flow Diagrams in the Purchaser's Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 General Specification.

.2 Section 23 30 00 - Heating Ventilation and Air Conditioning System.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 26 05 21 - Wire and Cable Systems.

.5 Section 26 50 00 - Facility Lighting and Controls.

.6 Section 40 05 00 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 Abbreviations and Acronyms

AMCA	Air Moving and Conditioning Association.
ANSI	American National Standard Institute.
ASA	American Standards Association.
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers.
ASME	American Society of Mechanical Engineers.
CEMA	Canadian Electrical Manufacturers Association.
CSA	Canadian Standards Association.
Dbt	Dry bulb temperature.
DCP	Distributed Control Processor.
DDC	Direct Digital Control.
EEMAC	Electrical and Electronic Manufacturers Association of Canada.
FM	Factory Manual.
IEC	International Electrotechnical Commission.
IEEE	Institute of Electrical and Electronic Engineers.

NEMA	National Electric Manufacturers Association.
NFPA	National Fire Protection Association.
SPL	Sound power level.
VAV	Variable Air Volume.
VFD	Variable Frequency Drive.
Wbt	Wet bulb temperature.

.2 Standards

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Regulations:

.1 Manitoba Building Code.

.2 National Building Code.

.3 Local Regulations and By-Laws.

.2 Mechanical Design Standards:

.1 NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

.3 Ductwork:

.1 Recommended Practices by the Sheet Metal and Air Conditioning Contractors' National Association Inc. and applicable sections of ASHRAE standards.

.2 SMACNA - Accepted Industry Practice for Industrial Duct Construction.

.3 ACNA/NEBB - Procedural Standards for Testing, Adjusting and Balancing.

.4 Fans:

.1 AMCA No. 99 - Standards Handbook.

.2 AMCA No. 210 - Laboratory Methods of Testing Fans for Ratings.

.5 General Installation:

.1 Applicable section of the ASHRAE standards, applicable Regulations and Codes of the Province of Manitoba.

.2 Manitoba Hydro Guideline - Power Smart Design Standards.

.6 Piping:

.1 ASME B31.1 - Power Piping.

.2 ASME B31.3 - Process Piping.

.7 Structural Design Standards:

.1 CSA Standard S16 - Steel Structures for Buildings.

.2 CSA Standard W59 - Welded Steel Construction (Metal-arc welding).

.3 SSPC, Steel Structures Painting Council.

.8 Electrical Design Standards:

.1 CSA Standard C22.1 - Safety Standard for Electrical Installations.

.2 CSA Standard C22.2 - Safety Standard for Electrical Equipment.

.3 NEMA Standard MG1 - Motors and Generators.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 Include costs for the HVAC Control System and HVAC Instrumentation associated with the HVAC System in the Target Prices proposed in Section 23 30 00 Heating Ventilation and Air Conditioning System.

1.5 SUBMITTALS

.1 General

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review, product data, installation manual including installation and test plans, testing procedures, and pre-commissioning procedures.

.3 Submit for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review, shop drawings indicating detailed layout of ductwork, locating each component. Including control diagrams, wiring diagrams as required and written sequence of operation.

.4 Submit manufacturer's installation, operation and maintenance manuals to the Engineer. Include electrical schematic of circuits, written description of system design, drawings illustrating control logic and equipment location, and technical bulletins describing equipment.

.5 Provide list of recommended spare parts.

.2 Shop Drawings

.1 Conventional control drawings showing pneumatics, electrical schematics and wiring diagrams, bill of materials, etc.

.2 List of alarm set point parameters, DCP Point Data Definition, Define Controller Points, and Define Controller Alarm Points.

.3 Sketch of all graphics.

.4 Proposed sequences of operations.

.5 Fabrication details and proposed wording for all lamacoid identification.

.6 Prior to commissioning, submit as-built information and drawings for each of above items, for use by Purchaser during commissioning.

.3 Manuals

.1 The operation manual shall be provided with graphic explanations of keyboard use for all operator functions specified under Operator Training.

.2 Computerized printouts of all data file including all point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, etc.

.3 A manual shall be provided including revised as-built documents of all materials required under the Section 1.5 Submittals of this Technical Specification.

.4 Protection of Software Rights

.1 Prior to the delivery of software, the Purchaser shall enter into Software License Agreement with provisions such as limiting use of software to equipment provided under these specifications, limiting copying, preserving confidentiality and prohibiting transfer to third party.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be delivered, handled and stored with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.7 WARRANTY

.1 General

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

.2 HVAC Control System

.1 All components, system software, and parts supplied by the DDC contractor shall be guaranteed against defects in materials and workmanship for one year from acceptance date. Labour to repair, reprogram, or replace components shall be furnished by the DDC contractor at no charge during the warranty period. All corrective software modifications made during warranty periods shall be updated on all user documentation and on user and manufacturer archived software disks.

Part 2 Products

2.1 DIFFERENTIAL PRESSURE GAUGES

.1 Magnehelic differential pressure gauge shall be provided across each filter bank. The pressure gauge shall come with a digital input to DCP to indicate pressure drop. The unit shall be installed with all necessary tubing, clips, pressure sensing devices and fittings. The gauge working range shall be 25-250 Pa. Scale markers shall indicate pressure drop at which the filters should be changed.

2.2 ROOFTOP AIR SUPPLY UNITS

.1 Air Supply Units 5750-AD-1001, 2001, 3001, 4001, 5001, 6001, 7001, 0001, 0002

.1 Mixing Box Controls:

.1 Provide factory installed modulating normally closed damper operators to be controlled via an adjustable modulating mixed air temperature control signal from the Network DDC system.

.2 Factory Supplied Controls/Wiring:

.1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays. Wiring and terminations shall be in accordance with Section 26 05 21 Wire and Cable Systems.

.2 A fire alarm signal shall be relayed by the HVAC control panel which will shut down the unit for a fire in its zone or instruct the unit to go to full outdoor air for a fire in an adjacent zone.

.3 Factory installed and wired non-fused disconnect switch in CEMA/ NEMA 1 enclosure shall be provided on AHU-2a, AHU-2b, and AHU-3. AHU-1a and AHU-1b shall be complete with CEMA/NEMA 3 weatherproof disconnect with integral door closure mounted on face of control panel.

.4 Automatic controls shall be housed in a control panel mounted in or on the Air Handling Unit, which will meet that standard of the specific installation. Each panel to include the following Items:

.1 Engraved Lamicoid faceplate (refer to Section 26 05 00 Electrical General Requirements).

.2 System ON-OFF switch.

.3 System ON light.

.4 Heat ON-OFF switch.

.5 Heat ON Light.

.6 Clogged filter light with unit mounted filter air pressure switch.

.5 Provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up. On a heating system failure, this device will shut down the fan and close the outdoor air damper. This device shall require resetting by interrupting the electrical circuit.

2.3 CONTROL BUILDING COOLING UNIT

.1 Evaporator Unit 5750-AC-0006

.1 Mixing Box Controls:

.1 Provide factory installed modulating normally closed damper operators to be controlled via an adjustable modulating mixed air temperature control signal from the Network DDC system. Wiring and terminations shall be in accordance with Section 26 05 21 Wire and Cable Systems.

.2 Factory Supplied Controls/Wiring:

.1 Provide a system of motor control, including all necessary terminal blocks, motor contactors, motor overload protection, grounding lugs, control transformers, auxiliary contactors and terminals for the connection of external control devices or relays.

.2 Fire alarm circuits (where required) shall be powered from a relay in unit circuitry.

.3 Automatic controls shall be housed in a control panel mounted in or on the air handling unit, which will meet that standard of the specific installation.

.4 Provide a single-point power connection for the entire unit with terminal blocks to and from VFD (supplied and installed by unit manufacturer).

.5 Provide a discharge air low limit equipped with an automatic by-pass time delay to allow for cold weather start-up.

.6 Provide unit mounted controller for monitor and control via BACnet.

.2 Condenser Unit 5750-AC-0005

.1 Controls for hermetic compressor units shall include compressor and condenser fan motor contactors, control circuit transformer, cooling relays, non-recycling pumpdown relays, ambient compressor lockout, manual reset high pressure controls and automatic reset low pressure controls. Head pressure actuated fan cycling control shall be provided on all multiple condenser fan units.

.2 Provide a minimum of four individually circuited compressors for redundancy and capacity control.

.3 Provide five minute anti-cycle timers.

.4 Provide interstage time delay timers.

.3 Control System for 5750-AC-0006

.1 Factory-mounted DDC systems shall be mounted, wired and tested by the Air Handling Unit manufacturer. Each control system shall be fully functional in a standalone mode or may be tied to a building automation system with BACnet or Purchaser’s approved equivalent. All control devices shall be mounted cabinets and wired in the shop. All factory-mounted controls shall be covered by the air-handling manufacturer's standard warranty. The system shall be designed to maintain space temperature and humidity.

.2 The air-handling units shall operate continuously. The return fan shall be interlocked to operate with the supply fan and with the fans operating the controls shall be energized. A static pressure control, sensing static pressure in the supply air duct furthest from the supply fan, shall modulate the fan capacity damper to maintain the adjustable preset supply duct static pressure. A static pressure control, sensing static pressure in the return air duct at the return fan, shall modulate the fan capacity controller to maintain the adjustable preset return duct static pressure.

.3 Mixed air control shall modulate outdoor, return, and relief dampers to maintain the adjustable mixed air temperature. The controller shall position the dampers to maintain a minimum outdoor air requirement when the outdoor air rises above an adjustable set point, outdoor air temperature exceeds the return air temperature, or outdoor air enthalpy exceeds return air enthalpy. A low limit temperature sensor shall override control of the mixing dampers to prevent mixed air temperature from dropping below an adjustable preset temperature.

.4 A discharge temperature control shall enable either the heating coil controls or the cooling controls to be enabled to maintain the adjustable preset discharge temperature. When cooling is required, control of discharge temperature shall be released to the condensing unit integral control system. Provide controller with

individually adjustable pull-in, pull-out set points to prevent cycling between controllers. When heating is called for the discharge temperature controller shall modulate SCR controller for the electric heating coil. The coil shall be provided with an airflow proving switch which will lock out the heating coil on low air flow. The manual and automatic high limit switches supplied with the coil shall also be interlocked.

.1 A loss of power relay shall be provided on the air handling unit.

.2 Field Programmable Trane Tracer MP580 Controller or Purchaser's approved equivalent.

.3 A dedicated programmable direct digital controller with the appropriate point capabilities shall be unit mounted on the air-handling unit. The controller shall utilize the latest graphical programming methods that are easy to learn, powerful, self documenting.

.5 EX2 Expansion Module:

.1 An expansion module for the Trane Tracer MP580 controller shall be included as necessary. Each EX2 adds six universal inputs, four binary outputs, and four analog outputs.

.6 Unit Mounted Display for MP580:

.1 Shall be located in a location deemed accessible by the Engineer.

.2 A dedicated unit mounted display touch screen shall be provided to facilitate local monitoring, trouble shooting, and changing of setpoints. The touch screen shall be a very intuitive operator interface for monitoring and changing building control functions.

.7 Outside Air Sensor:

.1 A 10,000 ohm at 25°C (77°F) thermistor-type sensor shall be provided for field mounting and wiring.

.2 Frost Protection Sensor shall be provided for field mounting and wiring.

2.4 ENGINEERING ROOM SPLIT SYSTEM AIR CONDITIONING UNIT

.1 Evaporator Unit: 5750-AC-0004

.1 The compressor shall be hermetically sealed, inverter controlled, Twin BLDC Rotary. Refrigerant flow shall be controlled by EEV (electronic expansion valve) at outdoor unit.

.2 Control signal shall be DDC type signal. Interconnect control wiring shall be 16AWG X2 shielded wire between outdoor and indoor units.

2.5 COMMUNICATION ROOM AIR CONDITIONING UNIT

.1 Evaporator Unit: 5750-AC-0001

.1 Microprocessor Control:

.1 The control system shall be microprocessor-based, factory-wired into the system and tested prior to shipment. The wall-mounted control enclosure shall include a 2-line by 16-character LCD providing continuous display of operating status and alarm condition. An 8-key membrane keypad for setpoint/program control, fan speed selection and unit On/Off shall be located below the display. The control display shall be field-wired to the control board using 4-conductor field-supplied thermostat wire.

.2 Temperature and humidity sensors shall be located in the wall box, which shall be capable of being located up to 91.4 m (300 ft) from the evaporator unit.

.3 Monitoring: The LCD shall provide On/Off indication, operating mode indication (cooling, dehumidifying), fan speed indication and current day, time, temperature and humidity (if applicable) indication. The monitoring system shall be capable of relaying unit operating parameters and alarms to the UCMS system using dry contacts.

.2 Control Setpoint Parameters:

.1 Temp. Setpoint 18-29°C (65-85°F).

.2 Temp. Sensitivity 1-5°C (1-9.9°F).

.3 Humidity Setpoint 20-80% RH.

.4 Humidity Sensitivity 1-30% RH.

.3 Unit Controls:

.1 Compressor Short-Cycle Control: The control system shall prevent compressor short-cycling by a 3-minute timer from compressor stop to the next start.

.2 Common Alarm and Remote On/Off: A common alarm relay shall provide a contact closure to a remote alarm device. Two terminals shall also be provided for remote On/Off control. Individual alarms shall be "enabled" or "disabled" from reporting to the common alarm.

.3 Temperature Calibration: The control shall include the capabilities to calibrate the temperature and humidity sensors and adjust the sensor response delay time from 0 to 90 seconds. The control shall be capable of displaying temperature values in °F and °C.

.4 System Auto Restart: For start-up after power failure, the system shall provide automatic restart with a programmable (up to 9.9 minutes in 6 second increments) time delay. Programming can be performed either at the wall-mounted controller or from the central, site-monitoring system.

.4 Alarms:

.1 Unit Alarm: The control system shall monitor unit operation and activate an audible and visual alarm in the event of the following factory preset alarm conditions:

.1 High Temperature.

.2 Low Temperature.

.3 High Humidity.

.4 Low Humidity.

.5 High Head Pressure.

.6 Loss of Power.

.7 Compressor Short Cycle.

.2 Custom Alarms:

.1 Filter Clog.

.2 Smoke Detected.

.3 Alarm Controls: Each alarm (unit and custom) shall be separately enabled or disabled, selected to activate the common alarm (except for high head pressure).

.4 Audible Alarm: The audible alarm shall annunciate any alarm that is enabled by the operator.

.5 Common Alarm: A programmable common alarm shall be provided to interface user selected alarms with a remote alarm device. Alarms shall be enabled or disabled from reporting to the common alarm.

.6 Remote Monitoring: All alarms shall be communicated to the site monitoring system with the following information: date and time of occurrence, unit number and present temperature and humidity.

2.6 HVAC CONTROL SYSTEM

.1 General

.1 Communication with UCMS and Fire Supression System shall be by Modbus TCP or Profinet.

.2 The control system shall be electric/electronic type. Wherever possible all control components shall be obtained from one manufacturer.

.3 Provide complete temperature control and energy management system. Specified products are based on Honeywell Excel 800 Direct Digital Control and Excel Touch Operator Interface. Equivalent fully integrated control systems and components from other manufacturer may be proposed for approval as equivalent. Damper actuators, control valves to be electric/electronic. All control loops for mechanical systems are software based and executed through DDC controller.

.4 All drawings and all Sections of the specifications shall apply to and from an integral part of this section.

.5 Wherever words "shall be capable of" appear in specifications, interpret as meaning that; where feature or performance referred to is being applied, that feature or performance shall be provided.

.6 All system components are to be designed and built to be fault tolerant and shall provide satisfactory operation without damage at 110% above and 85% below rated voltage and at ±3-hertz variation in-line frequency. Transient variation range is 54 Hz to 82 Hz. In an overfrequency event, the frequency will rise as high as 82 Hz in about 3 to 4 seconds and will usually return to normal in 20 to 30 seconds.

.7 Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be a.c. coupled or the Purchaser approved equivalent so that any single device failure will not disrupt or halt bus communication.

.8 All real time clocks and data file RAM shall be battery or capacitor backed.

.2 Control System Function

.1 Provide complete temperature control and energy management system. Specified products are based on Honeywell Excel 800 Direct Digital Control and Excel Touch Operator Interface. Damper actuators and control valves to be electric/

electronic. All control loops for mechanical systems are software based and executed through DDC controller.

.3 HVAC Panels

.1 The control system shall consist of an independent direct digital control (DDC) system with main panel located in the Service Bay, remote relay panels in the, and elsewhere throughout the Powerhouse as determined by the Contractor.

.2 An operator control interface shall be provided in the Control Room for access to the HVAC control system.

.3 Local HVAC relay panels shall have one switch per fan which shall allow three selections to be made, either “HAND” (on), “OFF” or “AUTO”. The fan switch shall also control any dampers associated with the fan. In “Automatic” position, each fan and associated dampers shall operate in a normal ventilation mode unless a fire is detected, in which case they shall transfer to the fire mode by zone. Local HVAC panels shall have indication light showing the state of system operation labelled “HAND”, “OFF” or “AUTO”. If more than one fan is controlled by the local HVAC panel, each fan shall be indentified and have indication light showing mode of operation labelled “HAND”, “OFF” or “AUTO”.

.4 In the “HAND” position all fans shall run and associated dampers shall operate. In the “OFF” position all fans shall stop and dampers shall travel to their applicable “OFF” position.

.5 Unless specifically noted otherwise, all fans shall be provided with fan status indication on the HVAC panel from an auxiliary relay in the MCC.

.6 Where fans are indicated in series with a motorized damper, the damper motor shall be equipped with an end of travel limit switch to energize the fan motor once the damper has reached the fully open position.

.7 All indications of fire detection shall be provided by contact closures in the Purchaser’s fire alarm control modules.

.4 Intake Gate Hoist Housing: Typically, the HVAC relay panel in the Intake Gate Hoist Housing shall include I/O’s for the following devices:

.1 Each of the Powerhouse rooftop main supply fans, including associated mixed air dampers systems comprising the return air and the outside air dampers.

.2 Each of the exhaust fans in the Intake Gate Hoist Gallery including associated dampers.

.3 Other miscellaneous fans and dampers.

.5 Turbine/Generator Floor: The HVAC relay panels in the Electrical Gallery area shall include the I/O’s for the following devices:

.1 Each of the Electrical Gallery smoke/heat control exhaust fans including the associated exhaust dampers.

.2 Each of the Electrical Gallery transfer fans.

.3 Each of the Draft Tube Gate Crane Gallery transfer fans.

.4 Other miscellaneous fans and dampers.

.6 Service Bay: The HVAC relay panel in the Service Bay shall include the controls for the following devices:

.1 Controls for the Control Building and Associated areas.

.2 Controls for the balance of the fans and dampers in the Service Bay.

.7 HVAC Emergency Relay Panels: In addition to the various HVAC relay panels, an HVAC Emergency Relay Panel shall be provided at el 152.1 m near the Service Bay overhead door, to allow manual intervention by responsible personnel in the event of a fire.

.1 For the purpose of the fire condition, the Powerhouse shall be divided into 12 zones: Service Bay el 141.7, Service Bay el 146.6, Service Bay Erection Floor, Units 1, Unit 2, Unit 3, Unit 4, Unit 5, Unit 6, and Unit 7; Electrical Gallery, and the Control Building. If a fire is detected in a zone the fans and dampers in that zone shall operate in a fire mode as described in the following Subsections of this Technical Specification.

.2 The HVAC Emergency Relay Panel shall have one 3-position switch, "HAND"/ "OFF"/"AUTO", per fan, which may provide a fire/smoke control function. These switches, in the "HAND" position, causing the fans to run and associated dampers in the zone to assume the fire mode. In the "OFF" position the switch shall shut down fans operating in the fire mode. In the "AUTO" position the HVAC and fire systems shall be controlled by the Fire Detection System. The emergency relay panel shall also have fan status lights.

.8 Advanced Plant Controller (APC)

.1 The controller platform shall be modular designed specifically to control HVAC - central plant, ventilation, filtration, heating, cooling, humidification, smoke control, and distribution systems. The controller platform configuration shall be a Controller Module, connected Panel Bus I/O Modules, LonWorks™ Bus I/O Modules, and optional Colour Touch-panel Operator Interface. The communication platform shall be freely programmable LonWorks™; provide energy management options and advanced system functions that allow standard and customizable control solutions required in executing the "Sequence of Operation".

.2 Basis-of-Design: Honeywell XCL8010A or latest equivalent version. Products of other manufacturers will be considered for approval provided they are equivalent or exceed the material requirements and functional qualities of the specified product.

.3 Requests for Purchaser's approval shall be in accordance with Section 21.4 Equal Articles, Materials or Equipment.

.4 The controller shall provide fully open LonWorks™ functionality capable of either integrating with other LonMark™ devices or stand-alone operation.

.5 Minimum Environmental requirements:

.1 Operating Temperature Ambient Rating: 0° to 50°C (32° to 122°F).

.2 Storage Temperature Ambient Rating: -25° to 70°C (-13° to 158°F).

.3 Operating / Storage Relative Humidity: 5% to 95% non-condensing.

.9 Temperature Sensors

.1 Temperature sensors shall be Resistance Temperature Detector (RTD) type of 1000-ohm platinum or 20,000 ohm RTD.

.2 T200 - Space temperature sensors shall be provided with blank commercial type locking covers. Production area sensors are to be designed so as only the sensor

element is exposed in the space to allow for washing down of the walls without affecting the sensor.

.3 T200 - Duct temperature sensors shall be rigid stem or averaging type as specified in the sequence of operation. Water sensors shall be provided with a separable copper, monel or stainless steel well. Outside air wall-mounted sensors shall be provided with a sun shield. Existing sensors if compatible shall be reused.

.4 Outside air, return air, discharge air, return air space sensors and well sensors shall be linear with ± 0.4°C (.7°F) between 0°C to 100°C (32°F and 212°F). This linearity shall be that of the sensor itself and not be accomplished by software at the NCP.

.10 Humidity Sensors

.1 Relative humidity sensors shall be capacitance type with 10% to 90% range. Provide sensors with a minimum +/-3% accuracy. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with covers identical to temperature sensors.

.11 Differential and static pressure sensors and switches

.1 Fan proof-of-flow switches shall be adjustable set point and differential pressure type. Switches shall be piped to fan discharge except where fans operate at less than one inch WG (250 kPa), they shall be piped across the fan. For fractional horsepower and non-ducted fans, current-sensing relays may be used. Maximum pressure rating shall be at least 10 inches WG (2.5 kPa).

.2 Control relays and analog output transducers shall be compatible with the NCP output signals. Relays shall be suitable for the loads encountered. Analog output transducers shall be designed for precision closed loop control with pneumatic repeatability error no greater than 1-1/2 percent.

.12 Identification of Equipment - General

.1 Refer to Section 40 05 00 Mechanical & Piping General Requirements.

.13 Instrument Cabinets

.1 Provide at each system or groups of systems, cabinet type (NEMA 1) metal control panel with all instruments mounted inside locking cover. All panels shall have same key to match existing. All cabinets to have see through windows to allow viewing of the Excel 5000-controller indication lights. Temperature indication and control point adjustment and gauges labelled as to function with lamacoid nametags fixed to panel face with self-tapping screws. All electrical equipment mounted in cabinet to be pre-wired to labelled terminal strips.

.14 Control Dampers

.1 Provide all control dampers of type and sizes indicated. All outside, exhaust and relief control dampers to be opposed blade low leakage moduflow dampers. Frames to be heavy ga. galv. steel formed for extra strength with mounting holes for flange and enclosed duct mounting. Dampers available in 50 mm (2") size increments from 203 mm (8") horizontal and vertical to 1,219 mm (48"). Requirements over 1,219 mm (48") to be standard modules with interconnecting hardware. 1.6 mm (16 ga.) damper blades, galv. steel, roll formed for high velocity performance. Blades of 203 mm (8") width maximum; blade seals and spring loaded stainless side seals. Dampers and seals suitable for temperature

ranges of -40°C to 100°C. Leakage shall not exceed 1% with approach velocity of 7.62M/s (1,500 fpm) when damper is closed against 100 mm (4") W.G. Acceptable Material: TAMCO 9000SC, Honeywell D642 or Purchaser's approved equivalent.

.15 Electric damper and valve actuators

.1 The actuator shall have mechanical or electronic stall protection to prevent damage to the actuator through the rotation of the actuator.

.2 Where shown, for power-failure and safety applications, an internal mechanical spring-return mechanism shall be built into the actuator housing. Alternatively, an un-interruptible power supply (UPS) may be provided.

.3 All rotary spring-return actuators shall be capable of clockwise or counter-clockwise spring-return operation. Linear actuators shall spring-return to the retracted position.

.4 Proportional actuators shall accept a 0 to 10 Vdc or 0 to 20 mA control signal and provide a 2 to 10 Vdc or 4 to 20 mA operating range.

.5 All 24 Vac/Vdc actuators shall operate on Class 2 wiring.

.6 All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return actuators with more than 7 N.m [60 in.-lb] torque capacity shall have a manual crank for this purpose.

.7 All modulating actuators shall have an external, built-in switch to allow the reversing of rotation direction.

.8 Fitting and a minimum 1 m electrical cable and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.

.9 Actuators shall be UL Standard 873 Listed as meeting correct safety requirements and recognized industry standards.

.10 Actuator housings shall be NEMA 2 and plenum rated.

.11 Actuators shall be designed for a minimum of 60,000 full-stroke cycles at the actuator's rated torque and 1.5 million repositions.

.12 Acceptable manufacturer: Honeywell Model N20, N34, and S05/10/20 series or Purchaser's approved equivalent.

.16 Low Temperature Cut-Outs

.1 Provide on coils or where noted, low temperature cut-outs with 6,096 mm (20 ft) temperature sensitive elements wound across downstream face of coil.

.2 All air systems introducing outside air shall have low temperature cutout switch. If system does not have steam or water coil ahead of supply fan, safety control can be located on leaving side of fan. Provide override for summer operation.

.3 Cutouts must have manual reset unless noted otherwise.

.17 Miscellaneous Devices

.1 Provide necessary relays, cumulators, three-way air valves, positioners, pneumatic-electric switches, three-way solenoid valves, two-way and three-way air switches, clocks, transformers, etc. to make complete and operable system.

.2 Install on local panels, unless noted otherwise.

.18 Air Flow Switches

.1 Provide differential static pressure switches with CSA approved enclosures for field installation.

.2 The switches shall be mounted in vertical position on vibration free surface.

.3 Switches shall be field adjustable from 20 to 250 Pa pressure. When used for filter status indication, ensure switches have range suitable for dirty filter conditions as related to available fan static.

.4 Diaphragm sensing element shall actuate snap acting SPDT switch with minimum contact rating of 5 amps at 120 Vac.

.5 Airflow switch shall have over-pressurization protection of 2.5 kPa or greater.

.19 Low Limit Thermostat

.1 Low limit thermostat shall be snap acting, two position, manual reset type.

.2 Low limit thermostat shall activate alarm and operate equipment in sequence described, should temperature over any 25 mm length of sensing element drop below preset temperature limit.

.3 Locate low limit thermostat after preheat coil and before cooling coil in air systems utilizing outside air.

.4 Low limit thermostat shall serpentine entire coil bank with a maximum sensor element spacing of 150 mm. Low limit thermostats shall be wired in series on coils requiring multiple thermostats.

.20 Relays

.1 DPDT relay with coils rated for 120 Vac or 24 Vdc as required.

.2 Contacts rated at 10 amps at 120 Vac.

.21 Differential Pressure Switch

.1 Switches shall be of snap action diaphragm type housed in CSA approved enclosure to facilitate field mounting when required.

.2 Minimum contact rating shall be 10 Amp at 120 and 240 Vac. Use horsepower rated switches where required.

.3 Provide switch with range adjustments for set point and differential.

.22 Operators Interface

.1 Install a “touch Panel Operator Screen” on each control panel.

.2 Screen to be minimum colour TFT touch panel display.

.3 Screen must be able to mount on panel door meeting IP65 (NEMA4) rating.

.4 The touch panel operation screens must allow for easy and self explanatory operation by finger tip or by touch-pen.

.5 User configurable fast access list can contain selected data points, time programs and parameters.

.6 Must be capable of graphical trending.

.23 Sequences of Operation

.1 Powerhouse and Service Bay Roof AHU:

.1 The fans covered by this section are supply units AD-0001 and 0002, AD-1001 to 7001 and smoke exhaust fans FA-1001 to 7001, FA-0016 and 0017.

.2 This area shall be divided into nine zones; one at each Unit and two in the Service Bay. If there is a fire alarm in the Powerhouse, the supply fans in the fire zone shall be de-energized and outdoor and relief air damper close. The exhaust fans in the fire zone shall be energized and the supply fan(s) in adjacent units shall be energized, the outdoor air dampers open fully, and the return and relief air dampers close.

.2 Service Bay Electrical Room and Electrical Gallery Fire Exhaust Fans (7).

.1 The fans covered herein are the exhaust fans FA-1002 to 7002, and FA-0013.

.2 An HVAC DDC control system shall control each exhaust fan and damper, under control of a space sensor, to maintain an adjustable set point temperature.

.3 Each fan control shall be enabled by a “HAND”/”OFF”/”AUTO” switch mounted in the HVAC panel. The controls shall open the respective damper and the damper end switch will energize the fan when a space temperature rises above the set point, as sensed by the room sensor.

.4 If a fire alarm is indicated for one of these areas, the respective damper shall be opened and the fan energized.

.3 Oil Room:

.1 The fan covered herein is the exhaust fan FA-0005.

.2 This fan shall run continuously and shall be manually controlled by a panel mounted “HAND”/“OFF”/“AUTO” selector switch. Fan status shall be monitored by the HVAC DDC control system.

.3 The oil room fan will be two-speed and switch shall be switched to high speed in case of a fire in the oil room or by selecting “HAND”.

.4 “AUTO” shall run the fan at low speed.

.4 Diesel Fire Pump Combustion Air and Cooling Fan:

.1 The fan covered herein is supply fan FA-0015.

.2 When powered the relief damper system shall be enabled and open. Once the damper is fully opened the fan shall be energized.

.3 On shutdown, the fan shall de-energize and the relief dampers shall close.

.5 Welding Shop:

.1 The fan covered herein is the exhaust fan FA-0010.

.2 This fan shall run continuously when in “HAND” mode and shall be manually controlled by an HVAC panel mounted “HAND”/”OFF” selector switch. With the exhaust damper fully open, a limit switch will energize the fan. Fan status shall be monitored by the HVAC DDC control system.

.6 Welding Fume Exhaust - (tags not yet defined):

.1 The fans covered herein are the exhaust fans for welding fumes, which provides exhaust at the source during welding operations.

.2 These fans shall operate intermittently from the local on/off switch. If the fan operates, the discharge damper shall open fully. With the fan discharge damper open the fan shall be energized.

.7 Waste Water Treatment Plant:

.1 The fan covered herein is the exhaust fan FA-0004.

.2 This fan shall run continuously and shall be manually controlled by an HVAC panel mounted “HAND”/”OFF” selector switch. With the exhaust damper fully open, a limit switch will energize the fan. Fan status shall be monitored by the HVAC DDC control system.

.8 Electrical Gallery:

.1 The fans covered herein are transfer fans FA-1003 to FA-7003.

.2 These fans shall run continuously and shall be manually controlled by panel mounted “HAND”/”OFF”/“AUTO” selector switches. In a fire alarm in the “AUTO” mode the fans shall be de-energized by the HVAC DDC control system, and the dampers shall be closed. When shut down due to a fire alarm, the override switch on emergency panel shall cause the system to restart.

.9 Draft Tube Gate Crane Gallery:

.1 The fans covered herein are the transfer fans FA-1004 to FA-7004.

.2 These fans shall run continuously and shall be manually controlled by panel mounted “HAND”/”OFF”/“AUTO” selector switches. In a fire alarm in the “AUTO” mode the fans shall be de-energized by the HVAC DDC control system. When shut down due to a fire alarm, the override switch on emergency panel shall cause the system to restart.

.10 Dewatering Gallery and Service Bay el 141.7m Transfer Fans:

.1 The fans covered herein are the transfer fans FA-0001, FA-2005 and 5005.

.2 These fans shall run continuously and shall be manually controlled by panel mounted “HAND”/”OFF”/ “AUTO” selector switches. In a fire alarm in the “AUTO” mode, the fans shall be de-energized by the HVAC DDC control system. When shut down due to a fire alarm, the override switch on emergency panel cause the system to restart.

.11 Pump Room Supply Fan:

.1 The fan covered herein is supply fan FA-0008.

.2 This fan shall be manually controlled by panel mounted “HAND”/ “OFF”/“AUTO” selector switches. In a fire alarm in the “AUTO” mode, the fans shall be energized by the HVAC DDC control system.

.12 Control Building Air Conditioning Unit:

.1 The unit covered herein is AC-0006.

.2 In a fire alarm the fan shall be de-energized by the HVAC DDC control system. When shut down due to a fire alarm, the override switch on emergency panel cause the system to restart.

.13 Control Building Exhaust Fan:

.1 The fan covered herein is FA-0012.

.2 The fans shall run continuously and shall be manually controlled by panel mounted “HAND/OFF” selector switches. An airflow proving switch shall be provided to provide a warning signal on low air flow.

.14 Communication Room Air Conditioning Unit:

.1 The unit covered herein is AC-0001.

.2 In a fire alarm the fan shall be de-energized by the HVAC DDC control system. When shut down due to a fire alarm, the override switch on emergency panel cause the system to restart.

.15 Battery Rooms and Water Treatment Room Exhaust Fans:

.1 The fans covered herein are FA-0006, FA-0007, FA-0022 and FA-0023. The fans shall run continuously and shall be manually controlled by local “HAND/OFF” selector switches. An airflow proving switch shall be provided to provide an alarm signal on low air flow.

.16 Diesel Generator Rooms Exhaust Fans and Ventilation:

.1 The fan covered herein is FA-0011 and 0024. The fans shall cycle from space temperature sensors to maintain the space temperature. “HAND/ OFF/AUTO” switches shall be mounted on the most convenient HVAC panel.

.2 With the Standby Diesel Generator energized, the mixed air damper system shall be enabled to operate. The system shall include three types of dampers: return air, outside air and exhaust air. Once enabled, the outside air dampers shall move to a minimum position for combustion air under the influence of a minimum position switch. A space thermostat shall modulate the outside air and exhaust air dampers from minimum to full outside air as required, should the space temperature rise above an adjustable set point. As the outside air and exhaust air dampers move from minimum to maximum, the return air damper will operate inversely, moving from maximum to minimum.

.17 Water Passage Exhaust:

.1 The fan covered herein is the exhaust fan FA-0014, which exhausts the water passages during runner repairs.

.2 The fan will operate intermittently from local on/off switches in the intake at each unit. The switches will energize dampers on the three extraction ducts from each channel of the water passage in a unit. When fully open, limit switches shall start the fan.

.18 Compressor Room Transfer:

.1 The fan covered herein is the transfer fan FA-0009.

.2 The fan shall run continuously and shall be manually controlled by a panel mounted “HAND”/“OFF”/“AUTO” selector switch. In a fire alarm in the “AUTO” mode, the fan shall be de-energized by the HVAC DDC control system.

.19 Compressor Room Heat Rejection:

.1 The fans covered herein are the supply fan FA-0002 which will exchange room air with outdoor air to maintain the room temperature.

.2 This fan shall run intermittently as required to maintain the space temperature at the preset adjustable set point. When the temperature rises to the set point the fan will be energized. With the fan energized and the

status proven by an airflow switch, the mixed air dampers shall be enabled. To achieve cooling, return, and outdoor air dampers shall be modulated from the space temperature sensor to maintain the adjustable space temperature set point. On shutdown, the outdoor air and exhaust dampers shall close, the return air open and the fans de-energize.

.20 Stairwell Pressurization and Supply:

.1 The fans covered herein are the supply fans FA-0018, 0019, 0020, 0021, 3006, 5006 and 7006.

.2 The fan shall be manually controlled by a panel mounted “HAND”/ “OFF”/“AUTO” selector switch. The fan will normally be de-energized in the “AUTO” position. In a fire alarm in the “AUTO” mode, the fan shall be energized by the HVAC DDC control system. Override switches in the HVAC Emergency Relay Panel would allow personnel to start or shut down the systems.

Part 3 Execution

.1 The system shall be engineered, programmed, and installed by personnel trained by the DDC manufacturer and regularly employed by the manufacture’s recognized, approved, certified or authorized agent. The agent shall have complete responsibility for proper installation and operation of the DDC including checkout, test, calibration, commissioning, and warranty of the equipment and the entire system. The system shall be installed in strict compliance with the specifications.

3.2 INSTALLERS

.1 The system shall be installed by competent mechanics, regularly employed by the DDC manufacturer with full responsibility for proper operation of the DDC including debugging and proper calibration of each component in the entire system.

3.3 EXAMINATION

.1 HVAC System Test

.1 The Contractor shall prepare the records at site, and as information on each sheet is recorded, dated and approved by the Contractor and the Engineer, the original shall be submitted to the Engineer for his final record. The Contractor shall advise the Engineer in writing when the Work may be inspected before proceeding with the next phase of installation and commissioning.

3.4 INSTALLATION

.1 The Contractor shall provide all labour, Material, Plant, Tools, equipment and services necessary and reasonably incidental to completion of temperature control/instrumentation systems as noted herein and/or on the Purchaser’s Drawings and Contractor’s Documents.

.2 Provide start-up, calibration, and seasonal readjustments as required.

.3 Install a fully Direct Digital Control (DDC), energy management, equipment monitoring and control, consisting of the following elements:

.1 Microcomputer based Distributed Control Processors (DCPs) interfacing directly with sensors, actuators, and environmental delivery systems.

.2 Electric and electronic controls for all items indicated on the Purchaser's Drawings and Contractor's Documents and as described hereinafter, including dampers, valves, panels, and electrical installation.

.3 Supply and installation of all conduit, wire, electric relays, connections and other devices required for wiring for systems as specified in this Section, whether line or low voltage, shall be responsibility of the General Contractor, except as noted above.

.4 Factory trained servicemen in employ of manufacturer shall make final wiring connections on all components, mount and electrically connect all controls.

.5 Electrical wiring shall be installed in conformance with CSA, ULC, Manitoba Building Code and Section 26 05 00 Electrical General Requirements.

.6 All temperature control wiring and cabling shall be as per Part 2 of Section 26 05 21 Wire and Cable Systems. All wiring and cabling shall be installed as per Part 3 of Section 26 05 21 Wire and Cable Systems.

.7 Ensure that adequate conduit is installed during initial phases of construction, to accommodate total systems requirements.

.8 Wire all safety controls in series with both "HAND" and "AUTO" starter positions to ensure that systems are properly protected.

.9 General Contractor shall provide all other conduit and wiring required for control systems operation, including tie-ins from supplied relays to motor starting circuits.

.10 Refer to Section 26 05 00 Electrical General Requirements for conduit and cable identification requirements.

3.5 TRAINING

.1 HVAC Control System

.1 All training shall be by the Contractor and shall utilize the manufacturer representative/the operators' manuals and as-built documentation.

.2 Operator training shall include as minimum two 8-hour sessions encompassing modifying text and graphics, sequence of operation review, selection of all displays and reports, use of all specified OWS functions, use of Excel Touch, troubleshooting of sensors (determining bad sensors), and password assignment and modification.

.3 One training session shall be conducted at system completion, and the other shall be conducted 45 days after system completion.

3.6 CLEANING

.1 Shall be in accordance with the requirements of Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

END OF SECTION

Keeyask Generating Station - HVAC Schedules

Fan Schedule

			Fan						
			Capacity [cfm]	Capacity [L/s]	External Static Pressure [Pa]	Fan Size	Motor [hp]	Manufacturer / Fan Type (or accepted equivalent)	
Tag No.	Function	Location							Remarks
5750-FA-0001	TRANSFER FAN	SERVICE BAY EL 141.7	11700	5500	150	2450	5	Northern Blower / Axial Fan	
5750-FA-0002	COOLING FAN NO. 1	COMPRESSOR ROOM	7000	3300	600	2000	5	Northern Blower / Axial Fan	
5750-FA-0003A	COOLING FAN NO. 2	COMPRESSOR ROOM	35000	16500	500	4450	20	Northern Blower / Axial Fan	
5750-FA-0003B	COOLING FAN NO. 3	COMPRESSOR ROOM	35000	16500	500	4450	20	Northern Blower / Axial Fan	
5750-FA-0004	EXHAUST FAN	WASTE WATER TREATMENT PLANT	3500	1650	200	1500	1.5	Northern Blower / Propeller Fan	
5750-FA-0005	EXHAUST FAN	OIL ROOM	3000	1400	150	1500	1	Northern Blower / Propeller Fan	
5750-FA-0006	EXHAUST FAN	SERVICE BAY BATTERY ROOM	200	60	60	A250	0.125	Northern Blower / Cabinet Fan	
5750-FA-0007	EXHAUST FAN	WATER TREATMENT PLANT	2100	950	150	1500	0.75	Northern Blower / Axial Fan	
5750-FA-0008	SUPPLY FAN	PUMP ROOM	1000	240	60	1500	0.125	Northern Blower / Axial Fan	
5750-FA-0009	SUPPLY FAN	COMPRESSOR ROOM	2100	950	90	1500	0.5	Northern Blower / Propeller Fan	
5750-FA-0010	EXHAUST FAN	WELDING ROOM	2200	1000	200	1500	1.5	Northern Blower / Axial Fan	
5750-FA-0011	EXHAUST FAN	DIESEL GENERATOR ROOM NO. 1	1000	350	60	1500	0.25	Northern Blower / Axial Fan	
5750-FA-0012	EXHAUST FAN	CONTROL BUILDING	1000	425	93	SQ120	0.167	Greenheck / Centrifugal	
5750-FA-0013	EXHAUST FAN	SERVICE BAY ELECTRICAL ROOM	6400	2975	160	2000	2	Northern Blower / Axial Fan	
5750-FA-0014	FUME EXHAUST FAN	INTAKE PASSAGE	20200	9500	1000	3300	20	Northern Blower / Axial Fan	
5750-FA-0015	TRANSFER FAN	DIESEL FIRE PUMP ROOM	10500	4950	125	2450	5	Northern Blower / Propeller Fan	
5750-FA-0016	EXHAUST FAN NO. 1	ERECTION FLOOR	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-0017	EXHAUST FAN NO. 2	ERECTION FLOOR	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-0018	EXHAUST FAN NO. 1	SERVICE BAY STAIRWAY	3000	1400	450	1500	1.5	Northern Blower / Axial Fan	
5750-FA-0019	EXHAUST FAN NO. 2	SERVICE BAY STAIRWAY	3000	1400	450	1500	1.5	Northern Blower / Axial Fan	
5750-FA-0020	EXHAUST FAN NO. 3	SERVICE BAY STAIRWAY	3000	1400	450	1500	1.5	Northern Blower / Axial Fan	
5750-FA-0021	EXHAUST FAN	UNIT 7 INTAKE STAIRWAY	3000	1400	450	1500	1.5	Northern Blower / Axial Fan	
5750-FA-0022	EXHAUST FAN NO. 2	UNIT 1 ELECTRICAL GALLERY BATTERY ROOM	200	60	60	A250	0.125	Northern Blower / Cabinet Fan	
5750-FA-0023	EXHAUST FAN NO. 3	UNIT 7 ELECTRICAL GALLERY BATTERY ROOM	200	60	60	A250	0.125	Northern Blower / Cabinet Fan	
5750-FA-0024	EXHAUST FAN	DIESEL GENERATOR ROOM NO. 2	1000	330	60	1500	0.25	Northern Blower / Axial Fan	
5750-FA-1001	EXHAUST FAN NO. 1	HOIST HOUSING	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-2001	EXHAUST FAN NO. 2	HOIST HOUSING	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-3001	EXHAUST FAN NO. 3	HOIST HOUSING	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-4001	EXHAUST FAN NO. 4	HOIST HOUSING	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-5001	EXHAUST FAN NO. 5	HOIST HOUSING	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-6001	EXHAUST FAN NO. 6	HOIST HOUSING	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-7001	EXHAUST FAN NO. 7	HOIST HOUSING	25500	12000	250	3650	20	Northern Blower / Propeller Fan	
5750-FA-1002	SMOKE EXHAUST FAN NO. 1	ELECTRICAL GALLERY	2900	1350	30	5310	0.5	Northern Blower / Axial Fan	
5750-FA-2002	SMOKE EXHAUST FAN NO. 2	ELECTRICAL GALLERY	2900	1350	30	5310	0.5	Northern Blower / Axial Fan	
5750-FA-3002	SMOKE EXHAUST FAN NO. 3	ELECTRICAL GALLERY	2900	1350	30	5310	0.5	Northern Blower / Axial Fan	
5750-FA-4002	SMOKE EXHAUST FAN NO. 4	ELECTRICAL GALLERY	2900	1350	30	5310	0.5	Northern Blower / Axial Fan	
5750-FA-5002	SMOKE EXHAUST FAN NO. 5	ELECTRICAL GALLERY	2900	1350	30	5310	0.5	Northern Blower / Axial Fan	
5750-FA-6002	SMOKE EXHAUST FAN NO. 6	ELECTRICAL GALLERY	2900	1350	30	5310	0.5	Northern Blower / Axial Fan	
5750-FA-7002	SMOKE EXHAUST FAN NO. 7	ELECTRICAL GALLERY	2900	1350	30	5310	0.5	Northern Blower / Axial Fan	
5750-FA-1003	TRANSFER FAN NO. 1	ELECTRICAL GALLERY	8100	3800	30	2700	1	Northern Blower / Propeller Fan	

5750-FA-2003	TRANSFER FAN NO. 2	ELECTRICAL GALLERY	8100	3800	30	2700	1	Northern Blower / Propeller Fan
5750-FA-3003	TRANSFER FAN NO. 3	ELECTRICAL GALLERY	8100	3800	30	2700	1	Northern Blower / Propeller Fan
5750-FA-4003	TRANSFER FAN NO. 4	ELECTRICAL GALLERY	8100	3800	30	2700	1	Northern Blower / Propeller Fan
5750-FA-5003	TRANSFER FAN NO. 5	ELECTRICAL GALLERY	8100	3800	30	2700	1	Northern Blower / Propeller Fan
5750-FA-6003	TRANSFER FAN NO. 6	ELECTRICAL GALLERY	8100	3800	30	2700	1	Northern Blower / Propeller Fan
5750-FA-7003	TRANSFER FAN NO. 7	ELECTRICAL GALLERY	8100	3800	30	2700	1	Northern Blower / Propeller Fan
5750-FA-1004	TRANSFER FAN NO. 1	DRAFT TUBE GALLERY	4600	2150	30	2450	0.5	Northern Blower / Propeller Fan
5750-FA-2004	TRANSFER FAN NO. 2	DRAFT TUBE GALLERY	4600	2150	30	2450	0.5	Northern Blower / Propeller Fan
5750-FA-3004	TRANSFER FAN NO. 3	DRAFT TUBE GALLERY	4600	2150	30	2450	0.5	Northern Blower / Propeller Fan
5750-FA-4004	TRANSFER FAN NO. 4	DRAFT TUBE GALLERY	4600	2150	30	2450	0.5	Northern Blower / Propeller Fan
5750-FA-5004	TRANSFER FAN NO. 5	DRAFT TUBE GALLERY	4600	2150	30	2450	0.5	Northern Blower / Propeller Fan
5750-FA-6004	TRANSFER FAN NO. 6	DRAFT TUBE GALLERY	4600	2150	30	2450	0.5	Northern Blower / Propeller Fan
5750-FA-7004	TRANSFER FAN NO. 7	DRAFT TUBE GALLERY	4600	2150	30	2450	0.5	Northern Blower / Propeller Fan
5750-FA-2005	TRANSFER FAN NO. 1	DEWATERING GALLERY	4300	2000	35	2000	0.25	Northern Blower / Axial Fan
5750-FA-5005	TRANSFER FAN NO. 2	DEWATERING GALLERY	4300	2000	35	2000	0.25	Northern Blower / Axial Fan
5750-FA-3006	EXHAUST FAN	UNIT 3 DEWATERING GALLERY STAIRWAY	3000	1400	450	1500	1.5	Northern Blower / Axial Fan
5750-FA-5006	EXHAUST FAN	UNIT 5 DEWATERING GALLERY STAIRWAY	3000	1400	450	1500	1.5	Northern Blower / Axial Fan
5750-FA-7006	EXHAUST FAN	UNIT 7 DEWATERING GALLERY STAIRWAY	3000	1400	450	1500	1.5	Northern Blower / Axial Fan

Control Damper Schedule

Type	Description	Location	Make	Model	Size	Remarks	QTY
CD-1	Return Air Damper	Service Bay -- Roof Fan	Tamco	1400	6000 x 1200	for each Air Supply Unit	9
CD-2	Return Air Damper	Service Bay -- Electrical Gallery	Tamco	1400	600 dia.		1
CD-3	Intake Passage Fume Exhaust	Powerhouse	Tamco	1400		per gate	21

Insulated Motorized Damper Schedule

Type	Description	Location	Make	Model	Size	Remarks	QTY
MD-1	Exhaust Damper	Service Bay -- U/S Wall	Tamco	9000	1375 x 1375	one louver for each	9
MD-2	Relief	Service Bay	Tamco	9000	1375 x 1375		18
MD-3	Water Passage Damper	Hoist Housing	Tamco	9000	1375 x 1375		1
MD-4	Exhaust Damper	Electrical Service Gallery -- Service Bay	Tamco	9000	600 dia.		11
MD-5	Outdoor Air Damper	Powerhouse -- Roof	Tamco	9000	1000 x 7800	for each Air Supply Unit	9
MD-6	Exhaust Damper	Exhaust Chase	Tamco	9000	2000x2000		1
MD-7	Exhaust Damper	Supply Chase	Tamco	9000			1
MD-8	Mixing Damper	Supply Chase	Tamco	9000	2000x2000		1
MD-9	Outdoor Air Damper	Diesel Generator Rooms	Tamco	9000	1200 x 1200	Emergency Power	3

Fire Damper Schedule

Type	Description	Location	Make	Model	Size	Remarks	QTY
FD-1	Fire Damper	Powerhouse & Service Bay	E.H. Price	FD-A	1000 x 1000		30
FD-2	Fire Damper	Powerhouse & Service Bay	E.H. Price	FD-R(V)C	600 x 600	600 x 600 and smaller	33

Supply Grille Schedule

Type	Description	Location	Make	Model	Size	Remarks	QTY
SG-1	Supply Grille	Compressor Rm	E.H. Price	152D	350 x 300	550 CFM; include opposed blade damper	4
SG-2	Supply Grille	Compressor Rm	E.H. Price	152D	500 x 500	1900 CFM; include opposed blade damper	3
SG-3	Supply Grille	Compressor Rm	E.H. Price	152D	750 x 600	800 CFM; include opposed blade damper	3
SG-4	Supply Grille	Water Treatment Rm	E.H. Price	152D	900 x 600	1650 CFM; include opposed blade damper	1
SG-5	Supply Grille	Powerhouse Roof	E.H. Price	152D	600 x 1200	two per supply unit	18

Transfer Grille Schedule

Type	Description	Location	Make	Model	Size	Remarks	QTY
TG-1	Transfer Grille	Powerhouse & Service Bay	E.H. Price	LG100	1100 x 1100	Two grilles per location	100
TG-2	Transfer Grille	Diesel Generator Rm	E.H. Price	LG100	400 x 400	Two grilles per location	4

Exhaust Grille Schedule

Type	Description	Location	Make	Model	Size	Remarks	QTY
EG-1	Fume and Smoke Exhaust	Powerhouse and Service Bay	E.H. Price	LG100	800 x 800		5

Louver Schedule

Type	Description	Location	Make	Model	Size	Remarks	QTY
L-1	Powerhouse Exhaust	Service Bay -- U/S Wall	E.H. Price	6776X	1375 x 1375	for each matching damper	29
L-2	Service Bay Supply Chase	Supply Chase	E.H. Price	6776X	2000 x 2000		1
L-3	Service Bay Exhaust Chase	Exhaust Chase	E.H. Price	6776X	2000 x 2000		1
L-4	Diesel Generator #1	Generator Room	E.H. Price	6776X	2000 x 2740		1
L-5	Diesel Generator #2	Generator Room	E.H. Price	6776X	2000 x 2740		1
L-6	Diesel Generator #1 Rm Exhaust	Generator Room	E.H. Price	DE635	910 x 535		1
L-7	Diesel Generator #2 Rm Exhaust	Generator Room	E.H. Price	DE635	910 x 535		1

Control Building Grille Schedule

Type	Description	Location	Make	Model	Size	Remarks	QTY
A	Square Cone Diffuser	-	E.H. Price	SCD	300 x 300	31 Border; 3C Cones; B12 Finish	40
B	Louvered Face Return	-	E.H. Price	530D	-	F Border; L Blade Orientation; B12 Finish	10
C	Louvered Face Supply	-	E.H. Price	510D	-	F Border; L Blade Orientation; B12 Finish	5
D	Spiral Duct Grille	-	E.H. Price	SDG ST	-	B12 Finish	5
E	Door Grille	-	E.H. Price	STG1	-	BF Border; B15 Finish	10

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary as shown on the Purchaser's Drawings, Contractor's Documents, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, testing, pre-commissioning and commissioning of the following:

.1 Powerhouse and Control Building Heating, Ventilation and Air Conditioning (HVAC) Systems.

.2 Refer to HVAC Flow Diagrams in the Purchaser's Drawings for additional scope details.

.3 Refer to Appendix A: HVAC Schedules.

.4 Refer to 23 09 00 Instrumentation and Control for HVAC for HVAC Instrumentation and Control System Specification.

1.2 RELATED SECTIONS

.1 Those Sections or Subsection of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 23 09 00 - Instrumentation and Control for HVAC.

.4 Section 26 05 00 - Electrical General Requirements.

.5 Section 26 05 21 - Wire and Cable Systems.

.6 Section 26 50 00 - Facility Lighting and Controls.

.7 Section 40 05 00 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 Abbreviations and Acronyms

ACI	American Concrete Institute.
AFBMA	Anti-Friction Bearing Manufacturers Association.
AISC	American Institute of Steel Construction.
AISE	Association of Iron and Steel Engineers.
AMCA	Air Moving and Conditioning Association.
ANSI	American National Standard Institute.
ASA	American Standards Association.
ASCE	American Society of Civil Engineers.
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers.
ASME	American Society of Mechanical Engineers.
ASTM	American Society for Testing and Materials.

AWS	American Welding Society.
BHN	Brinell Hardness Number.
CEMA	Canadian Electrical Manufacturers Association.
CGSB	Canadian Government Specifications Board.
CISC	Canadian Institute of Steel Construction.
CSA	Canadian Standards Association.
Dbt	Dry bulb temperature.
dBA	Decibel (A scale).
EEMAC	Electrical and Electronic Manufacturers Association of Canada.
FM	Factory Manual.
IEC	International Electrotechnical Commission.
IEEE	Institute of Electrical and Electronic Engineers.
NBS	National Bureau of Standards.
NEMA	National Electric Manufacturers Association.
SAE	Society of Automotive Engineers.
NFPA	National Fire Protection Association.
SMACNA	Sheet Metal and Air Conditioning Contractors' National Association, Inc.
SPL	Sound power level.
SSPC	Steel Structures Painting Council.
UL	Underwriter Laboratories.
ULC	Underwriter Laboratories of Canada.
VAV	Variable Air Volume.
Wbt	Wet bulb temperature.

.2 Standards

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Regulations:

.1 Manitoba Building Code.

.2 National Building Code.

.2 Mechanical Design Standards:

.1 NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.

.3 Ductwork:

.1 Recommended Practices by the Sheet Metal and Air Conditioning Contractors' National Association Inc. and applicable Sections of ASHRAE standards.

.2 SMACNA - Accepted Industry Practice for Industrial Duct Construction.

.3 ACNA/NEBB - Procedural Standards for Testing, Adjusting and Balancing.

.4 Fans:

.1 AMCA No. 99 - Standards Handbook.

.2 AMCA No. 210 - Laboratory Methods of Testing Fans for Ratings.

.5 General Installation:

.1 Applicable Section of the ASHRAE standards, applicable Regulations and Codes of the Province of Manitoba.

.2 Manitoba Hydro Guideline - Power Smart Design Standards.

.6 Piping:

.1 ASME B31.1 - Power Piping.

.2 ASME B31.3 - Process Piping.

.7 Structural Design Standards:

.1 CSA Standard S16 - Steel Structures for Buildings.

.2 CSA Standard W59 - Welded Steel Construction (Metal-arc welding).

.3 SSPC, Steel Structures Painting Council.

.8 Electrical Design Standards:

.1 CSA Standard C22.1 - Safety Standard for Electrical Installations.

.2 CSA Standard C22.2 - Safety Standard for Electrical Equipment.

.3 NEMA Standard MG1 - Motors and Generators.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Equipment Items 23 30 00 (a)i to 23 30 00 (i) will be based on the quantity shown in the Purchaser's Drawings and Contractor's Documents.

.1 The supply and installation of air filters and frames, vibration isolators, refrigerant piping and accessories are considered incidental to the Work set out in this Section and no separate measurement or calculation of Target Prices shall be made. Include the costs for these Items in the unit prices proposed for the Items to which it applies.

.2 No separate measurement will be made for Item 23 30 00 (j) - HVAC Control System.

.1 Provision of training is considered incidental to the Work set out in this Section and no separate measurement or calculation of Target Prices shall be made. Include the costs for these Items in the Estimated Cost proposed for the Items to which it applies.

.3 Measurement for Exposed Ducting Items 23 30 00 (k)i to 23 30 00 (k)iii will be based on the calculated weight of ducting in kg, which will be based on the length of ductwork in metres and ductwork dimensions shown in the Purchaser's Drawings and Contractor's Documents, and the unit weight (kg/m^2) based on the gauge (thickness hard-converted to metres) and density of the ductwork material specified herein.

.1 The supply and installation of supports and hangers, joints, seams, sealing, access doors, elbows and bends, branch fittings, splitter and turning vanes, air intake hoods, pitot tube test opening enclosures are considered incidental to the Work set out in this Section and no separate measurement or calculation of Target Prices shall be made. Include the costs for these Items in the unit prices proposed for the Items to which it applies.

.4 No separate measurement will be made for the following Items:

.1 23 30 00 (l) - HVAC ducting insulation.

.2 23 30 00 (m) - Instrumentation.

.3 23 30 00 (n) - Balancing.

.4 23 30 00 (o) - Pre-commissioning.

.1 All tests and pre-commissioning activities for the HVAC control system are considered incidental to the Work set out in this Section and no separate measurement or calculation of Target Prices shall be made. Include the costs for these activities in the Estimated Cost proposed for the Pre-commissioning of the HVAC System.

.3 Unit Price

.1 The unit prices for Equipment Items 23 30 00 (a)i to 23 30 00 (i) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein.

.2 The Estimated Cost proposed for Item 23 30 00 (j) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be used for supply, installation, transporting, unloading, handling, identification, and final connections of the HVAC Control System, and provision of training, specified in Section 23 09 00 Instrumentation and Control for HVAC.

.3 The unit prices for Items 23 30 00 (k)i to 23 30 00 (k)iii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, transporting, unloading, handling, fabrication, and installation of the exposed ducting specified herein.

.4 The Estimated Cost for Item 23 30 00 (l) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, transporting, unloading, handling, and installation of the HVAC ducting insulation specified in Section 23 07 00 HVAC Duct Insulation.

.5 The Estimated Cost for Instrumentation Item 23 30 00 (m) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the HVAC Instrumentation, specified in Section 23 09 00 Instrumentation and Control for HVAC. Instrumentation shall include, but not be limited to, Items such as pressure differential gauges and temperature sensors, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment vendor. Include the costs for vendor supplied/installed instrumentation with the Equipment Item to which it applies.

.6 The Estimated Cost for Balancing Item 23 30 00 (n) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for provision of all labour, Materials, supplies and equipment necessary to complete the specified activities for the complete system.

.7 The Estimated Cost for Pre-Commissioning Item 23 30 00 (o) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all Materials, supplies and equipment necessary for pre-commissioning and putting into service of the system(s) as specified herein.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 General

.1 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, product data, installation manual including installation and test plans, testing procedures, and pre-commissioning procedures.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, shop drawings indicating detailed layout of ductwork, locating each component. Including control diagrams, wiring diagrams as required and written sequence of operation.

.3 Submit manufacturer's installation, operation and maintenance manuals to the Engineer. Include electrical schematic of circuits, written description of system design, drawings illustrating control logic and equipment location, and technical bulletins describing equipment.

.4 Typical units complete with all accessories and specified finishes shall be submitted for all diffusers, registers and grilles, if requested by the Purchaser or Engineer. Refer to diffuser, register and grille schedule.

.5 The Contractor shall provide an electronic and a hard copy of all test certificates, performance curves and data sheets required by the Engineer. Sufficient information shall be given on all test certificates, performance curves and data sheets to enable the Material or equipment to which the certificates refer to be identified by the Engineer.

.6 The Contractor shall provide an electronic and a hard copy of all shop rejection certificates immediately after the Contractor's quality control department has determined that any part or parts of the Work set out in this Section do not meet quality control requirements. The certificate shall explain the Contractor's recommended remedial action together with any sketches, which may be required to explain the recommended remedial action.

.7 All balancing reports shall be submitted via the Quality docket for the system to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.8 Provide list of recommended spare parts.

.9 The Contractor shall provide a simplified 3D Model of the equipment in accordance to Subsection 21.7.7 3D Model Standards. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

.3 HVAC Control System

.1 For HVAC Control System refer to Section 23 09 00 Instrumental and Control for HVAC.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All Items shall be delivered, handled and stored with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.7 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

1.8 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 For HVAC Control System refer to Section 23 09 00 Instrumental and Control for HVAC.

Part 2 Products

2.1 FANS

.1 All Fans shall be supplied and installed as shown on the Purchaser's Drawings and Contractor's Documents. All fans shall comply with the requirements of AMCA standards for fans, and shall be marked with arrows showing the direction of airflow and rotation of fan wheel. Internal parts requiring lubrication shall be provided with tubes extending through the fan housing and terminating in an approved fitting at convenient locations. All fans shall be complete with motor, mounting frame or brackets, vibration isolators and, where shown or specified, V-belt drives, guards and ancillary equipment necessary to complete the installation. All fans shall be the size, capacity and type specified in the fan schedule provided in Appendix A and herein. The manufacturer and model reference stated on the fan schedule indicate minimum requirements, but alternate equipment may be supplied if acceptable to the Purchaser.

.2 All fans shall be sized and selected to operate below the prescribed sound pressure levels (SPL) per ASHRAE standards. Sufficient technical data must be provided by the Contractor to show that prescribed noise levels will not be exceeded.

.3 All V-belt drives shall be adjustable by means of variable pitch pulleys to allow a variation of ±15% of fan speed at the specified capacity and shall have a minimum of two V-belts in matched sets. The variable pitch type drive shall have a minimum belt capacity factor equal to 1.5 times the driver nameplate horsepower. Fans mounted outside shall have belt drives capable of operating at -45°C ambient. The driver shall be mounted on an integral slide-rail base complete with screw adjustment. All V-belt drives shall be provided with a heavy six gauge expanded metal mesh belt guard reinforced to prevent vibration and sized to permit full adjustment of the motor and drive on the slide rails. A tachometer port, of at least 64 mm diameter, with removable cover, shall be located immediately opposite the centre of the driven shaft.

.4 Safety guards and screens shall be provided wherever necessary. A fan shall not be considered safe by virtue of its location.

.5 Bearings shall be grease lubricated, self-aligning, anti-friction type suitable for continuous operation with a minimum certified rated life of 100,000 hours. The bearings shall be of ample size for all possible speed and loading combinations.

.6 Before shipment, all fans shall be statically and dynamically balanced.

.7 All fans shall be selected to operate at an elevation of 160 m ASL (180 m for intake hoist housing). Fan capacities are given for actual conditions. The fans shall be selected to provide the required capacity at 35°C.

.8 Each fan located between inlet and outlet ducts shall have two access doors to allow access upstream and downstream of the fan. A terminal box located on the outside of the fan housing shall be provided for termination of electrical connections.

.9 Propeller Fans

.1 Propeller fans shall be heavy-duty type complete with airfoil blades, streamlined inlet, standard motor, guard screen, mounting panel and other ancillary equipment necessary to complete the installation as shown on the Purchaser's Drawings. Direct drive units with fan wheels on motor shaft shall have resilient mounted motors.

.10 Axial Flow Fans

.1 Axial flow fans including tube, vane, and centrifugal axial types shall be complete with vibration isolators, standard motor, drive components, companion duct flanges as required, guards, screens and other equipment necessary to complete the installation as shown on the Purchaser's Drawings.

.2 The rotor hub and blades shall be of welded steel or cast aluminum construction. All blades shall be airfoil shaped for maximum efficiency. The units shall have removable drive tube cover. Each unit shall have V-belt drive, with a suitable belt guard. All fans with exposed inlet or outlet shall have screens. Floor mounted units shall have reinforced legs.

.3 The motor size shall be based upon the peak horsepower requirements for the maximum setting of the V-belt drive rather than duty horsepower required.

.11 Centrifugal Fans

.1 Centrifugal type fans shall have curved blades with non-overloading characteristics and be complete with standard motor, adjustable motor base, vibration isolators, V-belt drive, guard and all other auxiliary equipment necessary to complete the installation as shown on the Purchaser's Drawings.

.2 The fan wheel blades, rims and back plates shall be securely welded together. Fan housings shall have streamlined inlets, and scrolls and side sheets joined by deep lock seam joints to ensure air tightness. Fan wheel shafts shall be of the heavy-duty type and shall be accurately ground and polished. The shafts shall rotate on self-aligning ball bearings of ample size for all possible speed and loading combinations. Fan and drive shall be mounted on integral slide-rail base and the entire unit shall be isolated from its supporting pad by means of spring vibration isolators.

.3 The maximum operating speed of the centrifugal fans shall be not greater than 50% of the first critical speed.

.12 In-Line Centrifugal Fan

.1 Duct mounted supply, exhaust or return fans shall be of the centrifugal, belt driven, inline type. The fan housing shall be of a square design constructed of heavy-gauge galvanized steel or aluminum and shall include square duct mounting collars.

.2 Fan construction shall include two removable access panels located perpendicular to the motor mounting panel. The access panels must be of sufficient size to permit easy access to all interior components.

.3 The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced.

.4 Motors shall be heavy-duty ball bearing type carefully matched to the fan load and furnished at the specified voltage, phase, and enclosure. Motors and drives shall be mounted out of the airstream. Motors shall be readily accessible for maintenance.

.5 Precision ground and polished fan shafts shall be mounted in permanently sealed, lubricated pillow block ball bearings. Bearings shall be selected for a minimum L10 life in excess of 100,000 hours (L50 average life in excess of 500,000 hours) at maximum cataloged operating speed.

.6 Drives shall be sized for a minimum of 150% of driven horsepower.

.7 Pulleys shall be of the fully machined cast iron type, keyed and securely attached to the wheel and motor shafts. Motor pulleys shall be adjustable for final system balancing.

.8 A NEMA-1 disconnect switch shall be provided as standard, except with explosion resistant motors, where disconnects are optional. Factory wiring shall be provided from motor to the handy box.

.9 Fan shall bear the AMCA Certified Ratings Seal for Sound and Air Performance.

.10 Fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.

.11 Acceptable material: Greenheck BSQ, Loren Cook SQN, or Purchaser's approved equivalent.

.13 Cabinet/Ceiling Fans

.1 Fans shall be direct drive forward curved centrifugal type. The housing shall be galvanized steel with the outlet convertible for horizontal or vertical discharge. Motor shall be mounted on vibration isolators and provided with a plug type disconnect.

2.2 WELDING EXTRACTION ARMS

.1 Provide a Torit FT-500 with 14' flex trunk.

.2 Extraction Arm shall be equipped with a damper and spark screen in the hood as standard.

.3 Extraction Arm shall have a connection diameter 200 mm and maximum fume temperature 120°C.

.4 Fume exhaust fans shall provide 1,000 cfm flow with 2 HP, 575/3/60 motor.

2.3 GRILLES, REGISTERS AND DIFFUSERS

.1 General

.1 Steel Diffusers to have baked enamel finish, unless noted otherwise herein. Aluminum grilles and registers to be of welded construction and to have etched finish with lacquer overcoat unless noted otherwise herein. Shop drawings shall

be accompanied by an itemized list indicating unit locations by room number and unit size.

.2 Refer to diffuser register and grille schedules.

.2 Diffuser

.1 Type A diffuser shall be steel construction with three fixed concentric cones. Cones shall be square, one piece die formed and finish shall be a white powder coat. Diffuser shall be Price 300 mm (11.81 in.) x 300 mm (11.81 in.) SCD/31/B12 or the Purchaser's approved equivalent.

.3 Grilles

.1 Grilles shall be installed at the locations shown on the Purchaser's Drawings and shall be of the type shown in Appendix A – HVAC Schedules. They shall be rigid, free of flutter and vibration and be provided with sponge rubber gaskets complete with adequate fastenings to prevent streaking between outlet and duct.

.2 Grilles and registers to be of one-piece construction with hidden mullions. Grilles, registers and diffusers in shop to have duty chain attached between frame and core to ensure against core falling out.

.3 Type E transfer grille shall be steel construction with sight proof core. Grille shall have a 33.5 mm (1-5/16 in.) flat border with countersunk screw holes on both sides and finish shall be an aluminum powder coat. Grille shall be Price STG1/BF/B15 or the Purchaser's approved equivalent.

.4 Type F transfer grille shall be 14 gauge steel with one inch square mesh, overall size shall be a minimum of three inches larger than daylight size. Grille shall have screw holes predrilled and finish shall be a white powder coat. LG100/STL/ CS/B12 or the Purchaser's approved equivalent.

.4 Registers

.1 Type B register shall be roll formed steel construction, fixed 45° deflection blades parallel to long dimension, and 19 mm (3/4 in.) blade spacing. Register shall have a 32 mm (1-1/4 in.) flat border with countersunk screw holes and finish shall be a white powder coat. Register shall be supplied with a black opposed blade steel damper. Register shall be Price 530/F/L/A/B12 or the Purchaser‘s approved equivalent.

.2 Type C register shall be roll formed steel construction adjustable single deflection blades parallel to long dimension, and 19 mm (3/4 in.) blade spacing. Register shall have a 32 mm (1-1/4 in.) flat border with countersunk screw holes and finish shall be a white powder coat. Register shall be supplied with a black opposed blade steel damper. Register shall be Price 510/F/L/A/B12 or Purchaser's approved equivalent.

.3 Type D register shall be of steel construction, adjustable double deflection, designed for mounting on circular ducts. Closed cell foam gaskets shall be supplied to seal the inlet and both ends of the grille to the duct. Register shall be supplied with air scoop, countersunk screw holes, and finish shall be a white powder coat. Register shall be Price SDG ST/A/B12 or the Purchaser's approved equivalent.

.4 Type G register shall be extruded aluminum construction, adjustable double deflection blades with the front blades parallel to the long dimension. Blades shall be 32 mm (1-1/4 in.) on 38 mm (1-1/2 in.) centers and 32 mm (1-1/4 in.)

flat border shall have countersunk screw holes. Finish shall be a white power coat. Register shall be supplied with a black opposed blade steel damper. Register shall be Price 152D/F/L/A/B12 or the Purchaser's approved equivalent.

2.4 LOUVERS

.1 Louvers shall be of the stationary all welded steel type with joints ground flush and smooth. Frames and blades shall be formed from minimum 16 gauge Galvanized steel. The blades shall be drainable, adequately supported for the loads specified and continuous for the louver width with no exposed mullions. Frame shall be 150 mm deep and have an approved caulking slot. Louvers shall be equipped with 16 x 18 mesh galvanized steel insect screens in a folded frame. The louvers shall have a factory applied high baked enamel finish with colour to match the cladding. Airolite type 6776 or the Purchaser's approved equivalent.

2.5 DAMPERS

.1 Dampers shall be supplied as shown on the Purchaser's Drawings, Contractor's Documents and in the schedules provided in Appendix A – HVAC Schedules and shall be the size, capacity and construction as specified.

.2 All dampers shall be constructed to withstand 1-1/2 times the pressure, velocity and other forces to which they are subjected without undue vibration or deflection. All blades shall operate freely without binding in the frames and ducts. All dampers shall be complete with gaskets, fasteners and other Items essential for installation and operation.

.3 Balancing Dampers

.1 Balancing dampers shall be installed at all branch ducts as shown on the Purchaser's Drawings and Contractor's Documents and as required to balance the air distribution system. Dampers shall be made of 16 gauge galvanized steel and be provided with indicating and locking quadrants. They are designated on the Drawings as BD and shall be as in Balancing Damper Schedule.

.2 Blades shall have a maximum width of 300 mm and shall be stiffened by forming a "V-bend" at the leading and trailing edges and along the centre. Blades shall be interconnected with self-aligning non-binding linkage. Other hardware shall be of the type and size shown in the following table:

Damper Size	**Bearing Size**	**Bushing Type**	**Quadrant Type**
to 500 mm	10 mm	Self-oiling bronze	Standard Duty
510 - 750 mm	14 mm	Self-oiling bronze	Heavy Duty
751 - 1275 mm	20 mm	Ball Bearing	Heavy Duty Ball Bearing

.3 Damper hardware shall be Duro-Dyne or the Purchaser's approved equivalent.

.4 Combination Fire and Smoke Control Dampers

.1 Combination fire and smoke control dampers are designated on the Purchaser's Drawings and Contractor's Documents as FD-XX. They shall be UL approved Leakage Class 1 fire and smoke dampers complete with electric motor operator, refer to Section 23 09 00 Instrumentation and Control for HVAC. They shall be installed in accordance with the manufacturer's instructions, where shown on the Purchaser's Drawings and Contractor's Documents and where otherwise required by the authorities having jurisdiction. They shall have a minimum of a 2-hour fire rating. The dampers shall come with a re-settable/override release option.

.2 An actuator shaft shall permit operation by a standard electric motor and a fusible link shall provide an automatic override system to close the damper in fire mode.

.3 These dampers shall be spring loaded to fail in the closed position.

.4 All fire and smoke dampers shall be ULC approved, and shall be Price or the Purchaser's approved equivalent.

.5 Control Dampers

.1 Tamco Series 1000 - low leakage air-foil or Purchaser's approved equivalent.

.2 Blades to be extruded aluminum.

.3 Blade seals shall be of extruded EPDM. Frame seals shall be extruded silicone. Seals are to be secured in an integral slot within the aluminum extrusions. Blade and frame seals are to be mechanically fastened to eliminate shrinkage and movement over the life of the damper. Adhesive or clip-on type blade seals shall not be approved.

.4 Dampers shall be available with either opposed blade action or parallel blade action.

.5 Leakage shall not exceed 15.2 l/s/m² against 0.25 kPa w.g. differential static pressure.

.6 Motorized Dampers

.1 These dampers are designated on the Purchaser's Drawings and Contractor's Documents as MD-XX. Motorized dampers with insulated blades shall be installed in all outside walls where shown on the Purchaser's Drawings and Contractor's Documents. All motorized dampers shall be suitable for operators specified in Section 23 09 00 Instrumentation and Control for HVAC.

.2 The dampers blades shall be extruded aluminum construction internally insulated with expanded polyurethane foam and thermally broken. Four inch deep extruded aluminum frames shall be not less than 2 mm thickness and shall be insulated on four sides with Styrofoam. Frame shall be thermally broken. Shafts shall be aluminum hexagon with a celcon bearing rotating in a polycarbonate outer bearing inserted in the frame. They shall be suitable for operation when the damper is installed with the damper shaft in the vertical direction. Blade and frame seals shall be extruded silicone secured in an integral slot within the extrusions. The seals shall render the damper virtually airtight.

.3 All insulated motorized dampers shall be Tamco Series 9000 or the Purchaser's approved equivalent.

2.6 FAN VIBRATION ISOLATORS

.1 Unless otherwise noted, floor mounted air handling units shall have Vibro Acoustics CM spring mounts or the Purchaser's approved equivalent to give 25 mm static deflection. Floor mounted fans shall have spring mounts and shall give 38 mm static deflection. Suspended fans shall have spring hangers to provide 25 mm static deflection.

2.7 SUPPLY FAN AIR FILTERS AND FRAMES

.1 The air filters shall be supplied and installed as shown on the Purchaser's Drawings and Contractor's Documents and shall be the size, capacity and construction as specified in the individual equipment sections.

.2 The replaceable filter media shall be supported in filter frames constructed of high wet strength beverage board. The downstream media-retaining grid shall be welded wire on one inch centers.

.3 The media frames shall rest in factory fabricated holding frames. The frames shall be of galvanized steel and equipped with airtight seals and four spring-type positive sealing fasteners.

.4 Filter media for air filters shall be 50 mm deep pleated disposable filters designed for up to 2.5 m/s (500 ft/min) air flow with an initial resistance not exceeding 70 Pa (0.28 w.g.).

.5 All disposable filter media required shall be provided for operation of each filter bank from system start-up until acceptance by the Purchaser. At the time of acceptance, one new complete set of filter media shall be installed in each filter bank. Three additional complete sets of filter media shall be supplied. Disposable filter media shall be Farr 30/30 or the Purchaser's approved equivalent.

2.8 DIFFERENTIAL PRESSURE GAUGES

.1 Refer to Section 23 09 00 Instrumentation and Control for HVAC.

2.9 ROOFTOP AIR SUPPLY UNITS: 5750-AD-1001, 2001, 3001, 4001, 5001, 6001, 7001, 0001, 0002

.1 General

.1 Engineered Air LMD42/0 Air Handling Unit or Purchaser's approved equivalent.

.2 Air Handling shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule provided in Appendix A – HVAC Schedules.

.3 Substitution of any product other than that specified, must ensure no deviation below the stated capacities, air flow rate, heat transfer rate, filtration efficiency and air mixing quality. Power requirements must not be exceeded, and where specifically defined, sound power levels must not be exceeded. Applications for "equivalent" or "alternate" must address these factors.

.4 Unless stated otherwise, air-handling units are to be shipped to the job in one piece, factory assembled, factory tested and fully packaged. Modular units assembled to achieve a close proximation to the intent of this Section of the Technical Specification will not be considered equivalent. All equipment shall be pre-wired, and factory certified by an approved testing agency such as ETL, UL, CSA prior to shipment.

.5 Air handling unit shall be fully pre-wired for line voltage and control and shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the Canadian Electrical Code.

.6 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.7 The units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of 15 continuous years of proven production experience.

.2 Unit Construction

.1 Unit casing shall be of minimum 16 gauge (1.6 mm) satin coat galvanized sheet metal. Surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.3 The units shall be provided with a 0.85 mm solid galvanized interior metal liner throughout.

.4 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, access plenums and humidifiers/wet cells, electrical control panels. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.5 Units shall be provided with fully lined, e-profile gasket, hinged access doors with a minimum of two lever handles operable from both sides for all units. Hinged access doors shall open outwards on all sections for outdoors units. Doors located on sections with positive pressure shall have a clear warning label and a safety device must be affixed.

.6 Provide factory installed suitable lighting in each section containing an access door in accordance with CSA Standard C22.1 - Safety Standard for Electrical Installations. Lights shall be wired in EMT conduit to a switch with pilot light.

.7 Units shall be internally insulated with 51 mm thick, R-20, neoprene coated fiberglass thermal insulation.

.8 Insulation shall be secured to metal panels with a fire retardant adhesive and welded steel pins at 400 mm o/c. Insulation is secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.9 Units shall be designed to meet NBC requirements for snow and wind loads.

.10 Units shall be designed to meet Workplace Safety and Health Act (WSH) requirements.

.11 Unit casing floors shall be fabricated with 2.0 mm galvanized steel checker plate. Provide reinforcing channels under floor to minimize deflection.

.12 Service corridor (integral) shall be insulated with 50 mm (2 in.) thick nominal 3 lb/cu. ft (48 kg/cu. m) density acoustic insulation. Corridor shall also be fully lined with 22 gauge (0.85 mm) solid liner. Floor to be 14 gauge (2.0 mm) galvanized floor with rust resistant non-skid coating designed for load of 2.4 KPa (minimum).

.13 Access door(s) to service shall be complete with zinc plated piano hinges and brass pins in welded steel frames. Provide with lockable lever handles. Access doors from service corridor to internal unit components shall be as specified elsewhere.

.14 Corridor to be provided with glass globes and metal protective cage wired in EMT to a switch with pilot light. Corridor shall also be provided with an electric baseboard heater sized for -45°C outdoor ambient thermostat, and duplex service receptacle.

.15 Lights, heater, service receptacle and non-fused disconnect shall be fed from separate power source. For optional single point power supply, unit splitters or special disconnects to be provided.

.16 Air handling units shall be weatherproofed and equipped for installation outdoors. This shall include generally for the prevention of infiltration of rain and snow into the unit, louvers or hoods on air intakes and exhaust openings with 25 mm galvanized inlet screens; rain gutters or diverters over all access doors; all joints caulked with a water resistant sealant; roof joints turned up 51 mm with three break interlocking design; outer wall panels extend a minimum of 6 mm below the floor panel.

.17 Units shall incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free of penetrations. Unit underside joints are caulked.

.18 Outdoor units over 4.9 m in width, over 3 m in height, with a sloped roof ,or with unit split(s) shall be provided with a membrane roof to ensure prevention of infiltration of rain and snow through the top of the unit.

.19 Units mounted on roof curbs incorporate welded floor to base construction. Floors are of three break upstanding design with welded corners and free penetrations. Unit underside joints are caulked.

.20 Units shall be provided with optional channel flashing constructed of 22 gauge (0.85 mm) galvanized steel, painted to match unit.

.3 Fans

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating.

.2 All fan assemblies shall be equipped with greaseable, self aligning ball or roller type pillow block bearings, supported on a rigid structural steel frame. Fans shall be airfoil DWDI type.

.3 All drives shall be adjustable on fans to allow a variation of ±15% of fan speed at specified capacity. The drive shall have a minimum of two belts and shall have a capacity factor of at least 1.5 times the driver nameplate horsepower. All drives

shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure.

.4 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.5 Provide OSHA approved belt guards on all units with walk in sections over 1,524 mm high.

.6 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is welded to the structural frame of the unit. The isolators shall be neoprene-in-shear type for single 230 mm to 380 mm diameters forward curve fans. All other fans shall incorporate vertical spring type isolators with leveling bolts, bridge bearing waffled pads with minimum 25 mm static deflection designed to achieve high isolation efficiency. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.7 Provide single extended grease line from far side to access side bearing.

.8 Provide fan scroll access doors and drains.

.9 Fan motors shall be TEFC (Totally Enclosed Fan Cooled) Super-E high efficiency type, 575 Vac, 3 ph, 60 Hz.

.4 Filters

.1 Filter Sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the Purchaser's Drawings and Contractor's Documents.

.2 For units with filter banks up to 1,825 mm (72 in.) high, the filter modules shall be designed to slide out of the unit. Side removal 50 mm (2 in.) filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.

.3 For units with filter banks 73" (1,854 mm) high and larger, the filters shall be lift out from an access plenum upstream of the filters. Lift out 2" (50 mm) filters shall fit into a horizontal track from which they are lifted up and out.

.4 50 mm Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fiber media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. The filter media shall have a minimum efficiency of 30-35% on ASHRAE Standard 52.1-92, and a minimum of MERV 8 per ASHRAE 52.2. Rated U.L. Class 2.

.5 Provide Dwyer 3000 Photohelic air filter gauge with single pole double throw switch for remote alarm capabilities. Provide complete with static pressure tips and aluminum tubing all factory installed. Filter gauge to have a range of 0-500 Pa.

.6 Where the filter gauges are provided on outdoor units they shall be mounted inside of a weatherproof enclosure with viewing window.

.5 Dampers

.1 Outdoor air dampers shall be extruded aluminum, low leak, thermally broken, insulated blade Tamco Series 9000 or Purchaser's approved equivalent.

.2 Mixing dampers shall be parallel blade type.

.6 Mixing Box Controls

.1 Refer to Section 23 09 00 Instrumentation and Control HVAC System.

.7 Factory Supplied Controls/Wiring

.1 Refer to Section 23 09 00 Instrumentation and Control HVAC System.

2.10 CONTROL BUILDING COOLING UNIT

.1 Evaporator Unit: 5750-AC-0006

.1 General:

.1 Approved Manufacturer(s): Engineered Air or Purchaser's approved equivalent.

.2 Air Handling shall be built to the level of quality as herein specified and to the description of the Air Handling Unit Schedule provided in Appendix A – HVAC Schedules.

.3 Unless stated otherwise, air-handling units are to be shipped to the job in one piece, factory assembled, factory tested and fully packaged. Modular units assembled to achieve a close proximation to the intent of this Section of the Technical Specification will not be considered equivalent. All equipment shall where specified and applicable, be pre-wired, and factory certified by an approved testing agency such as ETL, UL, CSA prior to shipment.

.4 Air handling unit shall be fully pre-wired for line voltage and control and shall bear an approved label with all the necessary identification marks, electrical data, and any necessary cautions as required by the Canadian Electrical Code.

.5 All electrical circuits shall undergo a dielectric strength test, and shall be factory tested and checked as to proper function.

.6 The units and major components shall be products of manufacturers regularly engaged in the production of such equipment and with a minimum of 15 continuous years of proven production experience.

.2 Unit Construction:

.1 Unit casing shall be of minimum 18 gauge (1.3 mm) satin coat galvanized sheet metal complete with 22 Ga Satin Coat solid liners throughout. Exterior surfaces shall be cleaned with a degreasing solvent to remove oil and metal oxides and primed with a two-part acid based etching primer. Finish coat shall be an electrostatically applied enamel, to all exposed surfaces. All unprotected metal and welds shall be factory coated.

.2 All walls, roofs and floors shall be of formed construction, with at least two breaks at each joint. Joints shall be secured by sheet metal screws or pop rivets. Wall and floor joints shall be broken in and on all outdoor units roof joints broken out (exposed) for rigidity. All joints shall be caulked with a water resistant sealant.

.3 Units shall be provided with access doors to the following components: fans and motors, filters, dampers and operators, access plenums and

electrical control panels. Access doors shall be large enough for easy access. Removal of screwed wall panels will not be acceptable.

.4 Units shall be provided with hinged access doors in welded steel frames. Doors shall be fully lined, come complete with bulb trim seal gasket and Leverlok handles, operable from both sides. Whenever possible, hinged access doors to areas of negative pressure shall open out, and to areas of positive pressure shall open in. Where space constrictions require the use of outward opening doors to an area of positive pressure, a clear warning label and safety chain must be affixed. All access doors incorporate 250 mm x 250 mm (10 in. x 10 in.) single pane wire reinforced tempered glass viewing window.

.5 Provide suitable lighting in each section containing an access door in accordance with Section 26 50 00 Facility Lighting and Controls. Lights shall be wired in EMT conduit to a switch with pilot light.

.6 All units shall be internally insulated with 51 mm thick nominal, R-20 insulation.

.7 Insulation is secured with steel angles. All longitudinal insulation joints and butt ends shall be covered by a sheet metal break to prevent erosion of exposed edges. Drain pans and all floor areas shall be insulated on the underside.

.8 Cooling coil drain pans shall be fabricated of stainless steel and are an integral part of the floor paneling, a minimum of 50 mm (2 in.) deep, with welded corners. Drain pans shall extend a minimum of 150 mm (2 in.) downstream of coil face and be provided with a 40 mm (1-½ in) S.S. M.P.T. drain connection. Drain pans must have a fast pan and be sloped and pitched such that there is no standing water. Intermediate fast pans shall be provided between cooling coils where required for effective moisture removal.

.3 Fans:

.1 Centrifugal fans shall be rated in accordance with AMCA Standard Test Code, Bulletin 210. Fan manufacturer shall be a member of AMCA. All fans and fan assemblies shall be dynamically balanced during factory test run. Fan shafts shall be selected for stable operation at least 20% below the first critical RPM. Fan shafts shall be provided with a rust inhibiting coating. Low pressure forward curved fans of 450 mm (18 in.) or less diameter, shall be equipped with greaseable pillow block bearings, supported on a rigid structural steel frame.

.2 Drives shall be adjustable on fans with motors 7.5 HP or smaller. On fans with larger motors, fixed drives shall be provided. All drives shall be provided with a rust inhibiting coating. The air balancer shall provide for drive changes (if required) during the air balance procedure. Provide OSA belt guards for supply and return fan and motor assemblies.

.3 Motor, fan bearings and drive assembly shall be located inside the fan plenum to minimize bearing wear and to allow for internal vibration isolation of the fan-motor assembly, where required. Motor mounting shall be adjustable to allow for variations in belt tension.

.4 Fan-motor assemblies shall be provided with vibration isolators. Isolators shall be bolted to steel channel welded to unit floor, which is

welded to the structural frame of the unit. The isolators shall incorporate vertical spring type isolators with levelling bolts, bridge bearing waffled pads with minimum 25 mm (1 in.) static deflection designed to achieve high isolation efficiency. The isolators shall be neoprene-in-shear type for single 230 mm (9 in.) to 380 mm (15 in.) diameters forward curve fans. Fans shall be attached to the discharge panel by a polyvinyl chloride coated polyester woven fabric, with a sealed double locking fabric to metal connection.

.5 Fan motors shall be TEFC super high efficiency type, 575 Vac, 3 ph, 60 Hz. Provide pre-wired and tested Danfoss VTL Variable Frequency drives unit mounted in vented unit control panel.

.4 Refrigerant Cooling Coils:

.1 Refrigerant evaporator type coils shall be equipped with distributors connected to the coil by copper tubes. Solenoid valves, expansion valves, and related accessories are to be provided and installed by the refrigeration contractor.

.2 Refrigerant coils with multiple compressors shall be alternate tube circuited in order to distribute the cooling effect over the entire coil face at reduced load conditions. Provision for use of thermal expansion valves must be included for variable air volume and/or make-up air applications.

.3 Refrigerant shall be R410A. A minimum of four circuits will be provided.

.5 Filters:

.1 Filter Sections shall be provided with adequately sized access doors to allow easy removal of filters. Filter removal shall be from one side as noted on the Purchaser's Drawings.

.2 For units with filter banks up to 1,825 mm (72 in.) high, the filter modules shall be designed to slide out of the unit. Side removal 100 mm (4 in.) filters shall slide into a formed metal track, sealing against metal spacers at each end of the track.

.3 100 mm (4 in.) Filter shall be Pleated Panel Disposable Filters: An optimum blend of natural and synthetic fiber media with a rust resistant support grid and high-wet strength beverage board enclosing frame with diagonal support members bonded to the air entering and air exiting side of each pleat. Provide permanent re-usable metal enclosing frames. The filter media shall have a minimum efficiency of 30-35% on ASHRAE Standard 52.1-92, and a minimum of MERV 11 per ASHRAE 52.2. Rated U.L. Class 2.

.4 Provide all filter banks with "Dwyer 2000 magnehelic" air filter gauge complete with static pressure tips and aluminum tubing all factory installed at all filter banks. Filter gauge to have a range of 0 to 2" (0-500 Pa). In addition provide a dirty filter indicator Dry Contact for use by Controls.

.6 Dampers:

.1 Dampers shall be extruded aluminum, low leak, thermally broken, insulated blade Tamco Series 9000 on outside air and exhaust, TAMCO 1000 on Return.

.2 Mixing dampers (Variable outside air damper, Return air damper and Exhaust Air damper) shall be parallel blade type and be factory installed.

.7 Mixing Box Controls:

.1 Refer to Section 23 09 00 Instrumentation and Control for HVAC.

.8 Electric Heating Coil:

.1 Heater elements shall be 600 Vac, 3 ph, 60 Hz and shall be installed a minimum of 300 mm (12 in.) downstream from air filters. Insulation in heating sections shall be fibre reinforced foil faced. Heater element wiring shall terminate in a full height enclosure at one end of the heater. All internal wiring shall terminate on clearly identified terminal blocks. Heaters shall be equipped with an automatic reset disc type thermal cut-out. Heater elements shall be open type nickel-chromium construction, (60% Ni, 16% Cr, 24% Fe). Coil terminal pins shall be mechanically secured and insulated from the frame by means of non-rotating ceramic bushings. Provide SCR discharge air control of heater element.

.9 Factory Supplied Controls/Wiring:

.1 Refer to Section 23 09 00 Instrumentation and Control for HVAC.

.2 Condenser Unit 5750-AC-0005

.1 General:

.1 Condensing units shall be CETL approved. Condensing units shall be designed for a minimum of 8°C (15°F) liquid subcooling. Condensing units shall operate down to10°C (50°F) as standard. Multiple compressor/condenser circuits shall be separate from each other. Suction and liquid lines shall be extended to the outside of the cabinet. Service ports fitted with Schraeder fittings shall be connected to the suction and discharge lines for charging or pressure gauge readings.

.2 Provide internal hot gas bypass or freeze stat, receivers and subcooling circuit as required to suit piping arrangement.

.3 Refrigeration specialties such as solenoid valves, TX valves, etc. including R410A Refrigerant, to be supplied and installed by refrigeration contractor.

.3 Control System for 5750-AC-0006

.1 Refer to Section 23 09 00 Instrumentation and Control for HVAC.

2.11 ENGINEERING ROOM SPLIT SYSTEM AIR CONDITIONING UNIT

.1 Evaporator Unit: 5750-AC-0004

.1 Samsung AQV Neo Forte wall mounted evaporator, single zone split system or equivalent. Cooling capacity shall be 12,000 Btu/h. Heating capacity shall be 13,600 Btu/h.

.2 Indoor unit chassis shall be UL94 V0 with a galvanized steel mounting bracket. The outdoor unit shall be galvanized steel with a baked on powder coated finish for durability.

.3 The heat exchanger shall be mechanically bonded fin to copper tube.

.4 The indoor fan shall be a single antibacterial cross-flow type. Three fan speed settings and auto setting.

.2 Air Cooled Condenser Unit: 5750-AC-0003

.1 Unit shall be CETL approved.

.2 Condenser normal.

.3 Condenser unit shall provide 208 Vac, 1 ph power to evaporator unit via 14AWG x 3 interconnected power cable.

.4 Condenser fan shall be axial type with brushless DC electric motor, 31 W output, 0.10 Amps (FLA).

.5 Casing material shall be galvanized steel with a baked on powder coated finish.

.6 All components shall be factory-assembled, charged with R410A refrigerant and sealed. No internal piping, brazing, dehydration or charging shall be required.

.7 Samsung AQV12NSDX or the Purchaser's approved equivalent.

.3 Control System

.1 Refer to Section 23 09 00 Instrumentation and Control for HVAC.

2.12 COMMUNICATION ROOM AIR CONDITIONING UNIT

.1 Evaporator Unit: 5750-AC-0001

.1 Evaporator Cabinet Construction:

.1 The cabinet and chassis shall be constructed of heavy gauge galvanized steel, and shall be serviceable from one side. Mounting brackets shall be factory-attached to the cabinet. Internal cabinet insulation shall meet ASHRAE 62.1 requirements for Mold Growth, Humidity & Erosion, tested per UL 181 and ASTM 1338 standards.

.2 Fans:

.1 The air distribution system shall be constructed with a quiet, direct-drive fan assembly equipped with double-inlet blower, self-aligning ball bearings and lifetime lubrication. Fan motor shall be permanent-split capacitor, high-efficiency type, equipped with two speeds for airflow modulation. Dehumidification shall utilize the lower fan speed.

.2 Each system shall be capable of delivering 600L/s at high fan speed. The circulating-air fan shall be two-speed for precise dehumidification control. The fan motor shall be 0.5 HP (0.38 kW).

.3 System shall be suitable for plenum or ducted air distribution. Refer to Air Filter Box and High Static Blower Assembly specified in this Section of the Technical Specification.

.4 Ship-Loose Accessories:

.1 Remote Sensors: The unit shall be supplied with remote temperature and humidity sensors. The sensors shall be connected to the unit by a 10 m shielded cable.

.2 Air Filter Box: The evaporator Section shall be supplied with an air filter box for use with ducted installations. Two filters shall be included 102 mm x 508 mm x 635 mm (4 in. x 20 in. x 25 in.)

each, deep-pleated type, with a MERV 11 rating, based on ASHRAE 52.2-2007.

.3 High Static Blower Assembly: A blower box shall be field attached to the evaporator to provide up to 50 mm (2 in.) of external static pressure on the discharge side of the evaporator. The blower box shall contain a centrifugal type, double inlet blower, with belt drive and single speed motor, mounted to an adjustable motor base.

.2 Condensing Unit 5750-AC-0002

.1 Condensing unit components shall include a condenser coil, a direct-drive propeller-type fan, a scroll compressor, high-pressure switch, receiver and head pressure control valve, hot gas bypass system and liquid line solenoid valve. A hot gas bypass system shall be provided to reduce compressor cycling and improve operation under low load conditions.

.2 All components shall be factory-assembled, charged with R-407C refrigerant and sealed. No internal piping, brazing, dehydration or charging shall be required. Condensing unit shall be designed for 35°C ambient and be capable of operation to -40°C.

.3 The condenser coil shall be constructed of copper tubes and aluminum fins.

.4 The condensing unit shall be designed to operate at a sound level less than 58 dBA at a distance of 1 m.

.5 The outdoor condensing unit shall be designed for design ambient operation of 41°C.

.6 Acceptable material: Liebert Mini-Mate PFH037A-L7, or Purchaser's approved equivalent.

.3 Control System

.1 Refer to Section 23 09 00 Instrumentation and Control for HVAC.

2.13 REFRIGERANT PIPING AND ACCESSORIES

.1 All refrigerant piping shall be Type 'L' copper with long radius elbows. All joints to be brazed with Silfos. Continuously bleed oil-free nitrogen through piping when brazing to prevent oxidation of internal pipe surface. All piping shall be installed in accordance with good refrigerant piping practice with minimum number of fittings to minimize friction loss. Provide separate piping for split refrigerant circuits.

.2 Provide flexible vibration eliminators on liquid and suction pipe connections to condensing unit.

.3 Install refrigerant controls supplied by condensing unit manufacturer. Install thermo-expansion valve on each DX coil liquid line with external equalizer connection. Provide valve complete with external remote bulb, set to provide 5.5°C superheat. Install solenoid pilot control with filter drier in external equalizer line for on-off control of refrigerant flow. Install Henry angle drier immediately upstream of thermo-expansion valve. Provide Henry sight glass between drier and valve only on DX coils located above air-cooled condensers.

.4 Provide initial charge of refrigerant R22 and oil, as well as any additional amounts required during system warranty.

.5 Provide manual valves as required to isolate individual system components to minimize refrigerant loss during replacement of individual components. Valves welded/brazed with Silfos to copper piping. No flare or compression fittings. No ball valves. Valves up to 5/8" - packless line by Streamline; 7/8" and larger - packed line by Globemaster, Streamline or Henry.

.6 Provide refrigeration equipment manufacturer - approved wiring diagram illustrating all electrical wiring for refrigeration system.

2.14 HVAC CONTROL SYSTEM

.1 Refer to Section 23 09 00 Instrumentation and Control for HVAC.

2.15 MATERIALS

.1 General

.1 The materials and workmanship shall be free from defects and of the highest quality that may be considered applicable for this aspect of the Work. All materials shall be new and shall comply with the standards of the ASHRAE Guide and Data Book; SMACNA HVAC Duct Construction Standards or other standards specified in this Section of the Technical Specification.

.2 Deviations from these standards and from specified materials or components mentioned in this Section of the Technical Specification must be submitted to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. The Contractor shall indicate in writing the manner in which the deviations are equivalent to or better than that specified herein.

.3 . Standard electrical and mechanical components and equipment shall be of North American manufacture unless otherwise specified.

.4 No patching, plugging shimming or other such means to overcome defects, discrepancies or errors shall be employed without the written permission of the Engineer.

.5 Similar parts shall be made to gauge where possible, to ensure that such parts are interchangeable one with the other. As minimum requirements, this aspect of the Work shall be carried out in accordance with CSA Standards B97.1, "Standard Tolerances for Linear Dimensions, Inch and Metric"; B97.2, "Interpretation of Limits and Tolerances"; and B97.3, "Standard Fits for Mating Parts".

.6 Screws, bolts, studs, nuts and other fasteners should preferably be of Canadian Standard with Canadian Unified Standard thread form in accordance with the CSA Standard B1.1 or ANSI Standard BN.182.37M. Pipe, flanges and fittings shall conform to ANSI Standards.

.7 All parts shall have at least the masses due to their drawing dimensions. Upon completion of the shop fabrication and machining, the Contractor shall provide the Engineer with a complete list of the finished mass of each unit.

.8 Fabrication tolerances for structural steel shall be in accordance with CSA Standard S16 unless otherwise noted on the Purchaser's Drawings or required to allow installation of the equipment to the manufacturer's tolerances.

.2 Material Specifications

.1 The Material specifications shown below shall be used as minimum requirements for the various components of this aspect of the Work.

.2 The Contractor shall be responsible for selecting the proper and significant tests for the material under consideration to ensure against hidden defects.

Item	Standard	Class or Grade
Steel Plate	CSA G40.21	350W
Structural Steel	CSA G40.21	350W
Bronze Bushings and Sleeves	ASTM B584	Alloy C93700
Galvanized Iron and Steel Products	Galvanized to ASTM A123	
Galvanized Sheet Metal	ASTM A525M, ASTM 527	
Hot Rolled Steel	ASTM A576 or 1035	Grade 1030
Springs	ASTM A689	
Aluminum and Aluminum Alloy Shapes	CSA HA.4.M1 H14	
Aluminum Alloy Shapes	CSA HA.5.GS10 T6	
Tubing	ASTM B888 Copper Tubing	Type K Hard
Piping	ASTM A53	Grade B
Fasteners for Aluminum Parts		300 Series

.3 Supports and Hangers

.1 For size and details of hangers and supports see the Purchaser's Drawings.

Part 3 Execution

3.1 GENERAL

.1 General execution of this aspect of the Work, including but not limited to Site fabrication, installation, examination, preparation, cleaning, testing, pre-commissioning, commissioning and Site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements, in addition to any specific requirements indicated below.

3.2 FINISHING

.1 All equipment not protected by a galvanized coating shall be painted in accordance with Section 09 90 00 Painting and Coating.

3.3 FABRICATION AND INSTALLATION

.1 All ductwork dimensions shown on the Purchaser's Drawings refer to the inside dimensions. For ducts which require internal acoustical or thermal insulation the dimensions shall be increased to allow for the thickness of the lining.

.2 The Contractor shall seal all openings around ducts, registers and grilles, in wall penetrations, in accordance with the National Building Code and NFPA guidelines.

.3 The installation shall be in accordance with the requirements of SMACNA Standards, and the recommendations of ASHRAE and the Canadian Electrical Code.

.4 The Contractor shall, before installation of this aspect of the Work, inspect and take field measurements of the Work, inspect and take field measurements of the Work done by

others in areas where its equipment is to be installed and shall notify the Engineer in writing if any conditions exist which would prevent the proper installation of its Work.

.5 The Contractor shall install this aspect of the Work complete and shall provide competent supervision in addition to all common and skilled labour required for this purpose. The handling, assembly and installation of this aspect of the Work shall be done in a careful and thoroughly workmanlike manner.

.6 The Contractor shall provide all temporary and permanent supports for ductwork, fans, duct heaters, controls and all other components, which comprise this aspect of the Work. The Contractor shall also provide all necessary scaffolding, falsework, slings, hoisting equipment, small tools, jacks, braces and all materials, supplies and Items whatsoever necessary or proper for complete installation of this aspect of the Work.

.7 The Contractor shall erect this aspect of the Work under ordinary job conditions and not necessarily those which it considers most desirable. Inclement weather, Work carried out by others in the immediate vicinity, the necessity of moving Materials from storage to the Site of erection and all other circumstances characteristic of construction Work are to be expected and will not be the basis for a claim for extra compensation.

.8 The Contractor shall schedule its Work at Site so that ducts installed above suspended ceilings or passing through interior partitions shall be completed at a time which will not delay progress of the building construction.

.9 Ducts

.1 Ducts shall be fabricated from galvanized copper bearing sheet steel and shall be classified on the Purchaser's Drawings and Contractor's Documents in the following manner:

.1 Duct Pressure Classification 2: Duct Pressure Up to 500 Pa.

.2 Duct Pressure Classification 4: 500 to 1,000 Pa.

.2 Ductwork which does not have a duct pressure classification noted on the Purchaser's Drawing shall be assumed to be Class 2.

.3 Fabrication and installation of ductwork shall be performed in accordance with applicable codes and regulations as listed in Section 1.3.2 of this Section of the Technical Specification. Outdoor ductwork shall be two gauges heavier than required by the above codes and regulations. It shall be reinforced to withstand snow pressure and wind pressure as per the latest edition of the National Building Code. The reinforcing shall be arranged so that corrosion cannot occur and the rain and snowmelt can run off without leaving puddles.

.4 All rectangular ducts, elbows, and transitions shall be constructed using approved longitudinal and transverse joints. Open corners shall not be permitted. All laps shall be in the direction of airflow. Rivets and bolts shall be used throughout the fabrication and installation. All edges and slips shall be hammered down to leave a smooth interior.

.5 An alternative joint which may be used for the above and for removable duct sections is "Nexus, the 4-bolt Duct connection system" by Exanno Products Limited, or the Purchaser's approved equivalent.

.6 Bolted flange joints shall be fabricated of steel plate of angle iron having a material thickness and bolt spacing in accordance with the applicable standards.

.7 Unless otherwise indicated, all tees, bends, and elbows shall be constructed with a centre line radius of not less than 1.5 times the width of the duct. Where square

elbows are used, double thickness turning vanes shall be installed. All elbows 1,200 mm (48 in.) and greater shall be provided with duct runs in segments of 600 mm (24 in.) maximum.

.8 All uninsulated ductwork shall be cross-broken. If ductwork is insulated cross breaking may be omitted, providing the duct is fabricated from sheet metal which is two gauges heavier than that required by the applicable standards.

.9 All plenums and fresh air intakes shall be made of 16 gauge minimum thickness galvanized steel with angle iron reinforcing.

.10 Elbows in round ductwork shall have a centerline radius of 1.5 times the diameter and shall be fabricated from a minimum of four pieces.

.11 Ducts and plenums shall be constructed to withstand the full shutoff pressure of the fans. Single thickness partitions between ducts shall not be accepted. Openings for thermostats and controllers shall be provided in the ductwork as required.

.12 At points within the air system where air streams at different temperatures meet, baffling shall be installed for a good mix. Locations of baffling shall be approved by the Engineer.

.13 Where ductwork conflicts with mechanical and/or electrical installations and it is not possible to divert ductwork or piping to stay within allowable space limitations, streamliners shall be provided. Streamliners are not required for pipes with outside dimensions 100 mm and smaller, unless this exceeds 20% of the duct area. Irregular or flat shaped piping requires streamliners. Hangers and stays in the ductwork shall be parallel to the airflow. If a streamliner exceeds 20% of the duct area, the duct shall be split into two ducts with the original duct area being maintained. Streamliners shall be approved by the Engineer before installation.

.14 If ductwork is not adequately braced and/or supported as determined by the Engineer, additional bracing and/or supports shall be provided at no extra cost to the Purchaser. The Engineer shall review the additional bracing requirements.

.10 Diffusers

.1 Diffusers shall be installed in co-ordination with all related sub-trades so that they fit properly in ceiling suspension system.

.11 Hangers and Supports

.1 Hangers and supports shall be installed as shown on the Purchaser's Drawings, as indicated in this Section of the Technical Specification, as required to adequately support the ducts and associated equipment, and to provide for expansion and contractions. Ducts shall be supported on either side of each piece of equipment. Supports shall be designed to have adequate strength and rigidity and not stress the building construction.

.2 Install hangers and supports at 2.4 m centres maximum. Provide angles or channels as required between building steel where spacing does not coincide with the required hanger spacing. Attach hanger rods, angles and straps to beam clamps, concrete inserts or as shown on the Purchaser's Drawings and Contractor's Documents.

.3 All rectangular ductwork shall be supported by trapeze supports in accordance with the following schedule:

Half of Duct Perimeter	Hanger Rod Size	Angle	Spacing
Up to 1,800 mm	1/4 in. dia.	25 x 25 x 3 mm	2.4 m
1,800 to 2,400 mm	3/8 in. dia.	35 x 35 x 3 mm	2.4 m
2,400 to 4,300 mm	1/2 in. dia.	35 x 35x3 mm	2.4 m
43,000 and larger	1/2 in. dia.	35 x35x 3 mm	1.2 m

.4 Ductwork supported by wall brackets shall have the same spacing as above. Vertical ducts shall be supported at every floor, or 3.5 m maximum, with angle iron collars sized to provide proper bearing.

.5 Where hanger rods are attached to structural steel Grinnell Figure 87 or the Purchaser's approved equivalent, malleable iron C-clamps shall be used for rod sizes up to 3/8 in. For rod sizes greater than 3/8 inch Grinnell Figure 229 malleable beam clamps or Figure 228 forged steel beam clamp, or Purchaser's approved equivalent shall be used.

.6 Round ductwork shall be supported by a minimum 25 mm wide x 12 gauge hanger strap and a single or double 3/8 inch diameter rod 3.0 m centers. For ducts over 1,270 mm diameter two straps and rods shall be used in accordance with the applicable standards.

.7 The hanger rods shall be attached to channel inserts in uninsulated concrete or to channels provided in insulated surfaces. Where direct connection to a channel insert is not possible the hanger shall be secured to a structural steel member, which is attached to two adjacent inserts. Failing this the Contractor shall place Hilti HVA adhesive anchor, or Purchaser's approved equivalent, Contractor shall ensure that placement of anchors does not weaken the concrete.

.12 Duct Sealing: All ductwork shall have sealed joints and seams. Duct sealant shall be applied as follows:

.1 Exterior ductwork shall be constructed with the top sloped a minimum of 12 mm (1/2 in.) per 300 mm (12 in.). All joints shall be sealed by an application of TREMCO Mono Black Acrylic, or the Purchaser's approved equivalent, sealant applied with a gun and levelled with a putty knife. Material shall be applied in accordance with the manufacturer's recommendations.

.2 For ductwork carrying outdoor air from the inlet to the mixed air plenum or filter Section Duro-Dyne S-2 duct sealer and FT-2 fibreglass duct tape or the Purchaser's approved equivalent shall be used. Sealant shall extend 25 mm on each side of the joint or seam and be applied in accordance with manufacturer's recommendations.

.3 For all other ductwork use Duro-Dyne S-2 duct sealer or Purchaser's approved equivalent. Sealant shall extend 25 mm on each side of the joint or seam. Sealant shall be applied in accordance with manufacturer's recommendations.

.13 Rectangular Ducts: Flexible connections in rectangular ductwork and at air handling units shall be manufactured of ULC approved, flameproof, neoprene coated 24-ounce fibreglass, and 24 gauge sheet metal. The connection shall be preassembled, 75 mm metal, 75 mm fabric, 75 mm metal with a double seam folded back to form a metal shield on both sides of the fabric. Duro-Dyne metal-fab flexible connections or the Purchaser's approved equivalent shall be provided.

.14 Round Ducts: Flexible connections located on round ductwork and at axial flow fans shall be neoprene coated 24 ounce fibreglass cloth secured to companion flanges with

drawbands. Joints shall be cemented. The flexible connection on the inlet end of a fan shall be reasonably tight to prevent the formation of vena-contracta.

.15 Diffuser Connections: Provide a minimum of three duct diameters upstream of a diffuser to obtain the manufacturer's performance rating. Otherwise, provide equalizing grid in diffuser neck.

.16 Access Doors: Airtight and insulated access doors shall be provided at all electrical duct heaters, fire dampers and motorized dampers in a suitable location to facilitate inspection and servicing and at the inlet and outlet of axial fans. The doors and frames shall be fabricated in accordance with SMACNA HVAC Duct Construction Standards. Galvanized hinges with bronze pins shall be installed on the long dimension and shall be sized to accommodate door weight. Where indicated on the Purchaser's Drawings, Brixon pressure release safety latches or the Purchaser's approved equivalent shall be installed. These latches shall provide duct over-pressure relief and shall be selected in accordance with manufacturer's recommendations.

.17 Turning Vanes: Turning vanes shall be hollow air foil type installed on a Duro Dyne or Purchaser's approved equivalent, preformed vane guide rail manufactured from minimum 24 gauge galvanized steel or Purchaser's approved equivalent. Turning vanes shall be a maximum of 100 mm on centre and shall be designed to provide smooth linear flow for the various duct sizes and aspect ratios. Turning vanes shall be fabricated and installed in accordance with the manufacturer's recommendations where shown on the Purchaser's Drawings. Ducts 900 mm and more in width shall have two vanes of equal length installed with the intermediate guide rails riveted together.

.18 Splitter Vanes: Elbows with a centerline radius of less than 1.5 times the width shall be supplied with three vanes. The vanes shall be shaped to the required radius and welded to the ductwork.

.19 Air Intake Hood: Hoods shall be fabricated in accordance with SMACNA HVAC Duct Construction Standards. A 12 mm mesh galvanized bird screen shall be provided. The hood shall have insulation, which shall be held on with metal clips.

.20 Pitot Tube Test Opening Enclosures: Lawson-Taylor or Purchaser's approved equivalent 18 gauge cadmium-plated, deep-drawn flange type enclosure complete with gaskets and quick-lok cap retained by a ball chain shall be provided. At insulated ductwork, a quick-lok extension complete with neoprene prolite insulating plug shall be used. The openings shall be located in ductwork at supply fan discharges, on the intake of exhaust and return air fans, in hot and cold ducts coming off plenums, in major duct branches and everywhere that a pitot tube is required for proper balancing of air conditioning, ventilation and exhaust systems. They shall not be placed closer than 2 m to elbows and shall be spaced every 150 mm across the air stream at each location. The Purchaser's Drawings shall be referred to for additional opening requirements.

.21 Wall Relief Air Openings: Openings shall be located in walls above ceilings to allow the passage of relief and return air. A sleeve 50 mm greater than the wall thickness and made from 1.2 mm galvanized metal shall be provided. Openings located in fire rated walls shall have sleeves complete with fire dampers.

.22 Electrical Installation: Electrical installation in accordance with Section 26 05 00 Electrical General Requirements.

3.4 SITE QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 The Contractor shall submit three copies of its inspection and test program before this aspect of the Work commences. The Purchaser will return one copy to the Contractor indicating the inspection and tests it may wish to witness.

.3 Whether the inspection and/or tests take place at the Contractor's factory or at the factory of a Subcontractor, the Contractor shall supply all necessary labour, Material, equipment, apparatus, instruments and competent personnel who will take complete charge of the inspection and/or tests. These personnel shall be authorized to represent and make decisions for the Contractor for the proper carrying out of the inspection and/or tests to the entire satisfaction of the Engineer.

.4 If the Purchaser so requires, instruments used for testing shall be calibrated at the expense of the Contractor.

.5 Shop Inspection

.1 The Purchaser reserves the right to appoint Quality Assurance Representative(s), referred to herein as QAR, to perform inspection and quality assurance services on this aspect of the Work performed at the Contractor's shop and at those of its Subcontractors.

.2 The Contractor shall provide office space for use by the Purchaser's QAR while engaged in shop inspection of this aspect of the Work. The QAR shall have free access to all areas in the shop or shops where this aspect of the Work is being performed. The Contractor shall provide unpriced copies of all purchase orders issued for the Work to the QAR for attachment to its inspection reports.

.3 The Contractor shall indicate on all of its purchase orders that "This order is subject to inspection by Engineer".

.6 Shop Tests

.1 Destructive and non-destructive tests of Materials shall be made by the Contractor as required by the Technical Specification and by the appropriate Material standard. Such tests shall be at the expense of the Contractor and shall be in accordance with the CSA, ASTM or other applicable standards. All tests performed by the Contractor or its Subcontractor may, at the Purchaser's option, be witnessed by the Purchaser's QAR and an electronic and a hard copy of all test reports shall be given to the QAR, without delay, prior to further fabrication, for inclusion in its inspection reports.

3.5 SITE TESTS, BALANCING AND PRE-COMMISSIONING

.1 Procedures and Reports

.1 The Contractor shall submit, for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, details of its proposed installation and testing procedures.

.2 Testing

.1 The Contractor shall perform all Site tests of individual components and completed systems to demonstrate that the assembled Work meets the

requirements of this Section of the Technical Specification. Site tests shall be recorded on standard test forms documenting required tolerances and test values obtained. Site tests shall include final drive alignment readings after equipment has been installed and operated.

.2 The Contractor's proposed schedule of testing shall meet the dates given in the Contract Schedule provided in Appendix A – HVAC Schedules.

.3 The tests shall be performed in the presence of, and to the satisfaction of, the Engineer. Any defects, which become evident during the tests, shall be immediately corrected. Equipment, which does not meet guaranteed performance standards, shall be repaired or replaced to the satisfaction of the Engineer, at no additional cost to the Purchaser. The tests shall be continued and adjustments made until the installation is proven satisfactory by the Engineer.

.4 Pre-commissioning Tests:

.1 The Contractor shall provide all necessary test instruments, which shall be accurately calibrated. Checks and tests shall include, but not be limited to:

.1 Check and prove alignment of all equipment drives.

.2 Initial equipment lubrication where required.

.3 Check and prove phase rotation of all motors.

.4 Complete control wiring check.

.5 Dielectric test on wiring.

.6 Operational checks on equipment and controls.

.3 Balancing

.1 After installation of each system, the air flow shall be balanced to produce the desired volumes as designated on the Purchaser's Drawings at each inlet and outlet. The capacity, speed and power consumption of each fan shall be checked and the supply, return, exhaust and make-up air dampers and fans shall be adjusted.

.2 Balancing of the systems shall be done in accordance with the SMACNA "Manual for the Balancing and Adjustment of Air Distribution Systems" augmented by the following requirements:

.1 Locate each main duct and branch duct damper on as-built Drawings.

.2 Approved instruments shall be used for testing duct and diffuser air-balance. Correct "k" factors shall be obtained from the manufacturer of the grilles and diffusers.

.3 All air outlet and inlet readings shall be tabulated on a proper report sheet showing the following information:

.1 Room location and floor elevation.

.2 Outlet or inlet number in sequence working back towards fans.

.3 Model, size and core area.

.4 Design flow rate (L/s).

.5 Instrument reading.

.6 Calculated flow rate (L/s).

.3 All equipment readings shall be tabulated on a proper report sheet showing the following information:

.1 Make, size and type of unit, including all accessories.

.2 Design air flow - actual final air flow.

.3 Design static pressure - actual final static pressure (tabulated).

.4 Design RPM (fan) - actual final RPM (fan).

.5 Design HP - actual developed HP.

.6 All entering and leaving air temperatures at coils and mixing areas in ductwork.

.4 All readings shall be taken with the system in normal operation. A separate balance report shall be submitted for each system.

.5 The Contractor shall notify the Engineer, before installation of this aspect of the Work, if, in the Contractor's opinion, additional dampers are essential to balance the systems.

.6 The balancing instruments shall be approved by the Engineer and shall be accurately calibrated. Status pressures shall be measured by Pitot tube and manometer. Velocities shall be measured by velometers complete with necessary jets.

3.6 COMMISSIONING

.1 After the Contractor has completed all balancing, testing and pre-commissioning activities and turned over an operational system to the Purchaser, final commissioning will be performed by the Purchaser.

.2 Contractor shall provide commissioning support as requested by the Purchaser.

3.7 MAINTENANCE

.1 Procedures shall be detailed in accordance with the requirements set out in Subsection 21.7.12 Operation and Maintenance Manuals of the General Specification.

3.8 TRAINING

.1 Refer to Section 23 09 00 Instrumentation and Control for HVAC.

APPENDICES

APPENDIX A - HVAC SCHEDULES

END OF SECTION

Appendix A
HVAC Schedules

Part 1 General

1.1 SECTION INCLUDES

.1 This Section defines the requirements for the supply, installation and connection, and field pre-commissioning of the Unit Control and Monitoring System (UCMS) for the Keeyask Generating Station.

.2 The Unit Control and Monitoring System provides the generating station operations personnel with an interface to the status and control of each generator and associated auxiliary equipment. Included in the scope of the UCMS is equipment monitoring, automatic system control, interlocking, historical data storage, alarm annunciation and operator interface. The UCMS consists of a network of programmable logic controllers (PLCs), server computers and Human-Machine Interface (HMI) stations; the Purchaser's Drawings provide an overview of the planned system for the Keeyask Generating Station as well as installation details of typical UCMS systems.

.3 Typical UCMS functions will include:

.1 Acquiring data from the field devices, Intelligent Electronic Devices (IED), Programmable Logic Controllers (PLCs) and ancillary systems.

.2 Processing the field data to generate alarms and other significant process events.

.3 Presenting the data to operations staff through indicators, meters, graphical displays and reports.

.4 Performing control functions automatically or through operator action while respecting interlocks. Updating set points for selected systems.

.5 Performing system monitoring and diagnostics.

.6 Interfacing to select local switchyard controls and/or the switchyard control and monitoring system.

.7 Interfacing with the Station Remote Terminal Unit (RTU) to facilitate remote control and monitoring from the System Control Centre (SCC).

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wire and Cable Systems.

.4 Section 26 05 28 - Surface Grounding.

.5 Section 27 00 00 - Communication Systems.

.6 Section 33 72 00 - Unit Protection and Control System.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 CSA C22.1 - Canadian Electrical Code, Part I.

.2 CSA C22.2 - Canadian Electrical Code, Part II.

.3 CSA C22.2 No. 14 - Industrial Control Equipment.

.4 CSA Z462 - Workplace Electrical Safety.

.5 IEEE C37.1 - Standard for SCADA and Automation Systems.

.6 IEEE 1249 - Guide for Computer-Based Control for Hydroelectric Power Plant Automation.

.7 IEEE Std. 1050 - IEEE Guide for Instrumentation and Control Equipment Grounding in Generating Stations.

.8 IEEE Std. 1046 - IEEE Application Guide for Distributed Digital Control and Monitoring for Power Plants.

.9 IEEE Std. 1010 - IEEE Guide for Control of Hydroelectric Power Plants.

.4 Reference Documents

.1 Facility 3D model.

.2 Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity or deliverables of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurements

.1 Measurement for equipment Items 25 11 00 (a), 25 11 00 (b), and 25 11 00 (d) shall be based on the quantity as shown on the Purchaser's Drawings, Contractor's Document and as directed by the Engineer.

.2 No separate measurement shall be made for Item 25 11 00 (c).

.3 Unit Price

.1 The unit prices for Items 25 11 00 (a) - UCMS Network Equipment Supply and Installation, and 25 11 00 (b) - Line Protection System fibre Termination Panels, Supply and Install, in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply, Site storage, Site handling, preparation of surface for installation and installation

including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, touch-up painting, and hand over documents as specified herein, and as directed by the Engineer.

.2 The estimated cost for Items 25 11 00 (c) - Control Room Operator Desks and Interfacing to Viewers and the Facility Systems, in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the design, supply and installation including hardware for assembly and fixing onto control room floor and interfacing with supplies, data network and monitoring systems as specified herein, and as directed by the Engineer.

.3 The unit prices for Items 25 11 00 (d) - Unit Control and Monitoring System PLC Installation in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving, unloading, storage, Site handling, preparation of surface for installation and installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, touch-up painting, and hand over documents as specified herein, and as directed by the Engineer for Unit Control and Monitoring PLC.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Closeout Submittals

.1 Drawings:

.1 Field as-built record of UCMS panel interconnection drawings.

.2 Field as built drawing of equipment supplied by Contractor.

.3 Field as-built record of any revisions (including equipment relocations, wiring revisions and communication network revisions) made to the design drawings during construction.

.2 Test Reports:

.1 Record of all field tests and pre-commissioning tests.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 The submission for the UCMS system shall include:

.1 Brochures, specifications, drawings and manuals of equipment being supplied under this Section of the Technical Specification for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Field Inspection and Test Plan: Submit field inspection and test plan covering receipt of material at Site, storage, field installation, testing, and connections to integrate with the other systems. Work instructions shall be submitted for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.3 Field Inspection and Test Reports: Submit field inspection and test reports for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading.

.1 Site receiving, handling and storage in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification and vendor instructions.

.2 The Contractor shall inspect the equipment upon receipt and submit an inspection report to the Engineer identifying any defects or damage.

.3 Heated storage is required for the UCMS equipment if the facility is not ready for installation.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 SCOPE

.1 The Contractor shall be responsible for supply, delivery to Site, installation and pre-commissioning of:

.1 UCMS Network Equipment:

.1 Service Bay Fibre Termination Panel 1, SB1-FTP.

.2 Service Bay Fibre Termination Panel 2, SB2-FTP.

.3 Powerhouse Fibre Termination Panel 1, PH1-FTP.

.4 Powerhouse Fibre Termination Panel 2, PH2-FTP.

.5 Intake Fibre Terminal Panel.

.6 Spillway Fibre Termination Panel 1, SP1-FTP.

.7 Miscellaneous FTPs in powerhouse and spillway adjacent to equipment.

.2 Line Protection System Fibre Termination Panel:

.1 Line Fibre Termination Panel 1.

.2 Line Fibre Termination Panel 2.

.3 Line Fibre Termination Panel 3.

.4 Line Fibre Termination Panel 4.

.3 Cables Connections:

.1 AC and DC auxiliary cables for equipment supply.

.2 Discrete input and output (I/O) cables from the field devices to the UCMS system cubicles and desks.

.3 Instrumentation cables from the field devices to the UCMS system cubicles.

.4 PROFINET and Modbus Ethernet cables from the UCMS to the field I/O blocks.

.5 Ethernet cables from field devices to switches in UCMS switches.

.6 Fibre optic cables between the Fibre termination panels, from fibre termination panels to UCMS system equipment and from UCMS cubicle to minor FTPs adjacent to equipment, and from minor FTPs to the equipment.

.7 Media converters required to convert serial copper to Fibre/Ethernet or Ethernet copper to Fibre.

.4 Grounding and Bonding:

.1 Grounding pigtails from the main exposed network to the UCMS equipment grounding bars including connectors and terminals.

.2 The Contractor shall be responsible for design, supply, delivery to Site, and installation of:

.1 Control Room Operator Desks and Interfacing to Viewers and the Facility Systems:

.1 Operator desks for operators in the control room.

.2 Furniture in the control room.

.3 Raceways and wire duct for interfacing the desk with the desk Viewer (Viewer 1 and Viewer 2), larger viewer (Viewer 3) on the wall and other infrastructure in the control room.

.3 The Contractor shall be responsible for receiving equipment at Site shipped by others, handling and storage, installation and pre-commissioning of:

.1 UCMS Server Cubicle A.

.2 UCMS Server Cubicle B.

.3 Station PLC Panel(s).

.4 Unit 1 PLC Panel(s).

.5 Unit 2 PLC Panel(s).

.6 Unit 3 PLC Panel(s).

.7 Unit 4 PLC Panel(s).

.8 Unit 5 PLC Panel(s).

.9 Unit 6 PLC Panel(s).

.10 Unit 7 PLC Panel(s).

.11 Auxiliary PLC 1 Panel(s).

.12 Auxiliary PLC 2 Panel(s).

.13 Spillway PLC Panel(s).

.14 Remote I/O Panels,

.1 Auxiliary 1 Remote I/O Panel A.

.2 Auxiliary 1 Remote I/O Panel B.

.3 Auxiliary 2 Remote I/O Panel A.

.4 Intake Remote I/O Panel A.

.5 Intake Remote I/O Panel B.

.6 Spillway Remote I/O Panel A.

.7 Spillway Remote I/O Panel B.

.15 Air Gap Monitoring (AGM) server.

.16 Viewer 1 and Viewer 2 on the control desks in the control room.

.17 Viewer 3 on the wall in the control room.

.4 The Contractor shall provide support during commissioning to integrate the UCMS system with the generating facility in accordance with the requirements set out in Section X (insert title) of the General Specification.

.5 Work Excluded:

.1 Detail engineering, supply and delivery to Site of Unit Control and Monitoring equipment including Remote I/O panels.

.2 Programming of PLCs, Ethernet Switches, Routers, Gateways, and HMI system.

.3 Satellite Clock supply and installation.

.4 Supply of Control Room HMI Viewers.

.5 Supply of Engineering Workstation.

.6 Supply of Laptop.

.7 Supply of Ancillary Workstation.

.8 Supply of Air Gap and Vibration Monitoring Server.

.9 Supply of Communication Room fibre termination racks for connections to switchyard and the area fibre optic network.

.10 Commissioning of UCMS system with the rest of the plant system - Contractor assistance will be required on an as-needed basis.

2.2 EQUIPMENT DESCRIPTION

.1 General

.1 The final design of the UCMS system shall be to be performed by the Purchaser and its Consultants.

.2 The UCMS will consist primarily of a computer-based control system, hard-wired logic or programmable logic, indicating and recording instruments, control switches, control relays, and similar equipment to realize the functions described in Part 1 of this Section of the Technical Specification.

.3 A description of the overall system overview is provided in the Purchaser's Drawings. The capacity of the system can be estimated from the I/O list and the specification drawings, and the typical equipment details are included in tender reference drawings.

.2 UCMS Server Cubicles

.1 The UCMS design will include redundant servers to provide primary and secondary functionality for the GE Proficy HMI software. These servers will be 19" rack mounted and will be located in separate secure rooms, UCMS Room 'A' and 'B'.

.3 Programmable Logic Controllers (PLC)

.1 The design will be based on GE model RX3I PLCs with combination of rack I/O and PROFINET remote I/O.

.2 Station PLC:

.1 The Station PLC will be located in UCMS Room A.

.2 The Station PLC shall provide the following functionality and monitoring of:

.1 Joint Load Control - Common Controls.

.2 Joint VAR Control - Common Controls.

.3 Miscellaneous Alarms.

.4 UCMS Alarms.

.5 Fire System.

.6 Inverters.

.7 Communication Room Alarms.

.8 Communication Room Temperature.

.9 UCMS Room Temperature.

.10 48 VDC system Alarms.

.11 Interface to PAX system for alarm paging.

.12 Switchyard 'A' Interface.

.13 SCC/RTU Interface.

.4 Unit PLC

.1 Each unit will have its own PLC for a total of seven PLCs. These will be located on the mezzanine floor in the unit control cubicles.

.2 The remote I/O modules associated with a unit PLC will be located in the unit control cubicles, generator instrumentation panel, turbine instrumentation panel, and intake panels.

.3 The local control panel will have the following controls and indications:

.1 Stator Voltage Control Switch.

.2 Generator Speed Control Switch.

.3 Generator Load Control Switch.

.4 Power Meter EPM6000.

.5 Synchronizing Voltmeter.

.6 Synchroscope.

.7 Synchronizing Frequency Meter.

.8 Control Transfer Switch.

.9 Generator Breaker Open/Close Switch and Indication.

.10 Ground Disconnects Open/Closed Indication.

.11 Transformer Disconnect Open/Closed Indication.

.12 Auto/Manual Synchronizer Selection Switch.

.13 Generator Control - 1CS Start/Stop Switch.

.14 Intake Gate Trip Switch.

.15 Emergency Trip Switch.

.16 Automatic Synchronizer.

.17 Deluge Auto/Man Switch.

.18 Sync-check relays shall be provided to supervise both the automatic and manual synchronizing functions.

.19 The Local Control Panel for Units 1, 3, 5, and 7 shall also have the following indications:

.1 Station Service Disconnect Open/Closed.

.2 Station Service Breaker Open/Closed Indication.

.5 Auxiliary 1 PLC

.1 The Auxiliary 1 PLC will be located in the electrical gallery near Unit #1.

.2 The Auxiliary 1 PLC will have two remote I/O panels (Panel A and Panel B) located near SST2 and in service bay respectively.

.3 The Auxiliary 1 PLC will provide functionality and monitoring for:

.1 Miscellaneous Station Alarms.

.2 Forebay Water Level.

.3 Load Centre LC-PH1.

.4 Load Centre LC-PH2.

.5 Battery Charger BC-PH1A.

.6 Battery Charger BC-PH1B.

.7 DCDP-PH1.

.8 Station Service SS1.

.9 Station Service SS1 EPM6000.

.10 Station Service Transformer SST1.

.11 Station Service Transformer SST1 Qualitrol.

.12 Station Service Disconnect 89-SST1.

.13 Station Service SS2.

.14 Station Service SS2 EPM6000.

.15 Station Service Transformer SST2.

.16 Station Service Transformer SST2 Qualitrol.

.17 Station Service Disconnect 89-SST2.

.18 Black Start Diesel Generator DG1BS.

.19 Diesel Switchgear BSSG1.

.20 ATS1.

.21 ATS2.

.22 MCC-PH01.

.23 MCC-PH02.

.24 MCC-PH03.

.25 Intake MCC-IT1.

.26 DCMCC-PH1.

.27 Dewatering Sump – Between Units 2 and 3.

.28 Clearwater Sump – Between Units 2 and 3.

.29 Control Building Elevator.

.30 HVAC Alarms.

.31 Water Treatment Plant.

.32 Waste Water Treatment Plant.

.33 Diesel Fire Pump.

.34 Electric Fire Pumps.
.35 Air Compressors.
.36 Air Receivers.
.37 Service Bay Elevator.
.38 Bulk Oil Tank Monitoring.
.39 Load Centre LC-SB1.
.40 Load Centre LC-SB2.
.41 MCC-SB1.
.42 MCC-SB2.
.43 MCC-SB3.
.44 SCC/RTU Interface.

.6 Auxiliary 2 PLC

.1 The Auxiliary 2 PLC panel will be located near SST4 in the electrical gallery.
.2 The Auxiliary 2 PLC will have one remote I/O panel located adjacent to SS3 in the electrical gallery.
.3 The Auxiliary 2 PLC will provide functionality and monitoring for:
.1 Miscellaneous Station Alarms.
.2 Powerhouse South Transition Elevator.
.3 HVAC.
.4 Tailrace Water Level.
.5 Load Centre LC-PH3.
.6 Load Centre LC-PH4.
.7 Battery Charger BC-PH2A.
.8 Battery Charger BC-PH2B.
.9 DCDP-PH2.
.10 Station Service SS3.
.11 Station Service SS3 EPM6000.
.12 Station Service Transformer SST3.
.13 Station Service Transformer SST3 Qualitrol.
.14 Station Service Disconnect 89-SST3.
.15 Station Service SS4.
.16 Station Service SS4 EPM6000.
.17 Station Service Transformer SST4.
.18 Station Service Transformer SST4 Qualitrol.
.19 Station Service Disconnect 89-SST4.
.20 Black Start Diesel Generator DG2BS.
.21 Diesel Switchgear BSSG2.
.22 ATS3.
.23 MCC-PH04.
.24 MCC-PH05.
.25 MCC-PH06.

.26 MCC-PH07.
.27 Intake MCC-IT2.
.28 DCMCC-PH2.
.29 Powerhouse Temperature @ Unit 4.
.30 Dewatering Sump - Between Units 5 and 6.
.31 Clearwater Sump - Between Units 5 and 6.
.32 Switchyard B Interface.
.33 Off-site Line Power EPM6000.
.34 Switchyard Feed Power EPM6000.
.35 SCC/RTU Interface.

.7 Spillway PLC

.1 The spillway PLC cubicle will be located in the spillway electrical room at the north transition.

.2 The spillway PLC panel will have two remote I/O panels located in spillway hoist housing between Gates 1 and 2, and between Gates 6 and 7.

.3 The spillway PLC shall provide the following functionality and monitoring of:

.1 Miscellaneous Spillway Alarms.
.2 Spillway Control & Monitoring.
.3 Spillway Fire System Alarms.
.4 Spillway Horn Supply Fail Alarm.
.5 Load Centre LC-SP1.
.6 Load Centre LC-SP2.
.7 Load Centre LC-SP1 EPM6000.
.8 Load Centre LC-SP2 EPM6000.
.9 24 VDC Battery Charger SP-BC1.
.10 Spillway Diesel Fire Pump.
.11 Spillway Diesel Generator SP-DG1.
.12 Spillway Diesel Switchgear.
.13 ATS5.
.14 MCC-SP1.
.15 MCC-SP2.
.16 MCC-SP3.
.17 SCC/RTU Interface.

.8 Fibre Termination Panel Cubicles and Enclosures

.1 The proposed location of fibre termination panels are as follows:

.1 Service bay FTP Cubicle 1 SB1-FTP in UCMS Room A.
.2 Service bay FTP Cubicle 2 SB2-FTP in UCMS Room B.
.3 Powerhouse 1 FTP PH1-FTP near SST1.
.4 Powerhouse 2 FTP PH2-FTP near SST4.
.5 Intake FTP in intake gallery between Units 4 and 5.
.6 Spillway FTP cubicle SP-FTP near north transition at spillway.

.7 Line 1 FTP between Units 1 and 2 in electrical gallery wall mounted.

.8 Line 2 FTP between Units 3 and 4 in electrical gallery wall mounted.

.9 Line 3 FTP between Units 4 and 5 in electrical gallery wall mounted.

.10 Line 4 FTP between Units 6 and 7 in electrical gallery wall mounted.

.11 Small FTPs wall mounted adjacent to the equipment.

.2 Fibre termination panel and module shall be by ADC, with capacity indicated in the Purchaser's Drawings.

.3 The fibre used is predominantly multimode 62.5 micron fibre except the connections between the spillway and powerhouse.

.9 Control Room

.1 The control room shall be designed to promote operator efficiency, reduce errors and provide a secure environment.

.2 The operator consoles shall be modular in design and construction and of high industrial quality. They shall be capable of being expanded in the future to add additional modules and positions.

.3 The consoles shall be ergonomically designed to provide a suitable work surface with easy access to the computers.

.4 The workstation computers shall be located remotely in the UCMS rooms and Matrox KVM extenders shall be used to extend the keyboards, monitors and mice into the control room.

.5 The consoles shall be specifically designed to work with flat panel monitors mounted on open frames or arms above the console.

.6 The control room shall have two independent operator HMI workstations consisting of two monitors each. The workstation monitors will be as a minimum 24" measured diagonally with high resolution graphics (minimum 1,600 pixels x 1,200 pixels).

.7 A large screen monitor shall be mounted on the wall (or ceiling) as a third viewer. This viewer shall not be supplied with a mouse or keyboard.

.8 The Synergy software shall be used to share the viewer 1 and 2 mouse and keyboard with viewer 3.

.9 A second large screen monitor shall be used for the security Closed Circuit Television (CCTV) system.

.10 The operator HMI workstations will not all be powered from the same source.

.11 Loose hardware, such as computers, placed inside the console, shall utilize pull-out drawers or shelves to allow easy access for maintenance and service of the equipment.

.12 Any control, power or communication cables entering the consoles shall be terminated on terminal blocks, jack panels or fibre termination panels as required.

.13 Separate jack panels for MH's phones and corporate LAN shall be provided where required.

.14 Racks will be provided in the console for any rack mounted equipment.

.15 The UCMS workstations, monitors and other equipment deemed critical shall be fed from power bars placed under the removable console panels. These power bars shall be fed from separate inverter sources to provide redundancy.

.16 The hardwired unit emergency trip buttons will be located on the desk.

.17 The UCMS colour printer and the Purchaser's corporate printer shall be located in the control room.

.10 Networking

.1 General:

.1 The network infrastructure is redundant except for the PLC, Telemetering and RTU Ethernet switches.

.2 For the control networks, a tree topology using redundant trunks between the switches servers and workstations shall be used. The network link from individual devices or PLCs to the switches shall be without any redundancy.

.3 The main Ethernet Switches have redundant supplies while the other Ethernet Switches are fed from redundant supplies.

.4 Distributed managed Ethernet Switches shall be located at the PLC cubicles.

.5 The Ethernet Switches shall have virtual local area networks (VLANs) configured for the various sub-networks required.

.6 The VLANS shall be used to separate and isolate traffic between equipment.

.7 The HMI VLAN shall be connected to the UCMS and data Historian servers and viewers. The PLC VLAN shall be connected the servers, PLC, and RTU.

.8 Only the servers and the engineering workstation can have communication to both the HMI and PLC VLANs.

.9 The redundant fibre networks shall be kept physically separated as much as possible (coming together only to enter certain cubicles).

.2 Main Ethernet Switches:

.1 The main Ethernet Switches shall be RuggedCom. The layout of the plant will determine how many of these switches are required.

.2 The switches shall be powered from the inverters or 125 Vdc as required.

.3 These switches shall be physically separated to avoid any common mode failure in order to meet the network link redundancy requirements.

.3 PLC Ethernet Switches:

.1 The PLC Ethernet Switches shall be RuggedCom.

.2 There shall be one switch for each PLC, the RTU and the Telemetering.

.3 These switches shall be powered from the redundant 24 Vdc power supplies in each panel.

.4 The switches shall incorporate the highest levels of Network Security by limiting access to the network and network management functions only to personnel and computers that have been authenticated through appropriate security measures. NERC CIP security requirements shall be complied with.

.4 PROFINET LAN:

.1 PROFINET protocol shall be used to communicate with remote I/O and with auxiliary equipment.

.2 The PROFINET LAN shall utilize a ring topology to provide high availability. It shall use the Media Redundancy Protocol (MRP) which allows for implementing a network without the need for switches.

.3 Devices shall have two ports to be daisy chained to the next device.

.5 Industrial Data Network (IDN):

.1 The Industrial Data Network (IDN) Wide Area Network (WAN) shall provide a secure path for accessing remote sites or transporting data.

.2 All access to the IDN WAN shall be through authentication servers located off-Site.

.3 Depending on NERC restrictions, the IDN WAN shall provide a path for local and remote maintenance on the HMI, PLCs, and RTU. For this purpose, Virtual Routing & Forwarding (VRF) groups shall be provided on the IDN WAN.

.4 Firewall shall be provided between the IDN and UCMS LANS as well as between the IDN and the RTU/Telemetering.

.5 The following equipment shall be connected to the IDN.

.1 Station RTU.

.2 Telemetering.

.3 Transient Fault Recorders (TFR).

.4 Protective Relays.

.5 Revenue Metering.

.6 UCMS Server Out of Band Ports.

.7 UCMS HMI VLAN.

.8 Air Gap & Vibration Monitoring Server.

.9 Air Gap & Vibration Monitoring Equipment.

.10 Ancillary Workstation - Hydran.

.6 Manitoba Hydro Corporate Network:

.1 The Manitoba Hydro Corporate Network will be used for business communication and completely isolated from the UCMS network.

.2 The Manitoba Hydro Corporate Network will be available at the control desk for corporate computers and in the control room for a corporate printer.

.7 Switchyard Network:

.1 The switchyard network will use the IEC61850 protocol and will be extended into the powerhouse using Single-Mode fibre.

.2 The network will be redundant and will require two physically separate communication paths to the powerhouse.

.3 The following devices/systems shall be networked in the powerhouse area:

.1 Bay Controllers (89T control and interlocks x8).

.2 Line Protection.

.3 Switchyard HMI.

.11 Power Supply

.1 There will be two physically separated inverters and associated distribution panels that feed the HMI equipment.

.2 The PLCs will be fed from redundant 24 Vdc supplies which are sourced by 125 Vdc feeds from separate battery banks.

.12 Operator Interface System

.1 General:

.1 The primary server, historian server, engineering workstation, viewer 1, viewer 3 and Avocent KVM will be located in the Server A cubicle. This cubicle will be located in the UCMS Room A in the service bay at el 146.0.

.2 The secondary server, AGM vibration monitoring server, viewer 2 and ancillary workstation will be located in the Server B cubicle. This cubicle will be located in the UCMS Room B in the service bay at el 146.0.

.3 Viewer 4 will be located at the spillway.

2.3 MATERIALS

.1 The equipment includes:

.1 Powerhouse Fibre Optic Termination Panels PH1-FTP and PH2-FTP.

.2 Service Bay Fibre Optic Termination Panels SB1-FTP and SB2-FTP.

.3 Intake Fibre Optic Termination Panel.

.4 Spillway Fibre Optic Termination Panel SP-FTP.

.5 Line Fibre Termination Panels.

.6 Control Room Desks and Furnitures.

.2 All above equipment types shall be based on the Purchaser’s Drawings provided and capacity shall be based on I/O list.

Part 3 Execution

3.1 MANUFACTURER’S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, programming instructions, and datasheet.

3.2 INSTALLATION

.1 The Contractor shall install the panels as shown on the issued for construction package and supply hardware and anchors required for installations.

.2 The panels shall be bonded to the facility grid in accordance with the Issued For Construction documents.

.3 Terminate instrument, control and communication cables in accordance with the approved connection diagram, and supply all glands for cable entry into the panel, heat shrinks, and terminal lugs.

3.3 FIELD QUALITY CONTROL

.1 General

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Specific Quality Control Requirements

.1 The contractor shall inspect the equipment supplied by the Purchaser upon receiving for any defect or damage.

.2 All equipment and Material supplied by the Contractor shall be new, unused, and suitable for the intended use.

.3 All electrical equipment and Material supplied by the Contractor shall be CSA approved or ULC accepted for the application.

.3 Site Tests

.1 Visual and mechanical inspections (for all panels):

.1 Inspect for physical damage or defects.

.2 Check nameplate information for correctness.

.3 Check presence of foreign materials, moisture, dust, etc.

.4 Verify the correctness of panel wiring and connections in accordance with the Purchaser's Drawings.

.2 Electrical Tests (all panels) and Pre-Commissioning:

.1 All testing procedures shall be provided for the Engineer's Review.

.2 Perform acceptance test in accordance with the vendor instructions for individual relay, PLCs and devices.

.3 Verify all cable continuity end to end for copper connections.

.4 Power up the panels and confirm normal status of the equipment before handing over to the Purchaser for commissioning.

.5 All tests shall be witnessed by the Engineer.

.3 Commissioning (All Systems):

.1 Provide assistance to the Engineer in overall system commissioning by actuating field I/O and addressing and connection issues.

3.4 TOOLS AND TEST EQUIPMENT

.1 The Contractor shall purchase a new set of Combiflex crimping tools which shall be used for construction and left on Site for maintenance.

.2 The Engineer shall provide all specialized test equipment required for testing the UCMS.

3.5 SPARE PARTS

.1 Submit a list of recommended spare parts.

3.6 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

3.7 CLEANING

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section describes the general electrical installation requirements.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 26 05 21 - Wire and Cable Systems.

.4 Section 26 22 13 - Low-Voltage Distribution System.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards listed below in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time of the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Canadian Standards Association (CSA International):

.1 CSA C22.1 - Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.2 CAN3-C235 - Preferred Voltage Levels for AC Systems, 0 to 50,000 V.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 The Work of this Section is considered incidental to other Work and no separate measurement or payment shall be made. Include costs for the Work of this Section in the unit prices referenced for Items to which the Work of this Section applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Submit schedule of design and shop drawings for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. .

.3 Submit Work instructions for equipment installations, cable installation and termination, field testing, and pre-commissioning for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.4 Shop Drawings

.1 Submit shop drawings sealed by a Professional Engineer registered or licensed in the province of Manitoba.

.2 For those systems under the design responsibility of the Contractor, submit wiring and interconnection diagrams and installation details of equipment indicating proposed location, layout and arrangements for control panels,

accessories, piping, ductwork, and any other items that must be shown to ensure a coordinated installation.

.3 Indicate the clearances required for operation, maintenance, and replacement of operating equipment and devices on the shop drawings.

.4 If changes are required subsequent to shop drawing submission, notify Engineer of these changes before they are made.

.5 Quality Management Plan

.1 Submit for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Provide CSA certified equipment and material. Where CSA certified equipment and material is not available, submit such equipment and material to inspection authorities for special approval before delivery to Site.

.3 Submit test results of installed electrical systems and instrumentation to the Engineer.

.4 Submit certificate of acceptance from authority having jurisdiction upon completion of Work to the Engineer.

.6 Termination procedures shall be submitted for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, prior to undertaking the work.

.7 Site As-Built Drawings

.1 Provide one set of Site as-built record drawings for Site changes and corrections executed under this Contract.

.2 The minimum requirements for the Site as-built drawing mark-ups are:

.1 All revisions and additions will be in red ink.

.2 All removals will be in green ink.

.3 Use capital block text or legible printing.

.4 Sign mark-ups with initials, date revised and company name (e.g. ABC, Vendor/MH, Nov. 1, 2011).

.5 Detail reason for mark-up. Indicate if as-built is a result of RFI/NCR/ PCN etc. (e.g. "as built to replace pump", "as per RFI # /PCN #").

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Qualifications: electrical installation Work shall be carried out by qualified, licensed electricians who hold a valid Master Electrical Contractor license or apprentices in accordance with the provisions of Provincial Act respecting manpower vocational training and qualification.

.1 Employees registered in provincial apprentices program: permitted, under direct supervision of qualified licensed electrician, to perform specific tasks.

.2 Permitted activities: determined based on training level attained and demonstration of ability to perform specific duties.

.3 Site Meetings

.1 Shall be in accordance with the requirements set out in Section 23.3 Site Meetings of the General Specification.

.2 Site Meetings:

.1 After delivery and storage of products, and when preparatory Work is complete but before installation begins.

.2 Twice during progress of Work at 25% and 60% complete.

.3 Upon completion of Work, after cleaning is carried out.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Material Delivery Schedule

.1 Provide the Engineer with schedule 12 weeks prior to delivery.

.3 Packing, shipping, handling and unloading

.1 Deliver, store and handle Materials in accordance with Section X (insert title) of the General Specification.

.2 Deliver, store and handle Materials in accordance with manufacturer's written instructions.

.4 Waste Management and Disposal

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

1.8 COMMISSIONING

.1 Perform testing and pre-commissioning to the satisfaction of the Engineer prior to handover to the Purchaser.

Part 2 Products

2.1 DESIGN REQUIREMENTS

.1 Operating voltages: to CAN3-C235.

.2 Motors, electric heating, control and distribution devices and equipment to operate satisfactorily at 60 Hz within normal operating limits established by above standard.

.1 Equipment to operate in extreme operating conditions established in above standard without damage to equipment.

2.2 MATERIALS AND EQUIPMENT

.1 Material and equipment to be CSA certified. Where CSA certified material and equipment is not available, obtain special approval from inspection authorities before delivery to Site and submit such approval as described in Part 1 of this Section.

.2 Factory assembled control panels and component assemblies.

2.3 ELECTRIC MOTORS, EQUIPMENT AND CONTROLS

.1 Verify installation and co-ordination responsibilities related to motors, equipment and controls.

.2 Control wiring: in accordance with Section 26 05 21 Wire and Cable Systems.

.3 Conduit, cable and wire Support: in accordance with Section 26 05 29 Cable and Wire Support Systems.

.4 The equipment and control panels shall be in accordance with the applicable specification and shall meet the application requirements.

2.4 WARNING SIGNS

.1 Warning Signs: Install in locations as indicated in the Technical Specification, as shown on the Purchaser's Drawings, or as required by the Engineer.

.2 Minimum size 175 x 250 mm, lamicoid 3 mm red, white core, lettering accurately aligned and engraved into core, mechanically attached with self tapping screws or rivets, minimum 12 mm high lettering.

2.5 TERMINATIONS

.1 Panel terminations:

.1 Wiring between devices shall be point to point, with no splices or tee connections.

.2 Not more than two wires shall be connected at any device terminal or terminal block point.

.3 Wire runs shall be trunked in wiring ducts, or neatly bound in groups and secured to the panel. Anchoring and wiring ducts and wire bundles shall be with mechanical fasteners. Adhesive fasteners are not acceptable.

.4 The shield drain wire of analog circuit cables shall be routed through its own fed-through terminal block, connecting external and internal wiring shields.

.5 Spare unused conductors of cable shall be left long enough to reach any terminal block or device in the enclosure.

.6 Unused areas of panels shall be kept free of wiring to facilitate the installation of future equipment.

.7 Wiring to swing panels and doors shall be extra flexible, fine stranded conductor and shall be arranged so that a twisting, rather than a bending motion is imparted on the conductors when the door is opened.

.8 All wiring connections shall be readily accessible and removable for test or other purposes.

.2 Lugs:

.1 All wires shall have crimp on lugs with only one wire in each lug.

.2 Ring lugs shall Burndy Hylug type YAV, or Purchaser's approved equivalent.

.3 Lip-blade (bent tongue) type lugs shall be AMP type PIDG, or Purchaser's approved equivalent.

.4 Fork lugs are not permitted.

.5 Screw down terminals on relays and devices shall use ring lugs.

2.6 EQUIPMENT IDENTIFICATION

.1 Provide identification nameplates and labels for control items in English.

.2 Identify electrical equipment with nameplates and labels as follows:

.1 Nameplates: lamicoid 3 mm black, white core, lettering accurately aligned and engraved into core, mechanically attached with self tapping screws or rivets.

.2 Sizes as follows:

Name Plates

Size 1	10 x 50 mm	1 line	3 mm high letters
Size 2	12 x 70 mm	1 line	5 mm high letters
Size 3	12 x 70 mm	2 lines	3 mm high letters
Size 4	20 x 90 mm	1 line	8 mm high letters
Size 5	20 x 90 mm	2 lines	5 mm high letters
Size 6	25 x 100 mm	1 line	12 mm high letters
Size 7	25 x 100 mm	2 lines	6 mm high letters

.3 Labels: embossed plastic labels with 6 mm high letters unless specified otherwise.

.4 Wording on nameplates and labels to be reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification prior to manufacture.

.5 Allow for minimum of 25 characters per nameplate and label.

.6 Nameplates for terminal cabinets and junction boxes to indicate system and/or voltage characteristics.

.7 Disconnects, starters and contactors: indicate equipment being controlled and voltage.

.8 Terminal cabinets and pull boxes: indicate system and voltage.

.9 Transformers: indicate capacity, primary and secondary voltages.

2.7 WIRING IDENTIFICATION

.1 Wires shall be marked at both ends according to the wiring diagrams, included in the Purchaser's Drawings. Markers shall be clearly visible after conductors are terminated.

.2 Identify phasing of power wiring with permanent indelible coloured plastic tapes on both ends of phase conductors of feeders and branch circuit wiring.

.3 Maintain phase sequence and colour coding throughout.

.4 Wire markers shall be heat shrink type, to provide permanent identification.

2.8 CONDUIT AND CABLE IDENTIFICATION

.1 Cables shall be identified as follows, according to the cable listings provided in the Purchaser's Drawings and Contractor's Documents:

.1 At both ends.

.2 On both sites of passage through a wall/floor.

.3 At an entry/exit, to/from cable raceways.

.2 Colour code conduits, boxes and metallic sheathed cables to identify the system to which it belongs.

.3 Code with plastic tape or paint at points where conduit or cable enters wall, ceiling, or floor, and at 15 m intervals.

.4 Colours: 25 mm wide prime colour and 20 mm wide auxiliary colour.

	Prime	**Auxiliary**
Up to 250 V	Yellow	
Up to 600 V	Yellow	Green
Up to 5 kV	Yellow	Blue
Up to 15 kV	Yellow	Red
Telephone	Green	
Other Communication Systems	Green	Blue
Fire Alarm	Red	
Emergency Voice	Red	Blue
Other Security Systems	Red	Yellow

2.9 FINISHES

.1 Finishes shall be in accordance with Section 09 90 00 Painting and Coating.

.2 Standard exterior finish for indoor equipment shall be ANSI 61 Grey.

.3 Standard interior finish shall be white RAL 9003.

Part 3 Execution

3.1 INSTALLATION

.1 Do complete installation in accordance with CSA C22.1 except where specified otherwise.

3.2 NAMEPLATES AND LABELS

.1 Ensure manufacturer's nameplates, CSA labels and identification nameplates are visible and legible after equipment is installed.

3.3 CONDUIT AND CABLE INSTALLATION

.1 Install conduit and sleeves prior to pouring of concrete.

.1 Sleeves through concrete: schedule 40 plastic, sized for free passage of conduit, and protruding 50 mm.

.2 If plastic sleeves are used in fire rated walls or floors, remove before conduit installation.

.3 Install cables, conduits and fittings embedded or plastered over, close to building structure so furring can be kept to a minimum.

3.4 LOCATION OF OUTLETS

.1 Locate outlets in accordance with Purchaser’s Drawings, Contractor’s Documents and specifications.

.2 Do not install outlets back-to-back in wall; allow minimum 150 mm horizontal clearance between boxes.

.3 Change location of outlets at no extra cost or credit, providing distance does not exceed 3,000 mm, and information is given to the Contractor before installation.

.4 Locate light switches on latch side of doors.

.1 Locate disconnect devices in mechanical and elevator machine rooms on latch side of floor.

3.5 MOUNTING HEIGHTS

.1 Mounting height of equipment is from finished floor to centreline of equipment unless specified or indicated otherwise.

.2 If mounting height of equipment is not specified or indicated, verify with the Engineer before proceeding with installation.

.3 Install electrical equipment at the following heights unless indicated otherwise:

.1 Local switches: 1,400 mm.

.2 Wall receptacles:

.1 General: 300 mm.

.2 Above top of continuous baseboard heater: 200 mm.

.3 Above top of counters or counter splash backs: 175 mm.

.4 In mechanical rooms: 1,400 mm.

.3 Panelboards: as required by Code or as indicated.

.4 Telephone outlets: 300 mm.

.5 Wall mounted telephone outlets: 1,500 mm.

.6 Fire alarm stations: 1,500 mm.

.7 Fire alarm bells: 2,100 mm.

.8 Wall mounted speakers: 2,100 mm.

.9 Door bell pushbuttons: 1,500 mm.

3.6 CO-ORDINATION OF PROTECTIVE DEVICES

.1 Ensure circuit protective devices such as overcurrent trips and fuses for 600/347 V and 208/120 V lighting and receptacle systems are installed to required values and settings.

.2 All other protective device settings will be provided and applied by the Purchaser.

3.7 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Load Balance (lighting and receptacle systems):

.1 Measure phase current to panelboards with normal loads (lighting) operating at time of acceptance; adjust branch circuit connections as required to obtain best balance of current between phases and record changes.

.2 Measure phase voltages at loads and adjust transformer taps to within 2% of rated voltage of equipment.

.3 Conduct the following tests:

.1 Power distribution system including phasing, voltage, grounding and load balancing.

.2 Circuits originating from branch distribution panels.

.3 Lighting and its control.

.4 Motors, heaters and associated control equipment including sequenced operation of systems where applicable.

.5 Systems designed and installed by the Contractor: e.g. fire alarm system, communications.

.6 Insulation resistance testing:

.1 Megger circuits, feeders and equipment up to 350 V with a 500 V instrument.

.2 Megger 350-600 V circuits, feeders and equipment with a 1,000 V instrument.

.3 Check resistance to ground before energizing.

.4 Carry out tests in presence of the Engineer.

.5 Provide instruments, meters, equipment and personnel required to conduct tests during and at conclusion of the Project.

3.8 CLEANING

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Clean and touch up surfaces of shop-painted equipment scratched or marred during shipment or installation, to match original paint.

.3 Clean and prime exposed non-galvanized hangers, racks and fastenings to prevent rusting.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This specification covers the supply, installation and termination of wire and cable systems throughout the powerhouse, service bay, intake and transition and the spillway.

.2 The wire and cable systems shall comprise of the medium voltage power cables and overhead conductors, low voltage electrical power conductors and cables, control electrical power cables, and all required installation and termination hardware and materials.

.3 Install and terminate all specified and required cables with the associated hardware and materials.

.4 Install and terminate all specified and required wires with the associated hardware and materials.

.5 Provide as-built marked-up drawings identifying the as-installed locations and types of cables and wires and their terminations.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 As a minimum, the works shall be performed in accordance with:

.1 ANSI and IEEE:

.1 IEEE 505 - Standard Nomenclature for Generating Stations Power Systems.

.2 IEEE 1185 - Guide for Installation Methods for Generating Station Cables.

.3 IEEE 48 - IEEE Standard for Test Procedures and Requirements for Alternating Current Cable Terminations Used on Shielded Cables having laminated Insulation Rated 2.5 kV Through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV

.2 Canadian Standards Agency (CSA):

.1 CSA C22.1 - Canadian Electrical Code, Part I.

.2 CSA Z462 - Workplace Electrical Safety.

.3 CSA C22.2 No. 0.12 - Wiring Space and Wire Bending Space in Enclosures for Equipment Rated 750 V or less.

.4 CSA C22.2 No 18.3 - Conduit, Tubing and Cable.

.5 CSA C22.2 No.31 - Thermoset-Insulated Wires and Cables.

.6 CSA C22.2 No. 38 - Thermoset-Insulated Wires and Cables.

.7 CSA C22.2 No. 127 - Equipment and Wire Lead.

.8 CSA C22.2 No.131 - TECK 90 Cable.

.9 CSA C22.2 N. 208 - Fire Alarm and Signal Cable.

.10 CSA C22.2 No. 230 - Tray Cable.

.11 CSA C22.2 No. 239 - Control and Instrumentation Cables.

.12 CSA C22.2 No. 245 - Marine Shipboard Cable.

.13 CSA C68.3 - Shielded and Concentric Neutral Power Cables Rated 5-46 kV.

.3 TIA/EIA:

.1 TIA/EIA 568 - Commercial Building Telecommunications Cabling Standard.

.4 Documents:

.1 Station Wires and Cables Material Takeoff.

.2 3D Model of the facility.

.3 Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for the Items 26 05 21 (a)i to 26 05 21 (e)viii inclusive shall be in metres as measured in the field and determined by the Engineer.

.2 No separate measurement shall be made for Item 26 05 21 (f).

.3 No separate measurement will be made for fittings required for securing the cables on the cable trays, and cable supports at locations where cable trays are not available for these items.

.3 Unit Price

.1 The unit prices for the Items 26 05 21 (a)i to 26 05 21 (e)viii inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation with fittings, testing and pre-

commissioning, and handover documents as specified herein, as directed by the Engineer, and as follows:

.1 Item 26 05 21 (a) shall cover 15 kV Cables.

.2 Item 26 05 21 (b) shall cover 1000 V Power Cables.

.3 Item 26 05 21 (c) shall cover Control Cable and 600 V Shielded Cables.

.4 Item 26 05 21 (d) shall cover 125 Vdc Cables (600 V Shielded).

.5 Item 26 05 21 (e) shall cover Instrument Cables.

.2 The Estimated Cost for Item 26 05 21 (f) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the Fire Alarm Signalling Cable.

.3 Fittings required for securing the cables on the cable trays, and cable supports at locations where cable trays are not available shall be considered incidental to the Work. Include the costs for such Work in the unit prices proposed for the Items to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review, manufacturer's printed product literature, specifications and datasheet.

.3 Quality Plan submittals

.1 Submit for review the Quality Plan for the wire and cable system installation.

.2 Field Inspection and Test Reports: Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review proposed field inspection and test reports.

.4 Closeout Submittals

.1 Product data and specification for inclusion into the facility O&M manual.

.2 Record of pre-commissioning tests for inclusion into the facility O&M manual.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 The engineers, technologists, technicians and tradesmen assigned to the job shall be certified and experienced in wire and cable installations.

.2 The Contractor shall have qualified staff trained in project control and quality assurance, and to support quality surveillance.

.3 Provide services, if required, of representative or technician from Manufacturer, experienced in installation, to supervise installation, adjustment, preliminary testing, and final testing of systems and to provide instruction to project personnel.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading

.1 Deliver, store and handle materials in accordance with the General Specification and in accordance with Manufacturer's written instructions.

.2 Store materials off ground, in accordance with Manufacturer's recommendations, and in a clean, dry, well-ventilated area.

.3 Store and protect cables from nicks and blemishes.

.4 Replace defective or damaged materials with new.

Part 2 Products

2.1 WIRES

.1 All wires shall be CSA-approved with copper conductor. No aluminum wire shall be permitted.

.2 All equipment wires shall be SIS 600V, XLPE insulated, FT2 rated, stranded copper. Wiring to panel doors shall be extra flexible fine stranded conductor.

.3 For lighting and 120 Vac receptacle circuits in conduit, single conductor, 600 V rated, type RW90, XLPE insulated, stranded copper wires, of appropriate ratings, conforming to Canadian Electrical Code requirements shall apply.

.4 For 600 V ac receptacle circuits in conduit, single conductor, 1,000 V rated, type RW90, XLPE, insulated, stranded copper wires, of appropriate ratings conforming to Canadian Electrical Code requirements shall apply.

.5 Minimum wire sizes

.1 Current transformer circuits #12 AWG.

.2 Control circuits #14 AWG.

.3 AC and DC power circuits #12 AWG.

.4 Analogue signals #16 AWG.

.5 HVAC control wiring shall be, at a minimum, #14AWG at 50 V or greater and #18AWG for lower voltages.

2.2 CABLES

.1 All cables shall be CSA approved. All cables for installation on cable trays or exposed locations shall be FT4 rated and CSA tray-rated.

.2 All cables that are not installed in conduit or cable tray shall be armoured.

.3 Cables to be installed in cable trays shall be tray-rated.

.4 All cables shall be rated for operation over an ambient temperature range of -40°C and +40°C.

2.3 POWER CABLES

.1 15 kV cables shall be single or multi-conductor shielded, aluminum interlock armoured TECK-type with 133% insulation design, shall satisfy the requirements of CSA C68.3, and shall be rated for a continuous operating temperature of 90ºC.

.2 15 kV cable conductors shall be of stranded copper with a spiral lay meeting the physical and electrical requirements of CSA C68.3.

.3 1,000 and 600 V cables shall be single or multi-conductor aluminum interlock armored TECK-type and shall satisfy the requirements of CSA C22.2 No. 38-M and C22.2 No. 131-M, and shall be rated for a continuous operating temperature of 90ºC.

.4 1,000 and 600 V conductors shall be stranded copper, un-coated, un-tinned, meeting the requirements of CSA C22.2 No. 38-M.

.5 Minimum size LV AC and DC power circuit conductor shall be AWG#12.

.6 Wire and cable shall have RW90 rated insulation. Thermoplastic insulated wire and cable are not acceptable.

.7 Multi-conductor power cables shall contain an un-insulated copper-grounding conductor unless otherwise shielded in an enclosure.

.8 Cable outer jackets shall be flame-retardant (FT4 or better) Low-Acid-Gas Evolution rated PVC.

.9 When 1,000 V power cable is confined to tray and enclosures only, with no exposed field runs, non-armoured, tray-rated cable with CSA Type TC, with RW90, XLPE-insulated copper conductors, copper shields and flame retardant (FT4) Low-Acid-Gas Evolution rated PVC outer jacket shall be acceptable.

.10 Cable Conductor Identification - Conductors shall be identified by coloured tape: red (Phase A), black (Phase B) and blue (Phase C).

2.4 15 kV TERMINATION KITS

.1 Termination kits shall be of heat shrink design, and shall contain:

- .1 Internal insulation tubing.
- .2 Stress control tubing.
- .3 Anti-track tubing, moisture sealant.
- .4 Compression lugs, ground strap.
- .5 Constant tension clip to connect ground strap to shield.
- .6 Insulation boots.
- .7 Cable breakout for the cables.

.2 Termination kits shall be suitable for the cable type and size, shall have compatible voltage and insulation class, and shall meet the IEEE 48 design and test requirements.

2.5 CONTROL CABLES

.1 Control cables shall be in accordance with CSA C22.2 No. 239 and comprise of 600 V rated, armoured, multi-conductor, Teck 90 cables with stranded annealed, soft bare copper conductors, XLPE insulation, fire retardant FT4, low-acid-gas-emitting PVC inner jacket rated- 40°C to 90°C and overall spiral-wound copper shield, interlocked armour and fire retardant FT4, low-acid-gas-emitting PVC outer jacket rated -40°C to 90°C.

.2 Control cables confined to tray and enclosures only, with no exposed field runs, non-armoured, tray-rated CSA Type TC, multi-conductor cable with RW90, XLPE-insulated copper conductors, copper shield and flame-retardant (FT4) Low-Acid-Gas Evolution PVC outer jacket, rated -40°C to 90°C, shall be acceptable.

.3 Shielded cables shall have (2) helically applied 16 AWG - 19 strand bare copper drain wires. These are required to be in contact with the copper tape shield at all points throughout the cable length.

.4 Conductors of a multi-conductor power shall be number coded.

2.6 INSTRUMENT TRANSFORMER CABLE

.1 Cables used in instrument transformer secondary circuits shall be stranded copper conductors in overall amour, with colour-coded conductors, as follows. Conductors shall have an overall copper tape shield with 50% overlap between turns.

Designation	Colour Code
Potential, A Phase	Red
Potential, B Phase	Black
Potential, C Phase	Blue
Potential Neutral	White
Current, A Phase	Orange
Current, B Phase	Yellow
Current, C Phase	Brown
Current Neutral	White

2.7 INSTRUMENT CABLE

.1 Instrument cables shall be in accordance with CSA C22.2 No. 239 and shall comprise of minimum 600 V, armoured, multi-conductor cable with stranded annealed, soft bare copper with XLPE insulation rated -40°C to 90°C, twisted-pair or twisted-triad conductors.

.2 Instrument cables shall include either spirally-shielded copper, or aluminum mylar tape, with a tinned and stranded copper drain wire shields for each twisted pair or triad of conductors and for overall assembly of conductors, interlocked aluminum armour and fire retardant FT4, low-acid-gas-emitting PVC outer jacket rated -40°C to 90°C.

.3 Cables shall have two helically applied 16 AWG - 19 strand bare copper drain wires that are in contact with the overall shield, at all points throughout the cable length. One 16 AWG-19 strand drain wire within each individual pair or triad shall be provided.

2.8 BATTERY CABLE

.1 The battery cable for connection between battery terminals and the fused disconnect shall be Exane-125 type, 600 V rated, unarmoured with irradiated cross-linked polyolfin Exane 125^{o}C (XLPO), having highly-stranded copper conductor, and resistance to abrasion, cut through, low and high temperature, petrochemical fluids, sunlight and moisture.

.2 The cable design shall be in accordance with CSA C22.2 No. 245.

2.9 FIRE ALARM CABLES

.1 Cables shall be heavy duty 105^{o}C shielded CSA FAS105 type in accordance with CSA C22.2 No. 208.

.2 Cables shall be rated for 300 V.

.3 Outer jacket shall be of red colour and FT4 rated for cable tray installation and FT6 for plenum installations.

.4 Minimum size conductor for fire alarm signalling circuits shall be #16 AWG.

.5 Conductor identification:

.1 Colour coded for seven or less conductors.

.2 Colour coded with stripes for cables up to and including 30 conductors.

.3 Black with number coding for more than 30 conductors.

2.10 COMMUNICATIONS CABLE – NON-FIBRE

.1 Non-fibre twisted-pair communication and control cables shall be CAT6, UTP, AMP Type 219560-8 or Purchaser's approved equivalent.

.1 Jackets shall be colored Blue, for UCMS LAN, Yellow for Corporate LAN and phone, purple for Security LAN.

.2 Cable installed in cable trays shall have minimum FT4-rated outer jackets, otherwise they shall be installed in protective conduit tubing providing minimum FT4 rating.

2.11 COMMUNICATIONS CABLE - FIBRE OPTIC

.1 Fibre optic communications cable shall be in accordance with Telcordia GR-20 and EIA/TIA 598 B. Fibre cable color and bundling tubes shall be in accordance with EIA/TIA 598 B.

.2 Fibre cable installations must comply with manufacturer's recommendations and with information provided within these Specifications.

.3 All multimode cable installed as part of this contract shall contain multimode fibres with a 125 micron cladding and 62.5 micron core. Hybrid fibre shall contain a combination of multi-mode and a single mode cable.

.4 Single mode fibre optic cables shall be used for CCTV and security system with 125 micron cladding and shall be compatible with the equipment provided.

.5 All fibre cables shall be capable of supporting a short-term tensile load of 273 kg, without stretching, and shall be capable of bend radii of 15x times outside diameter under tensile load and 10x outside diameter under no tensile load. Minimum crush resistance of the cable shall be 150 kg/cm.

.6 Cable installation inside the Powerhouse must meet a minimum of FT4 requirements. This can be accomplished through use of cable that has FT4 rated jacket or placing the cable inside of FT4 rated conduit (either PVC or EMT).

.7 Cables require mechanical protection because of the nature of the traffic carried on them in the GS environment. Cables must be installed either in a conduit or in an aluminum interlocked armor configuration wherever appropriate bend radius control and crush protection cannot be guaranteed. AIA cable has an integrated mechanical jacket that can reduce the chances of bend radius or mechanical compromise of the cable.

.8 Following are lists of technical requirements and acceptable cable manufacturers for various types of fibre optic cables to be identified in the cable schedules:

Indoor/Outdoor AIA Cable Specifications

Item	Description	Requirement
1	Cable Manufacturer	Corning Cable Systems Draka Comteq OFS Prysmian
2	Glass Manufacturer	Corning Cable Systems Draka Comteq OFS Prysmian
3a	Data Sheets - Cable Physical Parameters	To Be Confirmed by Contractor
3b	Data Sheets - Fibre Physical and Optical Parameters	To Be Confirmed by Contractor
4	Conformance to Telcordia GR-20-CORE requirements and other industry standards i.e. IEEE 1222, IEC 60749, and any other standards cited under Telcordia GR-20-CORE	To Be Confirmed by Contractor
5	Suitable for direct burial and/or underground conduit installation	To Be Confirmed by Contractor
6	Cable Length	800 m (continuous length on 1 reel)
7	Cable Weight (kg/km)	N/A
8	All-Dielectric Cable Core	The cable core (i.e., inner poly jacket and inwards) must be all-dielectric
6	Maximum Unsupported Vertical Distance	To Be Confirmed by Contractor
7	Cable Configuration/Design	72 single mode fibres/loose tube/AIA
12	Sheath-Slitting Cords (a.k.a. ripcords)	Two under each jacket (for a total of six), 180° apart
13a	Cable Marking – General	Per GR-20-CORE
9b	Inner (PE-jacketed) Cable Marking - Identification	In addition to GR-20-CORE, also print "MANITOBA HYDRO OPTICAL CABLE" and number and type of fibres (72-SMF). Length is to be sequential, in metres.
9c	AIA-Jacket Marking	Sequential length in metres and 'FIBRE CABLE' or 'OPTICAL CABLE'
10	AIA Jacket Colour	Yellow
13	Fire-Rating	The overall cable must be FT4- or FT6-rated
14a	Reel Construction	Steel or wood
14b	Testing Access to both ends of the Cable	Minimum of 5 m of inside cable accessible
15	Fibre and Buffer Tube Identification	Standard colour code
16a	Buffer Tube Filling	Gel-filled
16b	Cable Water Blocking (Interstices Between Buffer Tubes)	Dry block technology

Item	Description	Requirement
22a	Cable Design Lifespan	40 years
22b	Installation Temperature Range	Inst. -30° C to +60° C
22c	Operating Temperature Range	-40° C to +60° C

Standard Singlemode Fibre Specifications

Item	Description	Requirement
17	Singlemode Class	Class IV(a) [dispersion-unshifted]
18a	Change in Optical Attenuation with Wavelength	1,285-1,310 nm max increase 0.10 dB/km (ref 1,310 nm)
18b	Change in Optical Attenuation with Wavelength	1,310-1,330 nm max increase 0.05 dB/km (ref 1,310 nm)
18c	Change in Optical Attenuation with Wavelength	1,525-1,575 nm max increase 0.05 dB/km (ref 1,550 nm)
19	Optical Attenuation @ 1,310 nm	≤ 0.35 dB/km
20	Optical Attenuation @ 1,550 nm	≤ 0.25 dB/km
25	Fibre Cut-off Wavelength	< 1260 µm
27a	Index of Refraction @ 1,310 nm	Specified by Contractor
27b	Index of Refraction @ 1,550 nm	To Be Confirmed by Contractor
28	Total Cladding Diameter	125.0 µm +/-1.0 µm
28a	Core Diameter	9 µm ± 1 µm
29	Optical Coating Material Diameter	250 µm ± 10 µm
30	Warranty	Minimum 5 years
31	Factory Test Results @ 1,310 nm and 1,550 nm	To Be Confirmed by Contractor

Standard Multimode Fibre Specifications

Item	Description	Requirement
30	Multimode, Graded Index	Type A1b or OM1; 62.5/125 µm
31a	Minimum Bandwidth @ 850 Nm	200 MHz/km
31b	Minimum Bandwidth @ 1,300 Nm	500 MHz/km
32a	100 Megabit Ethernet, Link Length @ 850 Nm	≥ 300 m
32b	100 Megabit Ethernet, Link Length @ 1,300 Nm	≥ 2,000 m
33a	Optical Attenuation @ 850 Nm	≤ 3.5 dB/km
33b	Optical Attenuation @ 1,300 Nm	≤ 1.5 dB/km
37	Total Cladding Diameter	125.0 µm +/-1.0 µm
38	Core Diameter	62.5 µm ± 3 µm
39	Numerical Aperture (NA)	≤ 27 NA ≤ 29; deviation from NA ± 0.02
40	Optical Coating Material Diameter	250 µm ± 15 µm
41	Warranty	Minimum 5 years
42	Factory Test Results @ 1,300 Nm	To Be Confirmed by Contractor

2.12 TERMINATIONS

.1 Outdoor-rated MV shielded power cable terminations shall be manufactured moulded rubber terminations, IEEE 48, Class 1. Elastimold type 35MTG or Purchaser's approved equivalent with the grounding device for the metallic shield (Elastimold Type 20 MA for metalling type shield) and NEMA 2-hole, long-barrel terminal connector.

.2 Indoor-rated MV, shielded power cable terminations for cables rated 15 kV or less shall be done with an IEEE Standard 48 Class 1 termination. It shall either be a one-piece design, where high-dielectric constant stress control is integrated within a skirted insulator made of silicon rubber, or provide for positive placement of the stress control with the installation of a stress patch. The termination shall not require heat or flame or installation. The terminations shall be 3M Brand 5630 K series Quick Term II cold shrink Termination Kits or Raychem TFT-E-SG. Only a NEMA 2-hole, long-barrel terminal connector shall be used.

.3 Fibre optic cable terminations shall, unless otherwise stated, be SC type connectors with zirconium ferrule inserts. All jumper connections at the panels will be SC-UPC unless otherwise indicated.

Part 3 Execution

3.1 SCOPE

.1 Detail, quantify, supply, store on site, install and terminate all specified and required types of wires and cables associated, including, but not limited for the following identified equipment and systems except as noted otherwise:

- .1 120 Vac and 347 V Lighting Systems.
- .2 600 V, 347 V and 120/208 Vac low voltage distribution system equipment.
- .3 Power, control and instrumentation wires and cables.
- .4 LV power, control, protection and instrumentation cable.
- .5 All interconnecting wiring and cabling associated with systems designed, supplied or installed by the contractor.
- .6 For equipment associated with the Turbine and Generator (TG) contract:
  - .1 LV power, control, protection and instrumentation cable interconnections from non-TG Contractor-supplied equipment to TG Contractor-supplied and installed generator and turbine panels, panelboards, cubicles and associated governor and excitation equipment.
  - .2 Terminate only, at the motor starters, the LV power cables to the AC and DC head cover pumps which will be supplied and installed by the TG Contractor.

.2 Cables and/or terminations associated with the following systems will be covered under other sections or supplied and installed by others:

- .1 Preparation of cable including fitting and glands, termination at equipment and devices are included under equipment and system installation scope.
- .2 Supply and installation of cables from generator/turbine systems to equipment interface panels for interfacing with balance of plant systems. The supplier of the turbine and generator will terminate the cable supplied and installed by the Contractor at the generator and turbine interface panels.
- .3 Ethernet and fibre optic cables included in Section 27 00 00 Communication Systems scope.
- .4 Termination of 12.47 kV cables from the station to the switching station at dip pole outside the Powerhouse Area. The supply and installation of cable and termination kits is part of this contract.

.5 Termination of off-site power supply (OSPS) cables at dip pole outside the Powerhouse Area. The supply and installation of cable is part of this Contract.

3.2 DESIGN REQUIREMENTS

.1 The design of the wiring and cabling systems will be prepared by the Purchaser.

.1 Reference Codes and Standards:

.1 The wiring and cabling systems shall be designed, tested, installed, terminated and commissioned in accordance with the Engineer's design documents, these Specifications, and the latest revision of the standards and codes specified herein.

.2 Wire Systems:

.1 The Contractor shall be responsible for planning and designing the wire and conduit arrangements in accordance with the supply and switching circuit designations and their locations.

.2 The Contractor shall be responsible for detailing, itemizing and quantifying the wire in conduit circuits to identify for the purpose of supply:

.1 The lengths of each type and size of wire required for the circuits and devices and the planned conduit runs.

.2 All materials and hardware required for installing, securing and terminating the wire in conduit circuits.

.3 Cable Systems:

.1 The Contractor shall be responsible for preparing interconnection drawings and schedules for systems designed by the Contractor identifying cable types, sizes, ratings, end points, and conductor termination locations in order to carry out the work and to submit as-built record drawings for the project records.

.2 For specific wiring and cabling associated with equipment and systems supplied and/or installed by the Purchaser, cable types, sizes, ratings, end points, and conductor termination locations will be provided to the Contractor on drawings and schedules.

.3 The Contractor shall be responsible for detailing, itemizing and quantifying the cabling system of systems designed by the Purchaser for the purpose of supply, installation and termination.

.1 All required cables as specified on the drawings and schedules and as listed on the Purchaser's Drawings and schedules.

.2 All cable clamps, cable glands, connectors, cable tags, markers and associated hardware for the installation of the specified cables.

.3 All conductor and cable termination hardware, MV stress cone termination kits, wire numbering tags, spade and loop compression terminations, materials and hardware for the termination of cable conductors in the specified terminal locations.

3.3 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation/termination instructions, and datasheet.

3.4 INSTALLATION

.1 Wire and Cable Installation:

.1 Wiring and cables shall not be installed when ambient temperature is -10°C or lower.

.2 Wire and cables shall not be installed in conduit or cable tray until the cable support system has been satisfactorily completed and cleaned.

.3 The Contractor shall pull wire and cable into conduits and trays with sufficient length provided at the ends to conveniently form, terminate and make connections to all equipment and devices without stress on the wire or cable or connection.

.4 Cables shall be pulled with equipment designed for this purpose, including power-driven winch, cable-feeding flexible tube guide, cable grips, and lubricants. A sufficient number of trained personnel and equipment shall be employed to ensure the careful and proper installation of the cable. Pulling force shall not exceed manufacturer’s recommendation and a dynamometer shall be used in the pulling line to ensure that the pulling force is not exceeded.

.5 Woven-wire cable grips shall be used to grip cable ends when pulling small cables and short straight lengths of heavier cables. Pulling eyes shall be attached to the cable conductors to prevent damage to the cable structure. Pulling eyes and cable grips shall be used together for non-metallic sheathed cables to prevent damage to the cable structure.

.6 A non-conducting lubricant or cable-pulling compound, non-injurious to the insulation or sheath, shall be used as a lubricant to aid in pulling wire or non-metallic sheathed cable, where required. Oil or grease shall not be used for lubrication and excessive pulling stresses shall not be permitted.

.7 The minimum radius to which an insulated conductor shall be bent, either permanently or temporarily during installation, shall be eight times the outer diameter for unarmoured cable, and ten times the outer diameter for armoured , except for medium-voltage shielded cables where twelve times outer diameter shall apply. Recommendations from specific cable manufacturers for larger bending radii shall prevail. Rollers, sheaves, or tube guides for cable pulling shall conform to the minimum bending radius of the cable.

.8 Wiring for lighting and receptacle circuits may contain splices in outlet boxes and junction boxes by the use of approved crimp-type connectors. Splices are not permitted within conduit bodies.

.9 Power, control and instrument cable shall be continuous with no splice permitted. Cable joints and terminations shall be permitted where required. Shipping lengths of power cable reels shall be equal to a circuit length or summation of circuit lengths to minimize excess cable.

.10 If a cable or wire is damaged during installation, it shall be replaced in its entirety at no extra cost to the purchaser.

.11 Wire in pull boxes shall be tied and neatly racked on the sides of the boxes, in an approved manner.

.12 Cable shall be installed in cable trays in accordance with the requirements of the Canadian Electrical Code. Cables shall be lifted into place on the tray rather than pulled where possible. Suitable, purpose-designed rollers shall be used where pulling is necessary. The cables shall be segregated by voltage level and cable type. Segregation shall be based on the following grouping:

.1 12.47 kV.

.2 600 Vac.

.3 120 Vac.

.4 125 Vdc.

.5 48 Vdc.

.6 24 Vdc.

.7 Fibre and other control/communication cables.

.13 After being placed in a tray, cable shall be neatly straightened and positioned to present an orderly appearance and to aid in tracing cable circuits.

.14 All cables shall be supported in cable trays or approved cable raceways. Cable drops (except fiber optic cables) outside of the cable tray are not to exceed 10 m and must be supported at 2 m intervals by 'P' clamps or on Unistrut or similar support hardware and/or secured to cable ladders or instrument trays.

.15 Anchoring and securing of wires and cables shall be with secure mechanical fasteners. Adhesive fasteners are not acceptable.

.16 Vertical runs of TECK cable shall be strapped to the supporting structure at 500 mm intervals. Cables ties are not acceptable as a means of cable support. Verticals runs in cable shafts and vertical raceways shall be arranged to comply with CEC Rule 12-120 and CEC Table 21 requirements for maximum length without support.

.17 Multi-core cables with an overall outside diameter greater than 40 mm shall be individually clamped. Hold-down clamps and straps shall be of non-corrosive material and be compatible with the cable sheath and the support material. Single core cable shall be secured and supported individually or in trefoil-configuration with suitable non-magnetic clamps, straps or saddles, regardless of the diameter.

.18 Spare wires in the multi-core cables shall be neatly tied back with sufficient length to reach any point in the enclosure. Spare wires shall be either grounded at both ends or the ends shall be taped.

.19 For underground, direct burial cable installation, see Section 26 05 43 Installation of Cables in Trenches and Ducts.

.2 Non-Fibre Communications Cable Installation

.1 The Contractor shall install all CAT6 UTP communications cabling systems as detailed in CSA T529 (Adopted ANSI/EIA TIA 568a with modifications).

.2 The Contractor shall provide service loops of 3 m for cable ends in the communications room and 305 mm for cable ends at devices external to the communications room, on each end of each cable run.

.3 The maximum allowable pulling tension for CAT6 four pair copper shall be 110 N.

.4 The minimum allowable bending radius for CAT6 four pair copper cable shall be four times the cable diameter.

.5 CAT6 cables shall not be spliced.

.3 Fibre Communications Cable Installation

.1 Fibre optic cable can be easily damaged if due care is not used during the installation process therefore the following guidelines and techniques are to be adhered:

.1 The minimum static bend radius (i.e., long term while the cable is stored or in place after installation) is 10 x or 15x the cable's outer diameter (OD) - to be confirmed by the manufacturer. If information not provided, assume 15 times OD.

.2 Fibre optic cable shall not be sharply bent or kinked as glass fibres cannot be straightened. It can also damage the fibre permanently, resulting in expensive repair work.

.3 Glass fibre can stretch, fracture or break if the pulling tension is exceeded than the rated. Pull the cable by hand or use a breakaway swivel to prevent cable damage.

.4 When pulling a long length of fibre cable through a conduit, re-reel or "figure-eight" the excess to prevent cable damage due to kinks or sharp bends.

.5 Do not install other cables or conductors in the same conduit or duct designated for fibre optic cable.

.6 Do not attach extra hardware or unrelated attachments to the fibre optic cable conduit or duct.

.7 Seal any unused or spare fibre optic dedicated conduit at both ends.

.8 Cap or seal all outside ducts with "duct seal" or a duct plug where the duct enters a building. If the duct is an empty spare, install a plastic cap. If the duct contains a cable, seal around the cable with duct seal or use a duct plug around the cable. Duct seal material shall be of a type which shall not degrade cable jackets.

.9 Non-armoured fibre optic cables shall be installed either in dedicated fibre guard trays or, when installed in the same tray with control cables, Fibre optic cable can also be installed in either 2 in. PVC or EMT conduit. Where conduit is used for installation the following paragraphs apply:

.1 Junction boxes are not acceptable for bends or changes in direction of installed conduit or duct because they do not provide bend radius control.

.2 LB (and related) fittings are not allowed for fibre duct installations because they do not provide bend radius control.

.3 Pullboxes shall be at least 1.2 m (48") long with minimum cross-sectional dimensions of 0.1 m x 0.1 m (4" x 4") and used after every two 90º bends and/or every 30 m (100'). Metal pullboxes must be bonded to ground per CEC.

.2 Fibre optic cables to be installed in cable trays shall have FT4-rated cable jackets.

.3 At no time shall more than 2,700 N of tension be places on any fibre cable while it is being pulled through tray or conduit.

.4 It is preferred that all fibre cable be pulled with hand power only. If power winches or mechanical advantage devices are used to pull cable, a tensionometer

shall be used to insure that maximum tension is not exceeded. Alternatively, a "mechanical fuse" composed of a swivel and breakaway combination rated at 2,500 N may be included in the linkage.

.5 Torsion forces on the fibre optic cable during installation shall be avoided by the use of a swivel at the cable end.

.6 While under pulling tension, the minimum allowable bend radius shall be 15x the outside cable diameter, which shall be ensured through the use of suitable pulleys and sheaves where required.

.7 After pulling, the minimum allowable bending radius at rest shall be 10x the outside cable diameter - subject to confirmation by cable manufacturer.

.8 Fibre optic cables shall be pulled only from tops of reels in long smooth bends. As the cables are un-reeled, they shall be carefully inspected for sheath defects. If defects are found during the pulling operation or if the cable on the reel binds, twists, or does not roll off freely, the pulling operation shall be stopped immediately and the Engineer notified.

.9 The Contractor shall use pulling compound or lubricant where necessary. Lubricants shall be compatible with the cable jacket material and shall be used in accordance with manufacturer's recommendations.

.10 The Contractor shall ensure that the clamps used during cable pulling do not over-cinch or crush the cables. Cables are intended to be pulled from one end only and not gripped midway. Appropriately sized travelers must be used for pulling around corners or above equipment. The Contractor shall follow manufacturer's recommendations regarding size of the travelers.

.11 Lengths of fibre in the order of 5 m - 10 m of cable must be provided at either end of a fibre run. These storage loops can be of open formation in the case of Aluminum interlocked armour or within a Hoffman box for non-armoured cable. Said storage must be incorporated when planning routing of the cable from termination location to termination location.

.12 Sheaths of armoured fibre cable are to be grounded at one end only to reduce the potential for circulating currents. Cable sheath at the ungrounded end must be shrink wrapped appropriately to prevent inadvertent ground or personnel contact. Labelling in the vicinity of the ungrounded end of the cable should clearly indicate that the far end of the cable is grounded.

.4 Wiring and Cable Marking

.1 All cables shall be identified with permanent non-metallic tags, machine-stamped with the cable identifiers securely attached to each cable, in clearly visible locations. Tags shall be attached to each end of each cable, at each junction box, in intermediate pulling boxes and at points of entering or exiting cable trays.

.2 All single wires and single conductors of multi-conductor cables shall be identified at each end by a hot-stamped sleeve sized to the wire gauge. This marking shall correspond to the marking on the connecting wire when the wiring interconnects from one panel to another.

.3 CAT6 communications cables shall be labelled using colour labels on both ends with identifiers in accordance with TIA/EIA-606-A.

.4 Wiring for the UCMS and SCADA systems will follow the marking system shown on the interconnection drawings for these systems.

.5 Wire colours shall be as follows:

Three-phase power:	A phase - red.
	B phase - black.
	C phase - blue.
Single-phase power:	Line - black.
	Neutral - white.
DC power:	Positive - red.
	Negative - black.
Equipment grounds	Green, Green with yellow stripe, or bare.

.5 Medium Voltage Terminations

.1 For Indoor, MV cables shall be terminated as per Section 2.12 or Raychem stress relief cones or special termination fitting, which shall be installed strictly in accordance with the instructions of the cable or termination manufacturer.

.2 Care shall be taken in constructing stress cones to install the cone to the specified dimensions and to properly terminate and ground the outer shield conductor with the shield wire connected to the ground grid at only one end of the cable.

.3 If the MV cable ends are not to be terminated on the same working day that they are cut, the Contractor shall immediately protect cable ends from damage or moisture by sealing with cable caps and silicone sealant. Provide stress relief at all terminations. Provide correct phasing of the conductors of each circuit at all terminations. Provide proper connections of tape shield or tape shield and drain wire to ground.

.4 The completed MV cable terminations shall have voltage ratings of not less than 15,000 V (ungrounded neutral) and shall be subjected to standard withstand test voltage conforming to IEEE Standard No. 48.

.5 At the 12.47 kV distribution line end of the MV cables, the Contractor shall cut-to-length the cables for installation up the terminal poles for connection to the pole-mounted disconnect switches by the Purchaser.

.6 Low Voltage Terminations

.1 Terminal blocks shall be identified with permanent machine-written markers.

.2 Not more than two wires or multi-conductors shall be connected at any device terminal or terminal block point.

.3 All TECK cable shall be properly terminated at each end of the cable with approved TECK connectors or cable glands, with liquid tight connectors to be used throughout.

.4 All multi-core cables with metal armour shall have the armour bonded to ground at both ends.

.5 Individual wires shall be terminated with compression-type terminals, CSA certified for copper conductors, with NEMA standard hole sizes.

.6 Individual wires shall be terminated to stud-type terminals on relays, meters, terminal strips, etc., using ring type lugs with only one wire in each lug.

.7 All crimp-on compression lugs shall be installed according to manufacturer’s specifications using approved tools.

.8 The use of twist wire nuts (Marettes) for terminations or joints is not acceptable.

.9 Power, control and instrumentation terminals for the project shall include:

.1 Weidmuller type ST5-EN-TS35 terminal blocks for all current circuits, with three nuts per stud. The bottom nut tightens against the fixed link, the top two nuts tighten against the ring lug and act as a locking nut.

.2 Entrelec Type M10/10RS terminal blocks for all potential transformers, controls and DC distribution wiring (Under review).

.3 Entrelec Type M6/8/STP terminal blocks for PLC wiring, using pre-insulated lip bladed crimp connectors (Under review).

.4 Weidmuller ST5 terminal blocks sized accordingly for Motor circuits.

.5 ABB Type FT1 test type terminal blocks for metering circuits.

.6 ABB Combiflex RTxP type terminal blocks for protection.

.7 Weidmuller type RSF1 terminal blocks for all other circuits, using pre-insulated lip bladed crimp connectors.

.10 The Contractor shall ensure that DC and AC circuits are not terminated on the same terminal strip and instrumentation circuits shall be grouped and shall not be located beside control or power circuits.

.11 When preparing a cable termination the copper shield may be cut back to the edge of the outer cable jacket. The inner PVC bedding jacket may be cut back as required, either at the cable termination point or used as wire management for the cable conductors continuing to the point of wire termination. Both drain wires are to be terminated in accordance with MH standard grounding practices. The bare copper drain conductors are to be insulated with clear plastic tubing of sufficient diameter for either individual or for both drain wires.

.7 Non-Fibre Communications Cable Terminations

.1 CAT6 communications cable shall not be terminated on screw terminals except where specifically indicated.

.2 An approved insulation displacement connection (IDC) tool kit for copper cable terminations shall be used for all CAT6 cable terminations.

.3 CAT6 cables shall not be untwisted for more than 12 mm from the point of termination to maintain cable geometry.

.4 CAT6 cables shall be terminated in accordance with TIA/EIA-568-B.1, TIA/EIA-568-B.2.

.5 All elements of CAT6 cables shall be terminated and no cable shall contain un-terminated elements.

.8 Fibre-Optic Cable Terminations

.1 All fibre-optic cables will be terminated by the Contractor in accordance with the Purchaser's specifications.

.2 Unless otherwise advised by the Engineer, all fibre optic terminations shall use SC type connectors with zirconium ferrule inserts.

3.5 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specifications.

.2 Wires and Cables

.1 Site installation checks and test for all wires and cables and their terminations shall include:

.1 Check for any cuts or abrasions in the insulation or protective covering, or kinks in the insulation, jacket or amour.

.2 Connection tightness and termination security checks - visual and physical.

.3 Circuit continuity test using an accurate ohmmeter.

.4 Insulation resistance test, using 1,000 V megger for all equipment rated 600 V and above and 500 V megger for equipment rated less than 600 V, - recording each minute until three equal and consecutive readings, with acceptance being a minimum of 50 megohms between phase conductors and between phase conductors and ground in a 3-phase 600 V circuit and 25 megohms in a 300 V circuit.

.5 Armor and shielding continuity and grounding checks, using an accurate ohmmeter.

.6 In addition, for MV cables and their terminations, high-potential dielectric withstand test in accordance with the manufacturers recommended test procedures.

.3 Non-Metallic Cables (Fibre Optic)

.1 Site installation checks and tests for all fibre optic cables and their terminations shall include:

.1 The Purchaser will provide detailed testing requirements.

.2 Armor and shielding continuity and grounding checks, using DC bell or buzzer, etc. and/or accurate ohmmeter.

.2 All test data and checks shall be recorded and shall include the location and identification of equipments and megohm readings versus time for insulation tests.

3.6 CLEANING

.1 Shall be in accordance with Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed by the Contractor pursuant to this Section shall consist of supplying all labour, Materials, Plant, and Tools and performing all Work necessary for supplying, loading, transporting, unloading, handling, fabricating, installing and testing the portions of the grounding system embedded in the concrete structures or buried in the embankments, as shown on the Purchaser's Drawings.

.2 The embedded grounding system shall be installed within all poured concrete structures including piles, foundations, beams, slabs, walls, and decks as shown on the Purchaser's Drawings. The embedded grounding system shall ensure that all concrete components of the structure remain at equal electrical potential at all times.

.3 The embedded grounding system shall consist of interconnected copper conductors and copper ground grids embedded within the poured concrete structures. The concrete reinforcing steel shall be connected to the embedded copper conductors at regular intervals, and to embedded metal parts.

.4 Tails up from the embedded grounding system shall be provided for equipment grounding and shall be located so as to minimize damage during installation.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 26 05 00 - Electrical General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 American National Standards Institute/Institute of Electrical and Electronics Engineers (ANSI/IEEE):

.1 ANSI/IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

.2 Purchaser's Drawings

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

.2 Measurement

.1 Measurement for Items 26 05 27 (a) and 26 05 27 (b) will be in metres based on the neat lines as shown on the Purchaser's Drawings and as directed by the Engineer.

.2 Measurement for Items 26 05 27 (c) to 26 05 27 (f) inclusive will be based on the number of Items as shown on the Purchaser's Drawings and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 26 05 27 (a) and 26 05 27 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply and installation of embedded grounding wire as specified herein, as directed by the Engineer, and as follows:

.1 Item 26 05 27 (a) shall cover 500 MCM stranded bare copper conductor.

.2 Item 26 05 27 (b) shall cover 4/0 AWG stranded bare copper conductor.

.2 The unit prices proposed for Items 26 05 27 (c) to 26 05 27 (f) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply and installation of embedded grounding connections and accessories as specified herein, as directed by the Engineer, and as follows:

.1 Item 26 05 27 (c) shall cover horizontal exothermic tee connection 500 MCM run and 500 MCM tap.

.2 Item 26 05 27 (d) shall cover horizontal exothermic tee connection 500 MCM run and 4/0 AWG tap.

.3 Item 26 05 27 (e) shall cover horizontal exothermic tee connection 4/0 AWG run and 4/0 AWG tap.

.4 Item 26 05 27 (f) shall cover horizontal exothermic cross connection 500 MCM to 500 MCM.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents.

.2 Product Data

.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria and physical size.

1.6 WASTE MANAGEMENT AND DISPOSAL

.1 The requirements shall be in accordance with Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Conductors: bare, stranded, soft annealed copper wire, size No. 4/0 AWG and 500 kcmil for ground bus, electrode interconnections, metal structures, gradient control mats, transformers, switchgear, motors, ground connections.

.2 Connectors: exothermic (Cadweld) type conductor connectors.

.3 Use all materials provided by one manufacturer - do not mix products or materials.

Part 3 Execution

3.1 INSTALLATION REQUIREMENTS

.1 Install the embedded ground grid in accordance with the Purchaser's Drawings.

.2 Connect the steel reinforcement to the grounding system, using exothermic connections at regular intervals not exceeding 12 m, and at every corner of the floor surfaces. Provide additional connections for large surfaces such as the transformer deck.

.3 Powerhouse Complex

.1 Throughout the Powerhouse Complex install the embedded ground grid consisting of bare, stranded copper conductors embedded below the floor surfaces or reinforcing as shown on the Purchaser's Drawings. The copper grid will make continuous, closed loops or meshes over all floor areas surrounding installed equipment, cables and exposed structural metalwork.

.2 Interconnect the grounding grids on each floor level with all other floor levels and areas using multiple embedded vertical or horizontal runs of copper conductor.

.3 Vertical conductors, from the grids on the various powerhouse levels, shall extend into the foundation of the Powerhouse Complex. These shall be connected to the embedded metal parts including service gate guides, draft tube, spiral case, and to the concrete reinforcing bars. Dedicated connections from the powerhouse grid shall provide high security ground connections for generator frames, neutral cubicles, surge protection cubicles and isolated-phase bus enclosures.

.4 Tailrace Deck

.1 Install the tailrace deck ground grid, consisting of embedded 500 kcmil copper conductors in all areas occupied by the high-voltage equipment. Interconnect the tailrace ground grid with the powerhouse ground grid.

.2 Extend connections from the tailrace deck ground grid to the generator step-up transformer tanks, disconnect switches, lighting arrestors, high-voltage neutral point and to the high-voltage bus supports installed at the transmission line terminations.

.5 Intake Deck

.1 If radio tower is located on the intake deck - install embedded #4/0 AWG copper ground conductors in the intake deck structure and hoist housing concrete and one meter around each of the radio tower footings, connect to the tower legs and the generating station ground system using exothermic connections.

.6 Spillway

.1 Install embedded #4/0 AWG copper ground conductors in the spillway structure concrete. Connect to the powerhouse grounding system and to embedded rebar and metal parts using exothermic connections. Provide stub-ups to equipment.

3.2 INSTALLATION METHODS

.1 Install continuous grounding system including electrodes, conductors, connectors and accessories as indicated on the Purchaser's Drawings.

.2 Install exothermic (Cadweld) connectors in accordance with manufacturer's instructions.

.3 Protect exposed stubbed-up tails during and after construction. Provide Schedule 80 PVC sleeves on the stub-ups where they exit the concrete. After concrete placement, fill the sleeve with elastomer sealant to prevent water ingress into the concrete.

3.3 FIELD QUALITY CONTROL

.1 The requirements shall be in accordance with Section 7.13 Project Quality Management of the General Specification.

.2 Test all subsurface ground system interconnections for continuity by dc injection, between closest segments of conductors emanating from concrete slabs after forming is removed. Where impedance is greater than 10 milliohms between nearest conductors, mark the end 100 mm of both conductors with red waterproof spray paint and mark location on Contractor's Documents for future testing.

.3 All ground test data shall be submitted for review by the Engineer.

3.4 CLEANING

.1 Shall be in accordance with the requirements of Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Surface-Mounted Grounding and Bonding System shall consist of copper grounding conductors and ground buses, affixed to the wall and floor surfaces in the powerhouse complex and spillway, and placed in each cable tray run. The Surface-Mounted Grounding and Bonding System connects the embedded ground grid system to all pieces of equipment including panels, cubicles, exposed metalwork, cable trays, ducts, fences which are not connected directly to the embedded ground grid, and to all other components for the purpose of grounding and bonding the equipment enclosures and exposed metalwork to the station ground grid.

.2 The Contractor's responsibilities pursuant to this Section of the Technical Specification, in respect of the Surface-Mounted Grounding and Bonding System include but are not limited to the following:

.1 Detail, supply, handle, secure and store on Site:

.1 Specified type and ratings of copper ground conductor, ground bus, ground conductor terminations, mounting hardware and all required accessories for installation of the grounding and bonding system.

.2 Install, terminate and connect all specified and required surface-mounted grounding and bonding materials indicated on the Purchaser's Drawings.

.3 Install, terminate and connect all specified and required buried and surface-mounted grounding and bonding conductors, connectors and hardware required for grounding of Site fences and outbuildings as shown on the Purchaser's Drawings.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 27 - Embedded Grounding.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 CSA C22.1 - Canadian Electrical Code Part 1.

.2 ANSI/IEEE 837 - IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.

.4 Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurements

.1 Measurement for Items 26 05 28 (a)i to 26 05 28 (b)ii inclusive will be in metres based on the neat lines shown on the Purchaser's Drawings and as determined by the Engineer.

.2 Measurement for Items 26 05 28 (b)iii to 26 05 28 (g) inclusive will be based on the number of Items as shown on the Purchaser's Drawings and as determined by the Engineer.

.3 Unit Price

.1 The unit price for Items 26 05 28 (a)i to 26 05 28 (g) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission, shall be used for the supply, Site handling, storage, installation including consumables and connectors, testing and pre-commissioning, and turn over documentation as specified herein, as determined by the Engineer, as follows:

.1 Items 26 05 28 (a)i to 26 05 28 (b)ii inclusive bare copper conductors and hardware.

.2 Item 26 05 28 (b)iii shall cover miscellaneous structures.

.3 Item 26 05 28 (c)i and 26 05 28 (c)ii shall cover grounding equipment for the communication room.

.4 Items 26 05 28 (d) to 26 05 28 (g) inclusive shall cover grounding connections.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Provide manufacturer's printed product literature, specifications and datasheet, and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Provide as-built marked-up drawings identifying the as-installed locations and installation details and dimensions for the surface-mounted grounding and bonding system components.

.4 Submit earth loop and resistance test results for Engineer’s review in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

1.7 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Ground Conductors

.1 Ground conductor for tap connections from the powerhouse concrete-embedded ground grid to equipment and exposed metal work shall be bare copper, soft annealed, concentric stranded conductor of specified size - typically 500 kcmil and 4/0 AWG.

.2 Extra flexible #3/0 AWG (425 strands) copper conductor shall be for connection of switch mechanism operating rod to gradient control mat, fence gates, vault doors.

.3 The ground bus bars shall comprise of electrical grade tin-plated copper of the specified dimensions, complete with specified stainless steel supports and stainless steel hardware for anchoring, supporting and securing the bus to vertical concrete walls.

.4 The ground bus bar assemblies shall include flexible copper braid jumpers for spanning structural contraction or expansion joints.

.5 The ground bus bars shall be pre-drilled for support insulators, but shall be Site-drilled as required for tap connections.

.2 Bonding Conductors

.1 Ground conductor for bonding connections from the powerhouse concrete-embedded ground grid to equipment, cable trays, hand rails and exposed metal work shall be bare or PVC-insulated copper, soft annealed, concentric stranded conductor of specified size - typically #2/0, #6 AWG, #10 AWG.

.3 Connections and Terminations

.1 Connection of grounding conductors to termination lugs and other grounding conductors shall use compression connectors for all connections not visible after completion.

.2 Connection of grounding conductors to termination lugs and other grounding conductors shall use mechanical connection, with proper preparation of the contact surface, for all connections visible after completion.

.3 Due to limitations in the sizing of compression fittings, exothermic welds of appropriate size and rating may be used for specific grounding connections such as to large diameter reinforcing steel with due care and attention to Workplace Safety and Health regulations for workers' safety.

.4 Grounding and bonding connections to equipment and cubicles shall be made utilizing mechanical-bolted type connectors provided with the equipment for that purpose.

.5 Grounding and bonding connections to exposed structural metalwork shall be made utilizing compression terminations and mechanical contact connections of appropriate type, size and rating.

.6 Grounding and bonding connections to specific exposed metalwork, such as cable trays, fence posts and wire mesh, handrails, etc, shall be made utilizing fit-for-purpose mechanical bolted connectors as manufactured by Burndy™ or Purchaser's approved equivalent.

.7 Anti-oxidation compound shall be utilized on all bolted connections and crimp type terminations. The anti-oxidation compound shall be Burndy Penetrox, or Purchaser's approved equivalent, designed for the specific materials which are being joined.

.4 Bolted removable test links for testing as required.

.5 Gradient control mats (on tailrace deck)

.1 Galvanized steel, size 1 m x 1 m, 25 x 25 mm mesh and 25 mm thick.

.6 Accessories

.1 Compression connectors: Burndy Hyground™.

.2 Mechanical connectors: Burndy type GBM, GC, etc.

.3 Exothermic connectors: Cadweld™.

.4 Stainless steel bolted connectors and hardware.

.5 Cable sheath isolating sleeves.

.6 Anti-Oxidation Compound: Burndy Penetrox.

Part 3 Execution

3.1 INSTALLATION REQUIREMENTS

.1 The locations, routings, sizing and arrangement details of grounding and bonding system main circuits and connections shall be as indicated on the Purchaser's Drawings.

.2 Detail, itemize and quantify the surface-mounted, direct-buried grounding and bonding design arrangement, and details as indicated on the Purchaser's Drawings for the purpose of supplying and installing.

.1 All grounding and bonding conductors, buses, connectors, clamps, materials and hardware required for the complete and proper supply of the surface-mounted and direct-buried grounding and bonding as indicated on the Purchaser's Drawings and in this Section of the Technical Specification.

.2 All equipment, materials, hardware and tools required for the complete and proper installation, securing, and termination of the required surface-mounted and direct-buried grounding conductors and equipment bonding systems.

.3 Bond all electrical equipment enclosures, framework and equipment components to the embedded ground grid system.

.4 Bond all metallic cable raceways and all exposed metallic parts of the installation including structural members, rails, pipes, air ducts, frames, dividers, handrails, ladders, platforms, water, air and oil distribution systems to the nearest ground grid conductor in accordance with the requirements of the Canadian Electrical Code (CEC).

.5 Provide bonding as required to maintain the electrical continuity of cable trays, wireways, pipes, air ducts, rails and ladder ways. Bonding of electrical equipment, cable trays and wireways shall ensure electrical continuity and fault current capacity in accordance with the CEC.

.6 Bond all tanks, including fuel, lube oil, compressed air, etc.

.7 Form and support exposed bonding conductor on the surface of equipment or structures at not more than 1 m intervals using galvanically compatible hardware. Provide mechanical protection for exposed conductor as per the CEC.

.8 Metallic conduit shall not be used for bonding. Provide and install separate bonding conductors sized as per the Drawings and the CEC.

.9 Bond motors to ground using the feeder cable bonding conductor (in the case of 208/120 V motors) or via an external bonding connection between the motor frame and the station ground grid.

.10 Grounding and Bonding Connections

.1 Make grounding connections as specified. Paint, scale, rust, corrosion, and other foreign matter shall be removed from points of contact on metal surfaces before ground connections are made. Apply anti-oxidant compound to both surfaces before making connection. Remove excess compound after connection is made.

.2 Exothermic welded connections shall be made strictly in accordance with the weld manufacturer's written recommendations. Welds which are "puffed up" or which show convex surfaces, indicating improper cleaning, shall not be accepted.

.3 Make compression connections using a hydraulic compression tool with suitable dies to provide the correct circumferential pressure. Tools and dies shall be as recommended by the Manufacturer. An embossing die code or other standard method shall provide visible indication that a connector has been adequately compressed on the ground conductor.

.4 Make ground tap connections to equipment at points provided on the equipment for grounding, in accordance with the manufacturers' recommendations. Make ground connections to the ground buses of switchgear, distribution panels, motor control centres and other cabinet-mounted equipment by means of an acceptable bolted connector either as provided with the equipment or as provided by the Contractor and secured to a specified connection point.

.11 Cables and Busbar

.1 Terminate metallic sheaths and shields of all power, control or instrumentation cable using screw type ground lugs and an appropriately sized copper conductor for connecting to the panel/assembly ground bus. Multiple ground lugs may share a common connection to the ground bus.

.2 Install wall-mounted copper ground bus-bar where indicated on drawings, to which equipment bonding cables shall be connected. In areas with lower densities of electrical equipment use the cable tray bonding system for equipment bonding.

.3 For multi-conductor power cables connect the bonding wire and cable armour at both ends of the cable. The conductor shields shall typically be bonded at both ends, however, certain installations may require that the shield is left unconnected at one end.

.4 For single-conductor power cables connect the bonding wire and cable armour at both ends of the cable. The conductor shields shall typically be bonded at one end only, although certain installations may require that the shield is bonded at both ends.

.5 For multi-conductor control cables connect the bonding wire and/or drain wire(s) to the ground bus at one end of the cable only, as indicated on the Purchaser's Drawings.

.12 Chain link fences installed within the powerhouse complex area shall typically be encircled by a buried #4/0 ground conductor, at a distance of one meter outside the fence and at a maximum of 0.5 m below the surface of the ground. The ground conductor shall be bonded to the fence at regular intervals (not exceeding 10 m) and to the grounding system, using compression connections. The surface covering along the chain link fencing shall typically consist of a highly resistive material such as crushed rock or asphalt to increase the allowable touch voltage threshold. If the surface covering near the fence is concrete, the rebar must be bonded to the fence and the grounding system.

.13 Loads Outside of Station Grid

.1 The power cable that is used to feed station auxiliaries outside the powerhouse ground grid area must contain a bonding conductor that is connected to the ground bus in the switchgear and that is bonded to the device enclosure at the remote end. A local safety mat must be installed at the station auxiliary that is connected to the device or metallic enclosure which personnel may be in contact with. The local safety ground could be a mat or a #4/0 copper ground conductor that is buried within 1 m of the metal enclosure.

.2 If the distance to the auxiliary device is far from the station, there may be significant voltage drop in the ground conductor during a fault and therefore a dedicated ground conductor may be required that is adequately sized to connect the safety ground to the main ground bus.

.14 UCMS and Communications Systems

.1 Connect isolated ground bus-bars in the UCMS cabinets to the Powerhouse grounding system at one point only to prevent common mode voltages due to circulating currents. Bond all cable shields in instrumentation and control cables to the instrument isolated ground bar within the local UCMS cabinet.

.2 Install a dedicated ground bus within the Communications Room to provide a single point of grounding for communications equipment.

3.2 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Perform earth loop test and resistance tests using method appropriate to Site conditions and Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

3.3 CLEANING

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section of the Technical Specification covers the supply and installation of the cable and wiring support systems for all cabling and MV/LV power wires throughout the Powerhouse Complex, Spillway and between the Spillway and Powerhouse Complex.

.2 The cable and wiring support system shall be comprised of required cable trays and associated hardware, required conduits and associated hardware, mounting and support hardware.

.3 The Contractor shall use the approved design developed by the Engineer, and shall be responsible for the following Work:

.1 Detail, quantify, supply, handle, secure and store on Site:

.1 Specified types, sizes and lengths of metal cable tray, tray barrier and fittings and materials for forming and securing cable drops to equipment and complete with all required installation hardware.

.2 Specified types, sizes and lengths of rigid metal conduit and complete with all required installation hardware.

.2 Install all specified and required cable trays and associated hardware.

.3 Install all specified and required surface-mounted conduits and associated hardware.

.4 Install all specified and required embedded conduits and associated hardware.

.5 Provide as-built marked-up drawings identifying the as-installed locations and dimensions of cable trays and conduits.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 07 91 26 - Joint Fillers.

.3 Section 07 92 00 - Joint Sealants.

.4 Section 26 05 21 - Wire and Cable Systems.

.5 Section 26 05 28 - Surface Grounding.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work sshall be performed in accordance with:

.1 ASTM:

.1 ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

.2 Canadian Standards Agency (CSA):

.1 CSA C22.1 - Canadian Electrical Code, Part I.
.2 CSA Z462 - Workplace Electrical Safety.
.3 CSA C22.2 No. 18.3 - Conduit, Tubing and Cable.
.4 CSA C22.2 No. 40 - Conduit Junction and Pull Boxes.
.5 CSA C22.2 No. 45 - Rigid Metal Conduit.
.6 CSA C22.2 No. 56 - Flexible Metal Conduit and Liquid Tight Flexible Metal Conduit.
.7 CSA C22.2 No. 83 - Electrical Metallic Tubing.
.8 CSA C22.2 No. 126.1 - Metal Cable Tray Systems.

.3 National Electrical Manufacturers Association:
.1 NEMA VE 1 - Metal Cable Tray Systems.
.2 NEMA VE 2 - Cable Tray Installation Guidelines.

.4 Project Models.

.5 Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for equipment Items 26 05 29 (a) to 26 05 29 (d) shall be in metres based on the neat lines shown on the Purchaser's Drawings and as directed by the Engineer.

.2 Measurement for equipment Item 26 05 29 (e) shall be based on the quantity as shown on the Purchaser's Drawings and as directed by the engineer.

.3 No separate measurement will be made for miscellaneous connectors and fittings to secure the conductors shall be incidental to the installation.

.3 Unit Price

.1 The unit prices proposed for Items 26 05 29 (a) to 26 05 29 (e) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, Site handling, storage, installation including supports, fittings, or firestops as required, and visual inspections as follows:

.1 Item 26 05 29 (a) shall cover horizontal cable trays.

.2 Item 26 05 29 (b) shall cover vertical cable trays.

.3 Item 26 05 29 (c) shall cover exposed conduits and support systems.

.4 Item 26 05 29 (d) shall cover embedded conduits and support systems.

.5 Item 26 05 20 (e) shall cover cable tray supports.

.2 Miscellaneous connectors and fitting them to secure the conductors are considered incidental to the Work. Include costs for this Work in the unit prices proposed for Item to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.3 Quality Plan submittals

.1 Submit the Quality Plan for the cable and wire support system installation for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Field Inspection and Test Reports: Submit proposed field inspection and test reports for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Managment of the General Specification.

.2 Qualifications

.1 The engineers, technologists, technicians and tradesmen assigned to do this aspect to of the Work shall be certified and experienced in wire and cable installations.

.2 The Contractor shall have qualified staff trained in project control and quality assurance, and to support quality surveillance.

.3 Provide services, if required, of representative or technician from manufacturer, experienced in installation, to supervise installation, adjustment, preliminary testing, and final testing of systems and to provide instruction to Project personnel.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspections of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading

.1 Deliver, store and handle Materials in accordance with Subsection 7.24 Inspections of Deliveries to Site and Storage of the General Specification and in accordance with the manufacturer's written instructions.

.2 Store Materials off ground, in accordance with manufacturer's recommendations, and in a clean, dry, well-ventilated area.

.3 Replace defective or damaged materials with new.

Part 2 Equipment and Materials

2.1 DESIGN REQUIREMENTS

.1 The final routing, elevations, sizing and installation details of the cable and wire support systems are to be reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.1 Cable Tray Systems:

.1 The designed vertical grouping of the cable tray runs is generally in accordance with the voltage level of the supported cables, with highest voltage at the top, as follows:

.1 12.47 kV power distribution.

.2 347-600 V power distribution.

.3 120-208 V power distribution.

.4 48 V and 125 V dc power distribution.

.5 LV AC control systems.

.6 DC control systems.

.7 Communication and computer network systems.

.2 The Contractor shall be responsible for maintaining the above groupings throughout the entire installation to the satisfaction of the Engineer.

.3 The Contractor shall be responsible for detailing, itemizing and quantifying, for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, the cable tray system as depicted on the Purchaser's Drawings for the purpose of supplying and installing:

.1 All materials and hardware, including expansion joint assemblies, required for assembling and routing the cable trays.

.2 All materials and hardware required for the entrance and exiting of cables onto the cable trays, while maintaining acceptable bending radii, including the addition of open 'Tee' and 'dropout' sections for multiple cable access to panels.

.3 All materials and hardware, including miscellaneous lengths of instrument tray and/or cables ladders, as required for secure routing of cables from the principal cable tray runs to Items of equipment.

.4 All materials and hardware required for positioning and securing cables within and onto the cable trays, including single 3-phase metal cable clamps and three-single-phase-cables-in-flat non-metallic cable clamps, shall be utilized in order to maintain the required cable spacing and forming.

.5 All materials and hardware required for supporting, anchoring and proper installation and finishing of the cable trays.

.6 All locations and sizes of openings, where cable trays pass through floors or fire-rated walls, and which require firestopping.

.2 Conduit Systems:

.1 The Contractor shall be responsible for sizing, routing, detailing, itemising and quantifying the conduit system including the surface mounted conduits and the embedded conduits, in accordance with the requirements of the Canadian Electrical Code (CEC), for the purpose of supplying and installing:

.1 All conduit, materials and hardware required for accommodating the applicable wire interconnections between equipment.

.2 All materials and hardware for cutting to the correct length, bending, threading, and reaming ends, installation of expansion joints and general assembly of the conduits and fittings where required.

.3 All materials and hardware required for terminating the conduits onto the identified devices.

.4 All materials and hardware required for surface mounting and anchoring the conduits where required.

.5 All materials and hardware for embedding the conduit where required.

.6 All locations and sizes of openings, where conduits pass through floors or fire-rated walls, and which require firestopping.

2.2 CABLE TRAYS

.1 All metal cable trays shall comply with the requirements of CSA C22.2 No. 126.1.

.2 Cable tray shall be either:

.1 Class D1, heavy duty, ladder-type, minimum 14 gauge steel, hot dipped galvanized after fabrication per ASTM A123, widths as indicated on the Purchaser's Drawings, with 225 mm (9") rung spacing and 100 mm (4") inside depth side channel.

.2 Class D1, heavy duty, ladder-type, extruded from Aluminum Association Alloy 6063, widths as indicated on the Purchaser's Drawings, with 225 mm (9") rung spacing and 100 mm (4") inside depth side channel.

.3 Cable tray in the water treatment plant shall be aluminum.

.4 All cable trays shall be free of sharp burrs, projections and exposed sharp edges that might be injurious to the cables.

.5 All tray fixtures, fittings and supports shall be hot-dipped galvanized steel for steel trays, or fabricated from Aluminum Association Alloy 5052 for aluminum trays.

.6 Hanger rods and fasteners shall be stainless steel. All supports and hangers shall be equipped with end caps and shall be assembled with matching spring clamp nuts and cap screws.

.7 Solid covers shall be provided for cable trays installed in areas where cables may be exposed to physical damage.

.8 Barrier strips, the same height as the cable tray sides, shall be provided where required or specified for separation of power and control cabling and for separation between spaced and random fill sections for power cables.

.9 Only specific fittings for each cable tray type and size, such as bends, elbows, reducers, dropouts, tees and wyes, as fabricated by the cable tray manufacturer, shall be used.

2.3 CONDUITS

.1 Surface mounted and embedded conduits, fittings and accessories shall comply with the applicable CSA standards.

.2 All conduits shall be full weight and size, rigid, hot-dip galvanized steel. All conduit fittings, accessories, caps, bushings, pennies and supports shall be hot-dip galvanized. Wooden plugs or make shift caps for the embedded conduits will not be permitted.

.3 Acceptable product for the expansion joints is Crouse-Hinds XJG, complete with braided tinned copper ground strap and U-bolts. Equivalent product by Appleton is also acceptable or Purchaser's approved equivalent.

.4 Exposed boxes shall be cast steel, hot-dip galvanized with threaded hubs and gasketted steel covers. Covers shall be secured with cadmium-plated steel screws.

.5 EMT-type conduit and fittings may be used in office locations or where concealed in finished walls, as authorized by the Engineer.

.6 One-hole steel straps for conduits of 50 mm trade size or smaller and two-hole steel straps for conduits larger than 50 mm shall be provided for securing the conduit to surfaces.

.7 'U' channels with stainless steel threaded rod and stainless steel conduit fasteners shall be provided for mounting of parallel conduit runs.

2.4 FIRESTOPS

.1 Firestop materials shall be provided, conforming to standard CAN/ULC-S115, with a minimum fire resistance rating of 2 hours or equal to the fire rating of the penetrated wall, floor or ceiling, whichever is greater.

.2 Firestop materials shall be asbestos-free, capable of maintaining an effective barrier against flame, smoke and gases and rated not to exceed the opening sizes for which they are intended.

.3 Firestop materials for cable bundles shall comprise of non-curing, re-penetrable, intumescent materials.

.4 Accepted manufacturers of firestop materials are:

.1 Hilti.

.2 A/D Fire Protection Systems.

.3 Shall be in accordance with Section 07 91 26 Joint Fillers and Section 07 92 00 Joint Sealants.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, programming instructions, and datasheet.

3.2 INSTALLATION REQUIREMENTS

.1 Cable Trays

.1 The cable tray system and supports shall be installed rigid, level and straight. No part of the cable tray system shall rise, buckle, sag, twist or have any other un-designed deflection of more than 3 mm when installed. The tray sections and fittings shall join together to provide smooth joints.

.2 All cable trays shall be run parallel to or perpendicular to building lines.

.3 All cable trays shall be installed to ensure that cable bends are equal to or greater than the manufacturer’s specified minimum bending radii. In all cases the minimum radius for horizontal elbows, vertical riser, tee and cross trays shall be 300 mm.

.4 Cable trays shall not be run on roofs or exposed exterior surfaces unless specifically shown on the Purchaser’s Drawings or reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification.

.5 In areas where cables may be exposed to physical damage, cable tray installations shall include solid covers. Cable trays extending vertically through floors shall be totally enclosed for 2 m above the floor to provide mechanical protection.

.6 In accordance with CEC, a minimum 150 mm vertical clearance shall be maintained between cable trays in tiers, except for trays with cables 50 mm or more in diameter for which 300 mm clearance shall be maintained. This measurement shall be made between the closest part of each tray, not the rungs.

.7 A minimum clearance of 300 mm shall be maintained between the top of the tray to all ceilings, heating ducts and heating equipment, with 150 mm clearance allowed for short obstructions and 600 mm horizontal clearance shall be maintained on at least one side of cable trays to adjacent trays or other structures.

.8 Cable tray runs with expansion joints shall be installed per the manufacturer’s recommendations. Expansion joint splice plates shall be used to allow 30 mm of free movement between trays wherever the trays cross a structural expansion joint.

.9 All cable trays shall be supported from building structural members. Drilling or welding of structural members shall only be permitted as detailed on the Purchaser’s Drawings, and where necessary shall be evaluated for the effect on the structure. Embedded heavy-duty channel supports will be supplied in concrete walls and ceilings, to accept threaded rod or other types of hangers and brackets.

.10 Cable trays shall be secured using specific-purpose clamping hardware provided by the tray manufacturer. Support fasteners shall be wood screws to wood; toggle bolts on hollow masonry units and concrete inserts or expansion bolts on concrete or brick. Load applied to fasteners shall not exceed one-fourth proof

test load. Holes cut to depth of more than 40 mm in reinforced concrete beams or to depth of more than 20 mm in concrete joints shall not cut main reinforcing bars.

.11 Cable trays shall be supported at intervals not greater than 3 m, and so that the tray deflection under maximum load shall not cause permanent deformation or weakening of the cable tray. The maximum mid-span deflection of the tray shall not exceed 10 mm.

.12 Brackets for attaching trays to walls shall be standard tray fittings. Brackets for support from ceilings shall be either tree-type or trapeze-type.

.1 Tree-type brackets shall consist of one vertical double-channel center section fastened to inserts in the ceiling and carrying adjustable tray supports on each side.

.2 Trapeze-type brackets shall consist of two 12 mm (1/2" nominal) threaded rods suspended from inserts in the ceiling, to which are attached one or more horizontal steel channel sections upon which the tray shall be clamped.

.13 Supports shall adequately support the cable tray per the manufacturer's recommendations. Only one tray joint shall be allowed between a set of supports.

.14 In passages, walkways, and other access areas, supports shall be installed so that protruding ends are kept to a minimum length.

.1 Excess ends of supports and hanger rods shall be cut off and field cuts shall be smoothed and painted with a suitable corrosion inhibiting coating. Touch-up paint shall be an organic, cold galvanizing compound having a minimum of 65% zinc dust in the dry film.

.2 Alternative method is to cut off and terminate with acorn nuts (of material similar to nuts/rods).

.15 The Contractor shall, where necessary, modify the installation position of the cable trays in coordination with the on-Site mechanical ductwork, piping, structural members, fireproofing and sprinkler system piping to ensure the cable trays remain accessible after installation and do not interfere with the Work of other trades.

.16 The Contractor shall coat all field-cut ends of galvanized steel with a Galvfroid coating or Purchaser's approved equivalent.

.17 A continuous ground conductor, minimum size No. 2 AWG, or as shown on the Purchaser's Drawings, shall be provided throughout the length of the cable tray run. The ground conductor shall be bonded to the cable tray as detailed on the Purchaser's Drawings.

.18 Only the manufacturer's fittings shall be used and no field modifications to tray sections or fittings, to create custom elevation or directional changes, will be permitted unless authorized by the Engineer.

.19 Holes shall not be cut in cable tray for the purpose of allowing cables to exit unless specifically authorized by the Engineer. Where such holes are approved, they shall be provided with grommets to provide protection to the cable jacket.

.20 Where specified, power cables shall be laid in cable trays with 100% spacing maintained between circuits, with the cables held in position by means of specific design cable clamps, spaced at no greater than 1,500 mm intervals. Typically power circuits comprising of single-conductor cables, 2/0 AWG or larger shall be

installed in a flat arrangement with the arrangement and spacing maintained by means of plastic spacer blocks that allow for stacked arrangements of up to three layers deep. Where specified, 100% spacing for 3-phase cables shall be maintained by means of metal single-cable clamps. In tray runs where one horizontal , spaced layer of cables is possible, Contractor may propose to use approved spacing blocks to ensure cable spacing is maintained at not less than one cable diameter so as to retain the ampacity rating of the cables.

.21 Where non-spaced cables are specified, the cables shall be laid neatly, in not more than three layers deep.

.22 Control cables shall be laid neatly in not more than three layers deep. Barrier strips shall be installed in mixed use cable trays for separation of power and control cabling and in specified sections of power circuit cable trays for separation between controlled-spacing cable installation and random fill cable installation.

.23 Cable trays carrying 12.47 kV cables shall be marked "Danger 12470 V" by self-adhesive signs at a minimum interval of 30 m and in every room or enclosed area through which the trays pass.

.24 Cable trays shall be coded for identification as shown on the Purchaser's Drawings. The identification code shall appear in self-adhesive numbers at least once in every room or enclosed area through which the trays pass, where the tray number changes due to a change of elevation or direction, at any wall pass through, and every 30 m when in an open area.

.2 Conduits

.1 Embedded Conduits:

.1 Installation of the embedded conduit system shall consist of cutting to the correct length, bending, threading and reaming ends, installation of expansion joints and general assembly of the conduit and fittings.

.2 Bending shall be done in an approved manner and there shall be no flattening of the section or cracking of the conduit.

.3 The ends of cut conduit shall be carefully reamed to provide a smooth interior surface when assembled. All joints shall be threaded. Welding of the conduit will not be permitted. The ends of the conduit shall be protected and closed off by threaded caps or bushings and steel or fibre pennies.

.4 Conduit and fittings shall be placed accurately in the forms and shall be securely fastened in place to prevent displacement either at the terminals or along the run.

.5 All conduit and fittings shall form a continuous metallic path, all joints or connections shall be watertight.

.6 Where embedded conduit crosses a contraction or expansion joint, expansion fittings with integral bonding system shall be supplied and installed.

.7 Metal conduit installed underground shall be painted with two coats of corrosion inhibiting compound before backfilling. A marker tape shall be positioned 300 mm above the conduit run.

.2 Surface mounted conduits:

.1 Conduits shall be run parallel or perpendicular to building lines. Conduits shall be grouped whenever possible.

.2 Conduits shall be run on the flanged surface of structural steel and shall not pass through structural members.

.3 Conduits less than or equal to 50 mm trade size shall be supported by one-hole clamps. Conduits larger than 50 mm trade size shall be supported by 2-hole clamps.

.4 Conduit support fasteners shall be wood screws to wood; toggle bolts on hollow masonry units; concrete inserts or expansion bolts on concrete or brick; and beam clamps, or spring-tension clamps on steel work. Conduits or conduit supports shall not be welded to steel structures.

.5 Load applied to fasteners shall not exceed one-fourth proof test load.

.6 Fastener holes drilled to a depth of more than 40 mm in reinforced concrete beams or to a depth of more than 20 mm in concrete joints shall not cut main reinforcing bars. Any unused holes shall be properly filled and finished.

.7 Parallel conduit runs shall be supported on 'U' channels (trapezes) mounted at 1.5 m intervals. Horizontal channels (trapezes) shall be supported with threaded rod with a minimum diameter of 6 mm.

.8 Supports or equipment installed for other trades shall not be used for conduit support unless specifically authorized by the Engineer. Conduits shall not be supported by ceiling support system. Conduit and box systems shall be supported independently of either tie wires supporting ceiling grid systems or ceiling grid systems into which ceiling panels are placed.

.9 Pull boxes shall be installed at a minimum spacing of 30 m of conduit run. Conduit runs between outlet and outlet, between fitting and fitting, or between outlet and fitting must not contain more than the equivalent of three 90° bends, including those bends located immediately at the outlet or fitting.

.10 Conduits shall not be used as junction boxes.

.11 Where conduit crosses building contraction or expansion joints, the Contractor shall install an approved expansion fitting, with internal bonding conductor, and shall provide bends or offset in conduit adjacent to building joint where conduit is installed above suspended ceilings.

.3 Conduits shall be identified by color coding in accordance with Section 26 05 00 Electrical General Requirements.

.4 Conduits shall be cut square, properly reamed, have cut threads and shall have threads brushed clean, and joints must be brought butt-to-butt in the couplings. All conduits shall be deburred and cleaned of all debris and moisture throughout its length before pulling any wires.

.5 Where conduit is threaded in the field, each threaded end must consist of at least five full threads. Corrosion-inhibitive compound must be used on conduit threads in exterior areas.

.6 The Contractor shall install polypropylene fish cord in empty conduits. The fish cord shall have a minimum 890 N force tensile strength. A minimum 915 mm of slack length shall be provided at each end of cord.

.7 The Contractor shall cap open conduit ends to prevent entry of dirt and moisture.

.8 Field bending of conduit shall be carried out with approved hickey or conduit bending machines designed for the purpose, so as not to distort nor vary the internal diameter of the conduit. If the diameter of the bent conduit is less than 90% of the original diameter, the conduit must be discarded. Conduit elbows larger than 65 mm trade size shall be long radius, manufactured elbows.

.9 The use of dissimilar metals throughout the conduit system shall be avoided to eliminate the possibility of galvanic corrosion. Place appropriate insulators between the two contact faces where dissimilar metals are in contact.

.10 Conduit terminations in sheet metal enclosures shall be fastened with two locknuts and terminate with a bushing. The interior area immediately around the opening shall be cleaned free of paint to ensure a good bond between the conduit and enclosure. Install locknuts inside and outside enclosures.

.11 Boxes shall be plumb with the surrounding structures, and shall be securely fastened in place, independent of the conduits or wires entering them.

.12 A separate insulated ground conductor independent of the conduit shall be run in all conduits to every light fixture, receptacle and switch and shall be connected to the ground terminal in each conduit fitting and device. This ground conductor shall be continuous. It shall be the same size and type as the power wiring to the devices and shall have a green jacket.

.13 EMT conduit, where used, shall not be encased in concrete, mortar, grout or other cementitious material.

.14 The Contractor shall install rigid steel conduit to extend conduit stubs through concrete floors for connection to free-standing or wall-mounted equipment. Above 150 mm over floor, flexible metal conduit may be used where permitted by the Canadian Electrical Code.

.15 Flexible metallic conduit shall be used to connect recessed fixtures from outlet boxes in ceilings, metallic transformers, and other approved assemblies. Runs of flexible steel conduit shall not be more than 1,800 mm in length and shall be installed only in exposed or accessible locations. Interior cut surfaces of flexible conduit shall be smoothed to be free from burrs and sharp edges which might cause abrasion of wire coverings. The ends of flexible steel conduit shall be provided with grounding bushings and approved fittings.

.16 Liquid-tight flexible conduit shall only be used where permitted by the Manitoba Electrical Code and specifically in locations where a flexible connection is required. However, liquid-tight flexible conduit shall not be used in locations where exposed to light petroleum solvents, corrosive liquids or vapours or where ambient temperatures of 60°C or higher may be encountered.

.3 Firestops

.1 The Contractor shall use qualified trades people, trained in the application of the fire sealant materials, to install firestops at each location where cable trays, conduits or cables pass through floors or fire-rated walls.

.2 Installation of firestops shall be in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards. Application of sealing material shall be accomplished in a manner acceptable to the responsible fire and building authorities.

.3 All surfaces in contact with firestopping materials shall be prepared in accordance with manufacturer's instructions and shall be free of dirt, grease, oil or loose materials.

.4 Firestop material shall completely fill void spaces regardless of geometric configuration, subject to tolerance established by the manufacturer. Firestopping systems for filling floor voids 100 mm or more in any direction shall be capable of supporting the same load as the floor is designed to support or shall be protected by a permanent barrier to prevent loading or traffic in the firestopped area.

.5 All exposed surfaces of firestops shall be tooled or trowelled to a neat finish, flush with surrounding surfaces and all excess compounds shall be removed.

3.3 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Inspect for physical damage and defect of cable trays, fitting and supports.

.3 Care shall be taken to prevent any damage to the embedded conduits and surface mounted conduits during concrete placement or other Work, and any damage or displacement so caused shall be corrected to the satisfaction of the Engineer.

.4 Check presence of foreign materials, moisture, dust, etc.

.5 Each run of conduit shall be tested to ensure that it is free of obstructions as soon as assembled and shall be capped immediately.

.6 Each run of the embedded conduit shall again be tested immediately after concrete has been placed so that the conduit may be cleaned before any concrete found inside can harden. Any concrete or other substance in the run shall be immediately and thoroughly removed to the satisfaction of the Engineer, and the conduit recapped immediately. The Contractor shall be responsible for keeping the conduit capped and free from debris until such time as electrical wires are placed therein.

3.4 CLEANING

.1 Shall be in accordance with the requirements set out in Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion and verification of performance of installation, remove surplus Materials, excess Materials, rubbish, Tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section details methods for the direct burial of cable in trenches and for the installation of cable in ducts.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 26 05 21 - Wire and Cable Systems.

.4 Section 31 23 33 - Trenching and Backfilling.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 CSA C22.1 Canadian Electrical Code Part 1.

.2 CAN/CSA-C22.3 No. 7 - Underground Systems.

.3 ANSI/NETA-ATS - Standard for Acceptance Testing Specification for Electrical Power Equipment and Systems.

.4 Powerhouse and Spillway General Arrangement Drawings provided in the Purchaser's Drawings.

.5 Specification Reference Drawings provided in the Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be in determined accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate as set out in the Contractor's Submission multiplied by corresponding the unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

.2 Measurements

.1 Measurement for Items 26 05 43 (a) to 26 05 43 (c) inclusive will be in metres based on the neat lines shown on the Purchaser's Drawings and as directed by the Engineer.

.2 No separate measurement will be made for mechanical protection, markers or thermal or fine backfill materials.

.3 Unit Price

.1 The unit prices proposed for Items 26 05 43 (a) and 26 05 43 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission, shall be for excavation, cable installation, supply and installation of markers and mechanical protection and backfilling, as specified herein and as directed by the Engineer.

.2 The unit prices proposed for Items 26 05 43 (c)i and 26 05 43 (c)ii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for excavation, conduit supply and installation, cable pulling, supply and installation of markers and mechanical protection and backfilling, as specified herein and as directed by the Engineer.

.3 The supply and installation of mechanical protection, markers, and thermal and fine backfill materials are considered incidental to the Work. Include costs for such Work in the unit prices proposed for Items to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 3.8 Submittals of the General Specification.

.2 Product Data

.1 Submit manufacturer's instructions, printed product literature and data sheets for cables and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Test reports.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Storage and Handling Requirements

.1 Store materials off ground, in accordance with manufacturer's recommendations, and in a clean, dry, well-ventilated area.

.2 Store and protect cables from nicks and blemishes.

.3 Replace defective or damaged materials with new.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 CABLE PROTECTION

.1 38 x 140 mm treated wooden planks as required.

2.2 DIRECT BURIED AND DUCT BANK CONDUITS

.1 The encased and direct buried conduits shall be PVC suitable for application.

.2 Rigid pvc conduit for direct burial: to CSA C22.2 No. 211.2.

.3 Use end bells as required.

.4 The conduits shall be held in place using spacers for duct banks.

.5 The conduit sizes shall be in accordance with the Purchaser's Drawings.

2.3 MARKERS

.1 Concrete type cable markers: 600 x 600 x 100 mm with words: "cable", "joint" or "conduit" impressed in top surface, with arrows to indicate change in direction of cable and duct runs.

.2 Yellow PVC marker ribbon, 50 mm wide, continuously marked "CAUTION - ELECTRICAL SERVICE BELOW".

Part 3 Execution

3.1 CABLE TRENCH

.1 Cable trench construction methods are detailed in the Purchaser's Drawings.

3.2 EXAMINATION

.1 Verification of Conditions: verify that existing substrate is acceptable for cable installation in accordance with Manufacturer's written instructions.

.1 Visually inspect substrate in presence of the Engineer.

.2 Inform the Engineer of unacceptable conditions immediately upon discovery.

.3 Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from the Engineer.

3.3 DIRECT BURIAL OF CABLES

.1 After placing 75 mm to 100 mm sand bed, in accordance with Section 31 23 33 Trenching and Backfilling, lay cables maintaining 75 mm clearance from each side of trench to nearest cable.

.1 Do not pull cable into trench.

.2 Include offsets for thermal action and minor earth movements.

.1 Offset cables 150 mm minimum for each 60 m run, maintaining minimum cable separation and bending radius requirements.

.3 Make termination and splice only as indicated leaving 0.6 m minimum of surplus cable in each direction.

.1 Make splices and terminations in accordance with manufacturer's written recommendations using approved splicing kits.

.4 Underground cable splices are not acceptable.

.5 Minimum permitted radius at cable bends for metallic armoured cables, 12 times diameter of cables or in accordance with manufacturer's instructions.

.6 Cable separation

.1 Maintain 75 mm minimum separation between cables of different circuits.

.2 Maintain 300 mm minimum horizontal separation between low and high voltage cables.

.3 When low voltage cables cross high voltage cables maintain 300 mm vertical separation with low voltage cables in upper position.

.4 At crossover, maintain 75 mm minimum vertical separation between low voltage cables and 150 mm between high voltage cables.

.5 Maintain 300 mm minimum lateral and vertical separation for fire alarm and control cables when crossing other cables, with fire alarm and control cables in upper position.

.6 Install treated planks on lower cables 0.6 m minimum in each direction at crossings.

.7 Provide 150 to 200 mm sand protective cover, specified in Section 31 23 33 Trenching and Backfilling.

.8 Place treated plants end to end over backfill, and at depth indicated, if required by the Purchaser’s Drawings.

.9 Place a bright yellow PVC ribbon, minimum 50 mm wide, on the trench approximately 200 mm below surface ground level and run continuously parallel with and above the cable.

3.4 CABLE INSTALLATION IN DUCTS

.1 Install cables as indicated in ducts.

.2 Do not pull spliced cables inside ducts.

.3 Install multiple cables in duct simultaneously.

.4 Use CSA approved lubricants of type compatible with cable jacket to reduce pulling tension.

.5 To facilitate matching of colour coded multiconductor control cables, reel off in same direction during installation.

.6 Before pulling cable into ducts, and until cables are properly terminated, seal ends of cables with moisture seal tape.

.7 After installation of cables, seal ends of ducts with duct sealing compound.

3.5 MARKERS

.1 Mark cable every 150 m along cable runs and at changes in direction.

.2 Lay concrete markers flat and centred over cable with top flush with finish grade.

.3 Maintain accurate and detailed records of all underground cable routes and submit to the Engineer upon completion of the installation.

3.6 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Control of the General Specification.

.2 Perform tests using qualified personnel.

.1 Include necessary instruments and equipment.

.3 Pre-acceptance tests

.1 After installing cable but before splicing and terminating, perform insulation resistance test with 1,000 V megger on each phase conductor.

.2 Check insulation resistance after each splice and/or termination to ensure that cable system is ready for acceptance testing.

.4 Pre-commissioning Tests

.1 Ensure that terminations and accessory equipment are disconnected.

.2 Ground shields, ground wires, metallic armour and conductors not under test.

.3 Conduct testing in accordance with NETA recommendations.

.4 High Potential (Hipot) Testing.

.1 Conduct hipot testing as specified for type of cable being tested.

.5 Leakage Current Testing:

.1 Raise voltage in steps from zero to maximum values as specified for type of cable being tested.

.2 Hold maximum voltage for time specified time period.

.3 Record leakage current at each step.

.5 Provide the Engineer with list of test results showing location at which each test was made, circuit tested and result of each test.

.6 Remove and replace entire length of cable if cable fails to meet any of test criteria.

3.7 CLEANING

.1 Shall be in accordance with the requirements of Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Progress Cleaning

.1 Leave Work area clean at end of each day.

3.8 PROTECTION

.1 Repair damage to adjacent materials caused by cable installation.

END OF SECTION

Part 1 General

1.1 SCOPE OF WORK

.1 This Section of the Technical Specification includes the supply, installation and testing and commissioning of the 600 V switchgear associated with the Powerhouse Complex spillway load centres.

.2 This Section of the Technical Specification applies to LC-PH1, LC-PH2, LC-PH3, LC-PH4, LC-SB1, LC-SB2, LC-SP1 and LC-SP2.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wire and Cable Systems.

.4 Section 26 05 28 - Surface Grounding.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American National Standards Institute (ANSI):

.1 ANSI/IEEE C37.13 - Low Voltage AC Power Circuit Breakers Used in Enclosures.

.2 ANSI/IEEE C37.20.1 - Standard for Metal-enclosed Low Voltage Power Circuit Breaker Switchgear.

.3 ANSI/IEEE C37.20.2 - Metal-Clad and Station-Type Cubicle Switchgear.

.4 ANSI/IEEE C37.20.7 - IEEE Guide for Testing Metal Enclosed Switchgear rated up to 38 kV for Internal Arcing Faults.

.2 Canadian Standards Association (CSA International):

.1 CSA C22.2 No. 5 - Molded-case circuit breakers, molded-case switches and circuit-breaker enclosures.

.2 CSA C22.2 No. 31 - Switchgear Assemblies.

.3 CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.3 National Electrical Manufacturer’s Association (NEMA):

.1 NEMA SG-3 - Low Voltage Power Circuit Breakers.

.4 Purchaser’s Drawings

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified per Section 27 Clarification and Changes to the Work and Adjustments of the General Specification.

.2 Measurements

.1 Measurement for equipment Items 26 11 02 (a) to 26 11 02 (c) will be based on the quantity as shown on the Purchaser's Drawings and as determined by the Engineer.

.3 Unit Price

.1 The unit prices for the following Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submissions shall be for receiving at Site, offloading, storage, Site handling, preparation of surface for installation and installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, commissioning, touch-up painting, and hand over documentation as specified herein and as directed by the Engineer:

.1 26 11 02 (a) - Powerhouse Load Centre.

.2 26 11 02 (b) - Service Bay Load Centre.

.3 26 11 02 (c) - Spillway Load Centre.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit manufacturer's printed product literature, specifications and datasheets in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.3 Shop Drawings and Factory As-Built Record

.1 Submit factory as built record of the fabrication drawings for individual panels:

.1 Switchgear GA Drawings.

.2 AC Schematics.

.3 DC Schematics.

.4 Wiring Diagrams.

.5 Bills of Materials.

.4 Quality assurance submittals: submit the following in accordance with Subsection 7.13 Project Quality Management of the General Specification:

.1 Submit a Quality Management Plan (QMP) for the low-voltage distribution system.

.2 Type Test Report: submit type test report for equipment and fixtures signed by third party certifying that materials comply with specified performance characteristics and physical properties.

.3 Material purchase Orders: submit the Material procurement order to ensure the Material is in line with the Engineer's requirements specified in the Purchaser's Drawings.

.4 Factory Inspection and Test Plan: submit factory inspection and test plan for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, covering Material procurement, factory assembly, factory testing, and packing and shipment.

.5 Factory inspection and Test Report: submit factory inspection and test reports for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, and release for shipment certificate.

.6 Field Inspection and Test Plan: Submit field inspection and test plan covering receipt of Material at Site, storage, field installation, testing, connections to integrate with the other systems, and commissioning.

.7 Field Inspection and Test Reports: Submit field inspection and test reports for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.5 Closeout Submittals

.1 Provide equipment manuals in accordance with Subsection 21.7.12 Operation and Maintenance Manuals of the General Specification, indicating selection and details including:

.1 Technical specification.

.2 Descriptive bulletin on all accessories.

.3 Installation/mounting details including hardware required.

.4 Maintenance instructions.

.5 Guide to inspection frequency and troubleshooting.

.6 Testing and commissioning instructions.

.7 Contractors recommended spare parts.

.6 Drawings

.1 List of Drawings.

.2 Complete set of all as-built record Drawings.

.3 Complete list of panel schedules.

.7 Test Reports

.1 Record of factory tests.

.8 Record of field tests and pre-commissioning tests.

.9 The contractor shall provide a simplified 3D-model of the equipment in MicroStation DGN or AutoCAD, DWG format. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 The engineers, technologists, technicians and assemblers assigned to perform this aspect of the Work shall be certified and experienced in facility LV switchgear installation.

.2 The Contractor shall have qualified staff trained in project control and quality assurance, and to support quality surveillance.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading.

.1 Deliver, store and handle in accordance with Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification and manufacturer's written instructions.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer’s name and address.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 600 V SWITCHGEAR

.1 Secondary switchgear: Indoor 600 V, 3,200 A, 3-Phase, 3-Wire, High Resistance Grounded, minimum short circuit current withstand capability 42 kA.

.2 The switchgear shall consist of the required number of vertical sections bolted together to form a rigid assembly. The sides shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Provide ventilators located on the top of the switchgear over the breaker and bus compartments to ensure adequate ventilation within the enclosure. The top of the enclosure shall also have arc ventilation flaps that allow exhaust of arc gases during an arcing event. These flaps shall remain closed during normal operation.

.3 The assembly shall be provided with adequate lifting means and shall be capable of being moved into installation position and bolted directly to the floor without the use of floor sills.

.4 Each vertical steel unit forming part of the switchgear line-up shall be a self-contained housing having one or more individual breaker or instrument compartments, a centralized bus compartment and a rear cable compartment. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible. An arc ventilation system shall be provided within each breaker cell to redirect arc energy to the top of the enclosure away from operating personnel. Each cell shall be equipped with drawout rails and primary and secondary disconnecting contacts. Removable hinge pins shall be provided on the breaker compartment door hinges.

.5 The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door:

.1 Lever circuit breaker between positions.

.2 Operate manual charging system.

.3 Close and open circuit breaker.

.4 Examine and adjust trip unit.

.5 Read circuit breaker rating nameplate.

.6 The circuit breaker door shall be one-piece, covering the primary and secondary compartments for each breaker, and shall be specifically designed to resist forces produced during an arcing event. A two-point latch shall be provided for additional rigidity. A door bellows system shall be placed around the front of each breaker to prevent arc gasses from escaping around the breaker escutcheon, while also allowing easy racking of the breaker into the disconnected position with the door closed.

.7 The removable power circuit breaker element shall be equipped with disconnecting contacts and interlocks for drawout application. It shall have four positions, “connected,” “test,” “disconnected” and “removed.” The breaker drawout element shall contain a worm gear levering “in” and “out” mechanism with removable lever crank. Levering shall be accomplished via the use of conventional tools. Mechanical interlocking shall be provided so that the breaker is in the tripped position before levering “in” or “out” of the cell. Interlocking that trips the breaker will not be accepted. The breaker shall include an optional provision for key locking open to prevent manual or electric closing. Padlocking shall provide for securing the breaker in the connected, test, or disconnected position by preventing levering.

.8 Enclosure

.1 Main incoming cubicle to contain:

.1 Air circuit breaker.

.2 Feeder cubicles to contain:

.1 Air circuit breakers sized as indicated.

.2 Copper bus from main cubicle to distribution cubicles, including vertical bussing.

.3 Blanked off spaces for future units.

.9 Busbars and connections

.1 Three phase, insulated bus bars, continuous current rating 3,200 A, self-cooled, extending from main cubicle to distribution cubicles including vertical bus.

.2 Match primary switchgear bus bars and connections construction.

.10 Arc-Resistance

.1 The arc rating of the switchgear shall be Type 2B (operator protected around entire perimeter of equipment, even with the low voltage control compartment door open) as defined by ANSI C37.20.7.

.2 The arc resistant switchgear shall not have an arc plenum, and shall require 3 m minimum floor-to-ceiling height for arc exhaust, with no obstructions in the space above the switchgear.

2.2 PANEL METERS

.1 Install Crompton Instruments 087 Series analog ruggedized panel indicators for:

.1 Secondary switchgear main incoming breaker AC current. Scale 0-3000 A.

.2 Secondary switchgear main bus AC voltage. Scale 0-600 V.

.2 Meters shall be installed on the front of the switchgear enclosure.

.3 Instrument transformers may be shared with the digital power meter. Install additional instrument transformers as required.

2.3 AIR CIRCUIT BREAKERS

.1 Air circuit breakers: 600 V class, continuous current rating 800 AF, interrupting rating 42 kA.

.2 Draw out type low-voltage power circuit breakers with solid-state trip units providing adjustable over-current and instantaneous protection:

.1 Each low voltage power circuit breaker shall be equipped with a solid-state tripping system consisting of three current sensors, microprocessor-based trip device and flux-transfer shunt trip. Current sensors shall provide operation and signal function. The trip unit shall use microprocessor-based technology to provide the basic adjustable time-current protection functions. True rms sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached. Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker.

.2 Delayed direct-acting trips with coil rating calibration range, for overcurrent conditions from 80% to 160% of coil rating.

.3 Instantaneous trips with calibration from 500% to 1,500% of ampere rating of breaker for short circuit protection.

.4 Normal stored energy, closing mechanism to provide quick make operation.

.5 Motor charged, stored energy, quick-make, closing mechanism with emergency manual spring charging handle and switch to isolate power supply to spring charging motor.

.6 On-off indicator and spring charging indicator.

.3 Accessories

.1 Shunt trip relay (as required).

.2 Auxiliary switches, 4 N.O., 4 N.C. Wire to terminal blocks for connection to external systems.

.3 Under-voltage tripping with adjustable time delay (as required).

.4 Trip alarm.

.5 Pilot light.

.4 Standard of Acceptance: Eaton Cutler-Hammer Magnum DS or Purchasers's approved equivalent from ABB, Siemens, or Schneider Electric.

2.4 WIRING AND TERMINATIONS

.1 Small wiring, necessary fuse blocks and terminal blocks within the switchgear shall be furnished as required. Control components mounted within the assembly shall be suitably marked for identification corresponding to the appropriate designations on manufacturer's wiring diagrams.

.2 Provide control wiring 600 V, #14 AWG minimum, stranded copper type SIS.

.3 NEMA 2-hole crimp-type lugs shall be provided for all line and load terminations suitable for copper cable rated for 75°C, of the size indicated on the Purchaser's Drawings.

.4 Lugs shall be provided in the incoming line section for connection of the main grounding conductor.

.5 For connections to Purchasers external control and LV power circuits, provide modular terminal blocks rated 25 A 600 V minimum with barriers separating voltage levels. Provide a minimum of 15% spare terminals. For current transformer connections provide distinctly coloured, separate terminal blocks with shorting provisions.

.6 Supply and install wire labels on both ends of all control wires. Provide terminal blocks marked with associated wiring designations.

.7 Terminal blocks shall not mix voltages or AC/DC systems. Provide discreet terminal blocks for each.

.8 Wiring and terminations shall be as specified in Section 26 05 21 Wire and Cable Systems.

2.5 CURRENT TRANSFORMERS

.1 Where specified on the single line diagram, provide current transformers with an accuracy class and capacity as specified.

2.6 DC CONTROL POWER SUPPLY

.1 All control system shall be designed for operation at 125 Vdc. Control power will be provided from Purchaser's external battery system.

.2 Provide fused disconnect terminal blocks for termination of the incoming control power cable.

.3 Provide a summary of all electrical loads which draw power from the 125 Vdc system including continuous and momentary consumption values and duty cycles. Provide appropriately sized fused protection for all devices. Provide recommended ampacity and protection devices for DC control power supply.

2.7 AC POWER SUPPLY

.1 All equipment not related to control systems shall be designed for operation at 120 Vac. This includes:

.1 Anti-Condensation heaters (where required).

.2 Provide fused disconnect terminal blocks for termination of the incoming AC power cable.

.3 Provide a summary of all electrical loads which draw power from the 120 Vac system including continuous and momentary consumption values and duty cycles. Provide appropriately sized fused protection for all devices. Provide recommended ampacity and protection devices for AC power supply.

2.8 AUTOMATIC TRANSFER SYSTEM

.1 Install under-voltage relays for the automatic transfer system at the following locations:

.1 Line side of the secondary switchgear main incoming breaker.

.2 Secondary switchgear main bus.

.3 Load side of the secondary switchgear tie breaker.

.2 The under-voltage relays shall be equipped with 4 N.O. and 4 N.C. contacts for connection to the external automatic transfer control system. Wire all contacts to terminal blocks for connection to external systems.

2.9 AUTO-MANUAL SWITCH

.1 Install an Auto-Manual transfer control switch adjacent to the secondary switchgear main breaker. The switch shall:

.1 Have two maintained positions, labelled AUTO and MANUAL respectively.

.2 Be illuminated by an LED.

.3 Be labelled “AUTOMATIC TRANSFER CONTROL” above the switch and “MUST BE ILLUMINATED BEFORE SWITCHING TO MANUAL” below the switch.

.4 Be equipped with 6 N.O. and 6 N.C. contacts for each position.

.5 Self-illuminate when the secondary switchgear main-tie breaker Kirk Key interlock system corresponds with the current system configuration and the system may be switched to manual control without tripping either the main or tie breakers. The switch shall not illuminate if switching to manual control will cause either the main incoming or tie breaker to trip in the current system configuration.

2.10 SHOP FABRICATION

.1 Shop assemble and test all components of load centre.

.2 After completion of factory assembly and high potential test, prepare for shipment to Site in two sections, complete with hardware for re-assembly and re-connecting.

2.11 FINISHES

.1 Equipment finishes shall be in accordance with Section 26 05 00 Electrical General Requirements.

2.12 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 Electrical General Requirements.

2.13 WARNING SIGNS

.1 Provide warning signs in accordance with Section 26 05 00 Electrical General Requirements.

2.14 SOURCE QUALITY CONTROL

.1 Purchaser reserves the right to:

.1 Inspect place of manufacture.

.2 Inspect testing of any component.

.3 Inspect testing of complete substation prior to shipment including Hipot and BIL tests.

.2 Notify Purchaser in writing 15 days in advance that equipment is ready for inspection.

Part 3 Execution

3.1 INSTALLATION

.1 Confirm location with Engineer before securing. Set and secure switchgear cells in place, rigid, plumb and square, on channel bases.

.2 Interconnect switchgear with adjacent load centre transformer with bus bar connections or cable as indicated on the Purchaser's Drawings.

.3 Check factory-made connections for mechanical security and electrical continuity.

.4 Run two 4/0 AWG bare copper bonding conductors from the embedded ground system or station ground bus to the load centre ground bar. Connect one bonding conductor to each end of the load centre ground bus.

.5 Install, connect and terminate power and control cables.

.6 After completion of work, remove foreign material, including dust, before energizing substation.

3.2 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Perform tests in accordance with Section 26 05 00 Electrical General Requirements.

.1 Perform final equipment tests and commissioning of the 600 V Switchgear, including visual and mechanical inspections and checks and electrical installation and equipment tests to verify the installation work, in accordance with NETA and manufacturer's recommendations.

.2 Perform visual internal and external inspection and checks on equipment, enclosure, buswork and insulators, breaker racking and mounting systems, grounding and bonding connections, LV and control cabling and terminations, etc.

.3 Check all factory and field-installed electrical connections. Confirm torque values are as provided consistent with NETA published values unless otherwise specified by the manufacturer.

.4 Confirm correct operation and sequencing of electrical and mechanical interlock systems.

.5 Check the rigidity of all bushing and cable supports.

.6 Fasten all barriers and covers in place.

.7 Verify correct shutter installation and operation.

.8 Verify that all grounding connections are correctly made.

.9 Perform internal primary and secondary circuit continuity tests using multimeter.

.10 Perform internal primary and secondary insulation resistance tests using a 1,000 V megger for 600 V circuits and 500 V megger for protection and control wiring.

.11 Check breaker assembly operation in connected, test and withdrawn position.

.12 Perform bus joint contact resistance checks.

.13 All test data and checks shall be recorded and shall include the location and identification of equipments and megohm readings versus time for insulation tests.

.14 Submit all test records for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

3.3 CLEANING

.1 Shall be in accordance with the requirements set out in Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Leave Work area clean at end of each Working Day.

.3 Upon completion and verification of performance of installation, remove surplus Materials, excess Materials, rubbish, Tools and equipment.

.4 Remove from Site and dispose of all packaging materials at appropriate recycling facilities.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section details the installation requirements for the Purchaser-supplied electrical equipment detailed below:

.1 Current Limiting Reactors CLR1, CLR3, CLR5 and CLR7.

.2 Station Service Transformer Breakers 52SST1, 52SST3, 52SST5 and 52SST7.

.3 13.8 kV/12.47 kV Station Service Transformers SST1, SST3, SST5 and SST7.

.4 12.47 kV Station Service Switchgear Assemblies SS1, SS2, SS3 and SS4.

.5 12.47 kV/600 V Load Centre Transformers PHT1, PHT2, PHT3, PHT4, SBT1, SBT2, SPT1, SPT2.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 05 05 19 - Drilled-In-Place Anchors.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 26 05 21 - Wire and Cable Systems.

.5 Section 26 05 28 - Surface Grounding.

.6 Section 26 05 29 - Cable and Wire Support Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all registrations applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 CSA:

.1 CSA C22.1 - Canadian Electrical Code, Part 1 (21st Edition), Safety Standard for Electrical Installations.

.2 ANSI/NETA:

.1 ANSI/NETA ATS-2009 - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.3 Purchaser's Drawings.

.4 Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in of this Section of the Technical Specifications shall be in determined accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities for each Item as specified and incorporating any changes as identified in the General Specification.

.2 Measurement

.1 Measurement for equipment Items 26 12 25 (a) to 26 12 25 (e) will be based on the quantity as shown in the Purchaser's Drawings, and as directed by the Engineer.

.3 Unit Price

.1 The unit prices for the following Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission, shall be for receiving, offloading, storage, site handling, preparation of surface for installation and installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, touch-up painting, and hand over documents.

.1 26 12 25 (a) – Current Limiting Reactors CLR1, CLR3, CLR5 & CLR7.

.2 26 12 25 (b) – Station Service 13.8 kV Breakers 52SST1, 52SST3, 52SSt5, & 52SST7.

.3 26 12 25 (c) – 13.8-12.47 kV Station Service Transformers SST1, SST3, SST5, & SST7.

.4 26 12 25 (d) Station Service Switchgear Assemblies.

.5 26 12 25 (e) 12.7-0.6 V Station Service Transformers and NGR Assemblies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 3.8 Submittals of the General Specification.

.2 Submit in accordance with Section 21.7.2 Document Submissions of the General Specification.

.1 Field test results and reports.

.2 As-built record Drawings.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Quality management submittals

.1 Field Inspection and Test Plan: Submit field inspection and test plan covering receipt of material at Site, storage, field installation, testing, connections to integrate with the other systems, and pre-commissioning.

.2 Field Inspection and Test Reports: Submit field inspection and test reports for review and authorization by the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Storage and Handling Requirements

.1 Take receipt from Purchaser's storage area.

.2 Handle using proper equipment for lifting and handling, when necessary use a lifting eye and/or brackets and/or spreader bars supplied for that purpose.

.3 Keep doors locked and protect instruments from damage and dust.

.4 Store and protect from scratches and blemishes.

.5 Report defective or damaged items to the Engineer.

.3 Packaging Waste Management: remove and dispose of in accordance with Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 EQUIPMENT ANCHORING

.1 Supply Hilti-type anchor bolts for securing and anchoring support structures and cubicles to the concrete floor in accordance with the Purchaser's Drawings.

.2 Provide non-corroding metal shim stock of varying thickness for the levelling of the support structures and cubicles as required for proper alignment and installation.

Part 3 Execution

3.1 INSTALLATION

.1 Locate, install and ground in accordance with the Purchaser's Drawings and manufacturer's instructions.

.1 If applicable, assemble split sections into a complete assembly as required.

.2 Obtain Engineer's authorization prior to setting and securing in place, rigid, plumb and square.

.3 Pull in and secure primary, secondary, control and instrument cables.

.4 Terminate cables on equipment terminals as shown on the Purchaser's Drawings.

.5 Use torque wrench to adjust internal connections in accordance with manufacturer's recommended values, or as directed by the Engineer.

3.2 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Managment of the General Specification.

.2 Perform tests in accordance with Section 26 05 00 Electrical General Requirements.

.1 Perform final equipment checks and pre-commissioning including visual and mechanical inspections, and electrical installation and equipment tests, to verify the installation work, in accordance with the recommendations from the manufacturer, NETA specifications or as directed by the Engineer.

.2 Compare equipment nameplate information with specifications and authorized Shop Drawings.

.3 Primary Switchgear

.1 Visual and Mechanical Inspection:

.1 Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

.2 Perform mechanical operational tests.

.3 Perform specific inspections and mechanical tests as recommended by Manufacturer.

.2 Electrical Tests:

.1 Perform resistance measurements through contacts with low-resistance ohmmeter.

.2 Perform point to point wiring checks.

.4 Transformers and Reactors

.1 Visual and Mechanical Inspection:

.1 Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

.2 Perform specific visual inspections and mechanical tests as recommended by manufacturer.

.3 Verify that resilient mounts are free and shipping brackets have been removed.

.4 Verify that winding core, frame and if applicable, enclosure grounds are correct.

.2 Electrical Tests:

.1 Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.

.2 Perform point to point wiring checks.

3.3 CLEANING

.1 Shall be in accordance with the requirements of Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Leave Work area clean at end of each day.

.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Section 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

3.4 PROTECTION

.1 Shall be in accordance with the requirements of Subsection 7.18 Proactive Measures of the General Specification.

.2 Protect installed products and components from damage during construction.

.3 Repair damage to Work and to adjacent materials and equipment caused by installation.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section details the installation requirements for the Purchaser-supplied electrical equipment detailed below:

.1 600 V MCCs: MCC-PH1, MCC-PH2, MCC-PH3, MCC-PH4, MCC-PH5, MCC-PH6, MCC-PH7, MCC-IT1, MCC-IT2, MCC-SB1, MCC-SB2, MCC-SB3, EMCC-PH1, EMCC-PH3, EMCC-PH4, EMCC-SB1.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 05 05 19 - Drilled-In-Place Anchors.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 26 05 21 - Wire and Cable Systems.

.5 Section 26 05 28 - Surface Grounding.

.6 Section 26 05 29 - Cable and Wire Support Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this aspect of the Work shall be performed in accordance with:

.1 CSA:

.1 CSA C22.1 - Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.2 ANSI/NETA:

.1 ANSI/NETA ATS-2009 - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.4 Purchaser’s Drawings.

.5 Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's

Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

.2 Measurement

.1 Measurement for Items 26 12 27 (a) to 26 12 27 (e) will be based on the quantity as shown in the Purchaser's Drawings, and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 26 12 27 (a) to 26 12 27 (e) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving, offloading, storage, site handling, preparation of surface for installation and installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, touch-up painting, and hand over documents as follows;

.1 26 12 27 (a) – Unit Motor Control Center.

.2 26 12 27 (b) – Intake Motor Control Center.

.3 26 12 27 (c) – Service Bay Motor Control Center.

.4 26 12 27 (d) – Powerhouse Emergency Motor Control Center.

.5 26 12 27 (e) – Service Bay Emergency Motor Control Center.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 3.8 Submittals of the General Specification.

.2 Submit in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.1 Field test results and reports.

.2 As-built record drawings.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

.2 Quality management submittals

.1 Field Inspection and Test Plan: Submit field inspection and test plan covering receipt of material at Site, storage, field installation, testing, connections to integrate with the other systems, and pre-commissioning.

.2 Field Inspection and Test Reports: Submit field inspection and test reports for review and authorization by the Engineer.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Storage and Handling Requirements

.1 Receive equipment shipped by the Purchaser.

.2 Handle using proper equipment for lifting and handling, when necessary use a lifting eye and/or brackets and/or spreader bars supplied for that purpose.

.3 Keep doors locked and protect instruments from damage and dust.

.4 Store and protect from scratches and blemishes.

.5 Report defective or damaged items to the Engineer.

.3 Packaging Waste Management: remove and dispose of in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 EQUIPMENT ANCHORING

.1 Supply Hilti-type anchor bolts for securing and anchoring support structures and cubicles to the concrete floor in accordance with the Purchaser's Drawings and Contractor's Documents.

.2 Provide non-corroding metal shim stock of varying thickness for the levelling of the support structures and cubicles as required for proper alignment and installation.

Part 3 Execution

3.1 INSTALLATION

.1 Locate, install and ground in accordance with the Purchaser's Drawings and manufacturer's instructions and these Specifications.

.2 If applicable, assemble split sections into a complete assembly as required. Use torque wrench to adjust internal connections in accordance with manufacturer's recommended values, or as directed by the Engineer.

.3 Obtain Engineer's authorization prior to setting and securing in place, rigid, plumb and square.

.4 Pull in and secure power, control and instrument cables.

.5 Terminate cables on equipment terminals as shown on the Purchaser's Drawings.

3.2 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Managment of the General Specification.

.2 Perform final equipment checks and pre-commissioning including visual and mechanical inspections and electrical installation and equipment tests, to verify the installation Work, in accordance with the recommendations from the Manufacturer, NETA specifications or as directed by the Engineer.

.3 Compare equipment nameplate information with specifications and Purchaser's Drawings.

.4 Visual and Mechanical Inspection

.1 Perform visual internal and external inspection and checks on equipment, enclosure, buswork and insulators, racking and mounting systems, grounding and bonding connections, LV and control cabling and terminations, etc.

.2 Check all factory and field-installed electrical connections. Confirm torque values are as provided consistent with NETA published values unless otherwise specified by the Manufacturer.

.3 Confirm correct operation and sequencing of electrical and mechanical interlock systems.

.4 Check the rigidity of all bushing and cable supports.

.5 Fasten all barriers and covers in place.

.6 Verify correct shutter installation and operation.

.7 Verify that all grounding connections are correctly made.

.5 Electrical Tests

.1 Perform internal primary and secondary circuit continuity tests.

.2 Perform internal primary and secondary insulation resistance tests using a 1,000 V megger for 600 V circuits and 500 V megger for protection and control wiring.

.3 Perform bus joint contact resistance checks.

.4 All test data and checks shall be recorded and shall include the location and identification of equipments and megohm readings versus time for insulation tests.

3.3 CLEANING

.1 Shall be in accordance with the requirements of Section X Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Leave Work area clean at end of each day.

.3 Final Cleaning: upon completion remove surplus materials, rubbish, tools and equipment in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

3.4 PROTECTION

.1 Shall be in accordance with the requirements of Subsection 7.18 Proactive Measures of the General Specification.

.2 Protect installed products and components from damage during construction.

.3 Repair damage to work and to adjacent materials caused by installation.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section of the Technical Specification includes the technical requirements related to the installation of 13.8 kV Generator Circuit Breaker (GCB), Isolated Phase Bus (IPB) and VT & Revenue Metering Cubicle (VT Cubicle).

.2 The Purchaser supplied Isolated Phase-Bus System will comprise seven sets of isolated phase bus duct rated 13.8 kV, 6,000 A (main bus) and 600 A tap bus, complete with seven VT cubicles and in-line metering current transformers. The main isolated phase buses will interconnect from each setoff generator phase terminals to the generator breaker and from each generator circuit breaker to the step-up transformer low-voltage bushings. Each generator phase-bus will have separate tap bus runs and connections to the excitation power potential transformer and to the VT cubicle. On Units 1, 3, 5 and 7 bus duct arrangements, additional runs of tap buses connect to the HV bushings of the CLRs.

.3 The Contractor will also supply and install all bus support structures as required for the main and tap buses and bus enclosure and conductor terminations at all interconnected equipment.

.4 The GCB facilities will be supplied by the Purchaser and will comprise:

.1 Seven fully assembled 6,000 A, 13.8 kV Generator Circuit Breakers complete with three sets of potential transformers, three sets of current transformers, one set of surge capacitors and lightning arresters, a motorized isolating disconnect switch and two motorized grounding switches.

.2 Lifting beam for off-loading and on Site handling.

.3 Consumables including interior and exterior paint for field welded joints.

.4 Flexible braids required for isolated phase bus conductor connections (braids supplied in IPB scope of supply).

.5 The Contractor will be required to fabricate and install seven GCB platforms in accordance with the design provided by the Purchaser in the Purchaser's for the GCB assemblies.

1.2 RELATED SECTIONS

.1 Sections or Subsections of the General Specification as set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 05 05 19 - Drilled-In-Place Anchors.

.4 Section 05 12 23 - Structural Steel.

.5 Section 05 31 23 - Steel Decking.

.6 Section 05 50 00 - Miscellaneous Metal.

.7 Section 26 05 00 - Electrical General Requirements.

.8 Section 26 05 28 - Surface Grounding.

.9 Section 26 05 21 - Wire and Cable Systems.

.10 Section 26 05 29 - Cable and Wire Support Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Welding Society:

.1 AWS D1.2 - Structural Welding Code - Aluminum.

.2 Canadian Standards Association:

.1 CSA C22.1 - Canadian Electrical Code, Part 1 (21st Edition), Safety Standard for Electrical Installations.

.2 CSA W47.2 - Certification of Companies for Fusion Welding of Aluminum.

.3 CSA W59.2 - Welded Aluminum Construction.

.3 ANSI/NETA:

.1 ANSI/NETA ATS-2009 - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.

.4 Purchaser's Drawings

.5 Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Items 26 13 19 (a) to 26 13 19 (d) will be based on the number of Items as shown in the Purchaser's Drawings and as directed by the Engineer.

.3 Unit Price

.1 The estimated cost for Items 26 13 19 (a)i to 26 13 19 (a)vii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving, offloading, storage, Site handling, preparation of surface for installation including floor penetrations, installation including welding, mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, visual and mechanical checks check, touch-up painting, and turn over documentation for the IPB assemblies and GSU transformers.

.2 The unit prices for Items 26 13 19 (b) to 26 13 19 (d) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving, offloading, storage, Site handling, preparation of surface for installation, installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, visual and mechanical checks, touch-up painting, and turn over documentation for the Generator Circuit Breakers, Exciter Systems and 13.8 kV VT cubicles.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Submit in accordance with Subsection 21.7 Contractor's Documents of the General Specification:

.1 Copies of as-built drawings.

1.6 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Storage and Handling Requirements:

.1 Take receipt from Purchaser's storage area.

.2 Handle using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets and/or spreader bars supplied for that purpose.

.3 Keep doors locked and protect instruments from damage and dust.

.4 Store and protect from scratches and blemishes.

.5 Report defective or damaged items to the Engineer.

.3 Packaging Waste Management: remove and dispose of in accordance with Subsection7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with Subsection 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 GROUNDING

.1 Provide Burndy type GB or GBM mechanical connectors for single copper conductors to metal surfaces.

.2 Provide Burndy type GC mechanical connectors for two copper conductors to metal surfaces.

2.2 EQUIPMENT ANCHORING

.1 Supply Hilti-type anchor bolts for securing and anchoring the GCB and IPB support structures, and the metering cubicles to the concrete floor in accordance with the Purchaser's Drawings.

.2 Provide non-corroding metal shim stock of varying thickness for the levelling of the support structures and metering cubicles and as required for proper alignment and installation of the IPB ducts.

2.3 CIRCUIT BREAKER PLATFORM AND BUS SUPPORTS

.1 Supply materials, fabricate, construct and/or install all steel equipment support structures and brackets for IPB support.

.2 Supply materials, fabricate, construct and/or install an elevated platform to support the generator circuit breaker assemblies.

.3 The platforms shall be fabricated from structural steel, with a steel or cast-in-place concrete deck.

.4 The design of all bus supports and platforms will be prepared by the Purchaser.

Part 3 Execution

3.1 GENERAL

.1 Plan the installation and termination procedures for the IPB support structures, the metering cubicles and the IPB disconnect switches and review, detail and itemize the IPB assembly and associated equipment installation design so as to identify, quantify and supply:

.1 All Materials, Tools and equipment required for the proper handling, installation, levelling and anchoring of the support structures.

.2 All Materials, Tools and equipment required for the proper handling, assembly, installation, positioning, securing and termination of the IPB duct assemblies.

.3 All Materials, Tools and equipment required for the proper handling, installation, levelling and anchoring of the metering cubicles.

.4 All Materials, Tools and equipment required for the proper handling, assembly, installation, positioning, aligning and securing of the disconnect switches in the IPB tap assemblies.

.2 Plan the Generator Circuit Breaker installation procedure and review, detail, itemize and quantify the circuit breaker and support platform assemblies for the purpose of supply and installation:

.1 All Materials, Tools, equipment and anchor bolts required for the proper handling, installation, positioning and anchoring of the generator circuit breaker assemblies.

3.2 GCB INSTALLATION

.1 GCB Assembly

.1 The Contractor shall perform all Work and supply all Materials as detailed herein and on the Purchaser's Drawings.

.2 The circuit breaker will be shipped by the manufacturer as a complete assembly and shall be handled and installed as a complete assembly. When moving the circuit breaker, follow the manufacturer's rigging and lifting instructions.

.3 Inspect the shipment on receipt of the equipment at Site, note any missing or damaged components, compare the nameplate data with that of the Technical Specification and Purchaser's Drawings and notify the Engineer of any deficiencies or discrepancies.

.4 Arrange for the use of the overhead crane in the powerhouse to raise and place the assembled GCB on the GCB platform.

.5 Adjust the position of the circuit breaker and isolated bus assemblies to align the axes of the circuit breaker with the isolated bus assemblies.

.6 Install fasteners, bolts, and other hardware as required to fasten the circuit breaker assembly to the platform.

.7 Install two separate 500 kcmil soft drawn stranded bare copper conductors, and bonding connectors and hardware as required to bond the chassis of each GCB to the existing 500 kcmil pigtails at the base of the structure. Bond each 500 kcmil riser to the GCB at one location. Install additional 500 kcmil bonding jumpers at the GCB in accordance with manufacturer's instructions and as required.

.8 Ensure all surfaces are free of oxides and paint residues.

.9 Remove enclosure covers to access contact assemblies. Mark covers and brackets prior to disassembly to facilitate re-assembly. Ensure exposed contact surfaces are carefully covered (protected against contamination) during the period the enclosure covers are removed.

.2 Isolated Phase Bus (IPB) Connections

.1 Modify the IPB (if required) to facilitate connection to the Generator Circuit Breaker terminals and install Purchaser-supplied flexible braids and hardware after testing has been completed to the Engineer's satisfaction.

.2 Clean and lubricate all circuit breaker and isolator contacts, as well as the mating contacts on the flexible connections.

.3 Treat and tighten fasteners using procedure authorized by the Engineer.

.4 Connect the IPB to the generator and bus sides of the circuit breaker with correct phase configurations.

.5 Weld the IPB casing to the frame of the circuit breaker.

.3 Power and Control Cabling

.1 Supply and install and terminate cabling for the Generator Circuit Breaker as detailed on the Purchaser's Drawings, Section 26 05 21 Wire and Cable Systems and in this Section of the Technical Specification.

3.3 IPB INSTALLATION

.1 IPB Assembly

.1 On receipt of the equipment at Site, inspect the shipment, note any missing or damaged components and notify the Engineer of any deficiencies.

.2 Position, align and level the metering cubicles on the designated house-keeping pads, in accordance with the Purchaser's Drawings and secure the metering cubicles to the concrete floor of the powerhouse.

.3 Position, align and level the IPB support structures in accordance with the Purchaser's Drawings and the as-installed position and alignment of the generator phase terminations, the excitation transformer, the generator circuit breaker, the GSU transformer LV bushings and the CLR HV bushings; secure the support structures to the concrete floor of the powerhouse. Accurately carry out levelling, since a level foundation and plumb supports are essential for the accurate alignment of the isolated phase bus sections and consequently the successful operation of the bus duct and its equipment.

.4 Pre-assemble the IPB ducts as appropriate, place on the support structures, position, align and secure. Complete the assembly of IPB duct conductors and enclosures and make enclosure terminations and connections at each end of the IPB, in accordance with the IPB manufacturer's requirements and directions and the Purchaser's Drawings.

.5 Prior to final assembly of the isolated phase bus sections, inspect the inside of the assemblies for moisture and water accumulations and shall clean and dry each section as required, in accordance with the manufacturer's instructions.

.2 IPB Welding

.1 Ensure that only welders, properly qualified to CSA-W47.2 or ANSI/AWS D1.2 are utilized to weld the isolated phase bus conductor and enclosure connections. All aluminum field-welding shall be in accordance with CSA W59.2.

.2 Welding procedures shall be submitted by the Contractor for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.3 The Engineer will provide test joints for qualification of the Contractor's welders, in all applicable conditions, including welding positions and temperatures. Qualification welds will be examined for over-all appearance and cross sections, removed from the qualification joints, when suitably etched, should show weld metal to the joint root, have a convex appearance, be built up to the full size of the plate thickness and have porosity less than 5% of area examined.

.4 Welding shall be in strict accordance with the manufacturer's recommendations. Defects, such as lack of fusion, undercutting, overlapping, cracks, weld craters, poor end blending, excessive metal or weld overhang or porous welds shall be repaired immediately, taking the weld are back to clean metal. If excessive metal

or weld overhand is present at the ends of the weld, remove and add additional weld metal, if required, to present a neat termination.

.5 Completed joints shall be cleaned, inspected, and then painted per manufacturer's instruction to improve heat transfer.

.6 Prior to welding any enclosure joints, ensure that the enclosures, conductors and insulators have been carefully cleaned and inspected and ensure that all connections have been inspected.

.7 As the bus enclosure system is intended to be relatively air tight, verify air tightness per the manufacturer's procedure and refit or address any lack of tightness per manufacturer's guidelines.

.3 Control Wiring

.1 If loose-shipped, install and terminate the metering current transformers in their specified position in the IPB ducts, in accordance with the IPB manufacturer's requirements and directions and the Purchaser's Drawings.

.2 In general, run all secondary wiring for the isolated phase bus system in conduit where possible in accordance with Section 26 05 29 Cable and Wire Support Systems of the Technical Specification. The conduit must be run separately and remote from the phase conductors, and must not be run in the same duct or parallel to a phase conductor, unless the distance separating them is sufficient to prevent any possible interaction as a result of short circuits. Install all conduit runs in accordance with recommendations on isolation and conduit installation in the manufacturer's arrangement drawings.

3.4 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Generator Circuit Breakers

.1 The Purchaser will be performing the equipment and commissioning tests, as indicated below on the Generator Circuit Breakers prior to energization. In advance the Contractor shall be responsible for the following typical visual and mechanical inspections and checks to verify the installation, in accordance with the manufacturer's recommendations. The Contractor shall also provide the opportunity for Engineer's review of the described equipment in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Contractor's Installation Checks and Inspections:

.1 Check the circuit breaker enclosures and operating mechanism and control panels and cubicles for mechanical damage, dents, misalignment, etc.

.2 Check that all field-installed support anchoring and bus attachment torque values are as specified in the manufacturer's drawings.

.3 Verify the integrity and general air-tightness of all IPB enclosure connections.

.3 Equipment Visual and Mechanical Inspection:

.1 Compare equipment nameplate data with the Purchaser's Drawings.

.2 Inspect physical and mechanical condition.

.3 Inspect anchorage, alignment, and grounding.

.4 Verify the unit is clean.

.3 Isolated Phase Bus System

.1 The Purchaser will perform final equipment tests and commissioning of the Isolated Phase Bus System. In advance, the Contractor shall be responsible for the following typical visual and mechanical inspections and checks to verify the installation in accordance with the manufacturer's recommendations.

.2 The Contractor shall also provide the opportunity for Engineer's review of the equipment in accordance with Subsection 21.7.9 Engineer's Review of the General Specification

.3 Contractor's Installation Checks and Inspections:

.1 Check the bus enclosures and connections for mechanical damage, dents, misalignment, etc.

.2 Check that all field-installed support structure anchoring and bus attachment torque values are as specified.

.3 Verify the integrity and general air-tightness of all enclosure connections and joints pressurize the bus enclosures, with dry air, in accordance with the manufacturer's instructions.

.4 Verify the installation is cleaned inside and out.

3.5 CLEANING

.1 Shall be in accordance with the requirements set out in Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Leave Work area clean at end of each Working Day.

.3 Inspect and clean the completed installation, correct any installation deficiencies and touch-up any welds, minor scratches or surface damage with appropriate paint.

.4 Upon completion and verification of performance of installation, remove surplus Materials, excess materials, rubbish, Tools and equipment.

3.6 PROTECTION

.1 Shall be in accordance with the requirements set out in Subsection 7.18 Proactive Measures of the General Specification.

.2 Cover and protect the completed installation to keep it clean pending completion of all surrounding construction work and the start of equipment testing and commissioning.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Design, supply, installation, testing, and commissioning of the 600/347 V and 120/208 V low-voltage distribution system including auxiliary systems and lighting for the hydro generating units (G1-G7) and lighting and ancillary services in the Powerhouse and Spillway Complexes.

.2 The low-voltage distribution system shall be comprised of distribution panels, lighting panels, lighting transformers, disconnect switches, welding receptacles, power receptacles, and all of the cable, hardware and other Material required for installation and connection.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wire and Cable Systems.

.4 Section 26 05 28 - Surface Grounding.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ANSI and IEEE:

.1 IEEE 505 - Standard Nomenclature for Generating Stations Power Systems.

.2 ANSI/EIA 310D - Panels, Racks and Associated Equipment.

.3 IEEE C57.94 - Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type General Purpose Distribution and Power Transformers.

.4 ANST/NETA ATS-2009 Standard for Acceptance Specification for Electrical Power Equipment and Systems.

.2 Canadian Standards Agency (CSA):

.1 CSA C22.1 - Canadian Electrical Codes, Part I.

.2 CSA C22.2 No. 5 - Moulded-Case Circuit Breakers, Moulded-Case Switches and Circuit-Breaker Enclosures.

.3 CSA C22.2 No. 29 - Panelboard and Enclosed Panelboard Industrial Products - General Instructions.

.4 CSA C9 Dry Type Transformers.

.5 CSA C22.2 No. 47 - Air-Cooled Transformers (Dry Type).

.6 C22.2 NO. 42 - General Use Receptacles, Attachment Plugs, and Similar Wiring Devices.

.7 CSA C802.2 Minimum Efficiency Values for Dry Type Transformers.

.8 CSA Z462 - Workplace Electrical Safety.

.4 Purchaser's Drawings

.5 Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurements

.1 Measurement for equipment Items 26 22 13 (a) to 26 22 13 (j) shall be based on the quantity shown on the Purchaser's Drawings and Contractor's Documents, and as determined by the Engineer. Measurement for design Item 26 22 13 (k) shall be based on accepted design deliverables.

.3 Unit Price

.1 The unit prices for the following items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for Site supply, storage, Site handling, preparation of surface for installation and installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, touch-up painting, and hand over documents as specified herein and as directed by the Engineer.

.1 26 22 13 (a) - Supply and Installation of Distribution Panels.

.2 26 22 13 (b) - 600-600/347 V Isolation Transformer for 347 V Emergency Lighting.

.3 26 22 13 (c) - 347 V Lighting Distribution Panels.

.4 26 22 13 (d) - 600-120/208 V Isolation Transformers.

.5 26 22 13 (e) - 120/208 V Lighting Distribution Panels.

.6 26 22 13 (f) - 600-208/120 V Step Down Transformer for Emergency Supply.

.7 26 22 13 (g) - 120/208 V Essential Distribution Panels.

.8 26 22 13 (h) - 600 V Essential Distribution Panels.

.9 26 22 13 (i) - Safety Disconnect Switches.

.10 26 22 13 (j) - Welding and Power Receptacles.

.2 The Estimated Cost for Item 26 22 13 (k) – Distribution System Design in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the development of design concept with the Purchaser's inputs, study of the system to establish ratings, equipment selection, ac schematics, dc schematics, wiring diagrams, and bills of material Drawings.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit manufacturer's printed product literature, specifications and datasheet in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.3 Shop Drawings and Factory As-Built Record

.1 Submit factory as-built records of the fabrication drawings for individual panels as applicable, including:

.1 Panel GA Drawings.

.2 AC Schematics.

.3 Wiring Diagrams.

.4 Bill of Material.

.4 Quality Management

.1 Submit a Quality Management Plan (QMP) for the low-voltage distribution system.

.2 Type Test Report: submit type test report for panelboards and low-voltage distribution transformers signed by third party certifying that materials comply with specified performance characteristics and physical properties.

.3 Material purchase Orders: submit the material procurement order to ensure the material is in line with the Engineer's requirements specified in the Purchaser's Drawings and Contractor's Documents.

.4 Field Inspection and Test Plan: Submit field inspection and test plan covering receipt of Materials at Site, storage, field installation, testing, connections to integrate with the other systems, and commissioning.

.5 Field Inspection and Test Reports: Submit field inspection and test reports for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.5 Closeout Submittals

.1 Provide equipment manuals in accordance with Subsection 21.7.12 Operation and Maintenance Manuals of the General Specification, indicating selection and details including:

.1 Technical specification.

.2 Descriptive bulletin on all accessories.

.3 Installation/mounting details including hardware required.

.4 Maintenance instructions.

.5 Guide to inspection frequency and troubleshooting.

.6 Testing and commissioning instructions.

.7 Manufacturers recommended spare parts list with catalogue numbers, and names and addresses of suppliers.

.6 Drawings

.1 List of Drawings.

.2 Complete set of all as-built record drawings.

.3 Complete list of panel schedules.

.7 Test Reports

.1 Record of factory tests.

.2 Record of field tests, pre-commissioning, and commissioning tests.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Managment of the General Specification.

.2 Qualifications

.1 The engineers, technologists, technicians and assemblers assigned to the job shall be certified and experienced in facility LV distribution design and installation.

.2 The contractor shall have qualified staff trained in project control and quality assurance, and to support quality surveillance.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Subsection 7.24 Inspection of Deliveries to Site and Storage the General Specification and manufacturer's written instructions.

.2 Deliver materials to Site in original factory packaging, labelled with manufacturer’s name and address.

1.8 WARRANTY

.1 Shall be in accordance with the requirements set out in Section 25 Warranty of the General Specification.

Part 2 Products

2.1 SCOPE

.1 The Contractor shall be responsible for the following Work, including but not limited to the low-voltage distribution system equipment, components, and ancillaries as listed:

.1 600 V, 3-phase, 3-wire distribution panels.
.2 600/347 V, 3-phase, 4-wire lighting panels.
.3 120/208 V, 3-phase. 4-wire lighting panels.
.4 120/208 V, 3-phase, 4-wire hydro generator auxiliary distribution panels.
.5 600 V: 600/347 V lighting transformers.
.6 600 V: 120/208 V lighting transformers.
.7 120/208 V, 3-phase, 4-wire essential services distribution panels.
.8 120/208 V, 3-phase, 4-wire emergency lighting distribution panels.
.9 600 V: 120/208 V step-down transformers.
.10 Safety disconnect switches.
.11 600 V welding receptacles.
.12 120 V convenience receptacles.

2.2 DESIGN

.1 The final design of the low-voltage distribution system will be performed by the Contractor.

.1 Reference Codes and Standards:

.1 The low-voltage distribution system shall be designed, assembled, tested, installed and commissioned in accordance with these Specifications, and the latest revision of the standards and codes specified herein.

.2 General:

.1 The 600 V distribution panels, supplied and installed by the Contractor, shall be fed from the 600 V load centres to form a highly redundant, integrated distribution system, as shown on the Purchaser's Drawings, with the 600 V distribution panels principally supplying power to the non-motor loads while the various 600 V Motor Control Centres power the generating station motor load.

.2 The 600 V distribution panels shall include copper buses and bolt-on moulded case, manually-operated 3-pole circuit breakers.

.3 The 600 V/600-347 V Isolation Transformer and the 347 V lighting panels, shall be fed from the 600 V distribution panels and shall supply power to the plant lighting systems.

.4 The 600 V/120/208 V lighting transformers and the 120-208 V lighting panels shall be powered by the 600 V distribution panels and shall supply power to the lighting and convenience receptacles throughout the powerhouse complex and surrounding areas.

.5 The 600 V safety disconnect switches shall provide lockable isolation points adjacent to, and directly visible from, any motor which is located remote from its MCC supply.

.6 The 600 V welding and power receptacles and 120 V convenience receptacles shall installed throughout the powerhouse complex for maintenance and operational use.

.7 The Contractor's design responsibilities for the 600 V, 347 V and 120/208 V low-voltage distribution system equipments shall include, but are not limited to detailing, itemizing and quantifying the 600 V, 347 V

and 120/208 V low-voltage distribution system equipment, components and ancillaries for the purpose of supplying and installing:

.1 All equipment, materials and hardware required for the complete and proper supply of all required 600 V, 347 V, and 120/208 V low-voltage distribution equipment.

.2 All equipment, materials and hardware required for the complete and proper installation and interconnection of all required Items.

2.3 GENERAL REQUIREMENTS

.1 Distribution panel boards shall have 30% space for future circuits, with transformers sized to allow for growth.

.2 Equipment, terminal and junction boxes shall be NEMA 12 rated or Purchaser's approved equivalent. Where terminal and junction boxes are located in an area subject to fire-protection sprinkler systems, they shall be NEMA Type 3R or Engineer's approved equivalent.

.3 Equipment, terminal and junction boxes shall be supported independently of connecting conduits.

.4 Each cubicle, panel and terminal box shall be provided with lamacoid plastic equipment plates by the Contractor, which shall uniquely identify the component and specific devices within. The nameplates shall have black letters on a white background, and shall be fastened with metal screws.

.5 The nameplate and lamacoid equipment plate information will be supplied by the Engineer during the drawing approval stage.

.6 The Contractor shall provide identification labels for panels, cubicles, junction boxes and pull boxes indicating voltage and phase of circuits contained therein. For any enclosure containing 600 V circuits, an identification plate marked "DANGER: 600 VOLTS" shall be provided on the outside of the enclosures.

.7 The Contractor shall provide device plates for switches that are not within sight of the loads controlled, suitably engraved with a description of the associated loads.

.8 The Contractor shall provide device plates for convenience receptacles similarly marked indicating the voltage, the supply panel and circuit number.

.9 For receptacles other than 120 V, single-phase, duplex, convenience receptacles the device plates shall indicate the circuit number, voltage, frequency, phasing, and amperage available at the receptacle.

.10 Equipment finishes shall be in accordance with Section 26 05 00 Electrical General Requirements.

.11 For all supplied equipment and components in which cables and wires will be terminated:

.1 The arrangement and location of terminal blocks for the incoming connections shall be such that the incoming cables can be adequately supported and the individual wires conveniently connected to the terminal blocks.

.2 Parallel rows of terminal blocks shall be spaced at least 200 mm apart.

.3 All terminal blocks shall be identified according to the reviewed Contractor's Documents and Purchaser's Drawings using the terminal manufacturer's labels.

.4 Sufficient terminal blocks shall be provided for all circuits plus 20% spare, suitably distributed.

2.4 600 V DISTRIBUTION PANELS

.1 At least 20 wall-mounted or free standing, 600 V, 3-phase, 3-wire, distribution panels shall be supplied and installed, generally for non-motor loads. The distribution panels shall include flush-mounted front panels with feeder circuit breakers conforming of the following:

.1 Bolt-on moulded case circuit breaker having a thermal-magnetic trip mechanism.

.2 Frames constructed of a high-strength, moulded, glass-reinforced polyester case and cover.

.3 With an over center, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation.

.4 Common tripping of all poles.

.5 Suitable for reverse feeding.

.6 With ON and OFF position clearly marked on escutcheon and including a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.

.7 Including factory-installed mechanical lugs, CSA or ULC listed and rated as required.

.8 Continuous rating of 80% rated nameplate current.

.9 Provided with a padlockable hatch for locking the breaker in the open position.

.2 The distribution panels shall have the following ratings and characteristics:

.1 Enclosure Rating - Type 12 or 3R.

.2 Main Bus Connection - Lugs or moulded case circuit breaker.

.3 Main Bus Continuous Rating - to be determined based on load.

.4 Voltage - 600 V, 3-phase, 3-wire.

.5 Bus Short Circuit Rating - 65 kA_{rms} sym.

.6 Branch Feeders - Bolt-on moulded-case circuit breakers.

.7 Circuit breaker interrupting rating - 65 kAIC (fully rated).

.8 Temperature Rise Limitation on all Current Carrying Parts - 65°C over a 40°C ambient.

.3 Standard of acceptance: Eaton Pow-R-Line or Purchaser's approved equivalent.

.4 All 600 V Distribution Panels shall be supplied from the same manufacturer, and only one style of circuit breaker shall be used unless prior authorization is granted by the Engineer.

2.5 347 V LIGHTING PANELS

.1 At least two wall-mounted, 347 V, 3-phase, 4-wire, lighting panels shall be supplied and installed, generally for plant lighting system. The lighting panels shall include front doors with concealed hinges and flush lock assemblies.

.2 The lighting panels shall have the following ratings and characteristics:

.1 Enclosure Rating - Type 12 or 3R.

.2 Main Bus Connection - Lugs or main moulded case circuit breaker.

.3 Main Bus Continuous Rating - To be determined based on load.

.4 Voltage - 347 V, 3-phase, 4-wire.

.5 Bus Short Circuit Rating - 65 kA_{rms} sym.

.6 Branch Feeders - Bolt-on moulded-case circuit breakers.

.7 Circuit breaker interrupting rating - 65 kAIC (fully rated).

.8 Temperature Rise Limitation on all Current Carrying Parts 65°C over a 40°C ambient.

.3 Standard of acceptance: Eaton Pow-R-Line or Purchaser's approved equivalent.

.4 All 347 V Lighting Panels shall be supplied from the same manufacturer and preferably from the same manufactures as the 600 V Distribution Panels. Only one style of circuit breaker shall be used, and preferably the same style as used in the 600 V Distribution Panels, unless prior authorization is granted by the Engineer.

2.6 120/208 V LIGHTING PANELS

.1 At least 17 wall-mounted, 120/208 V, 3-phase, 4-wire, lighting panels shall be supplied and installed, generally for lighting and convenience receptacle loads. The lighting panels shall include front doors with concealed hinges and flush lock assemblies.

.2 The lighting panels shall have the following ratings and characteristics:

.1 Enclosure Rating - Type 12 or 3R.

.2 Main Bus Connection - Lugs or main moulded case circuit breaker.

.3 Main Bus Continuous Rating - To be determined based on load.

.4 Voltage - 120/208 V, 3-phase, 4-wire.

.5 Bus Short Circuit Rating - 20 kA_{rms} sym.

.6 Branch Feeders - Bolt-on moulded-case circuit breakers.

.7 Circuit breaker interrupting rating - 14 kAIC (fully rated).

.8 Temperature Rise Limitation on all Current Carrying Parts 65°C over a 40°C ambient.

.3 Standard of acceptance: Eaton Pow-R-Line or Purchaser's approved equivalent.

.4 All 120/208 V Lighting Panels shall be supplied from the same manufacturer and preferably from the same manufacturer as supplied the 600 V Distribution Panels. Only one style of circuit breaker shall be used, and preferably the same style as used in the 600 V Distribution Panels, unless prior authorization is granted by the Engineer.

2.7 120/208 V GENERATION EQUIPMENT PANELS

.1 In accordance with the Purchaser's Drawings, seven wall-mounted, 120/208 V, 3-phase, generation equipment panels shall be supplied and installed, generally for servicing loads relating to each unit's turbine and generator. The l20/208 V generation equipment panels shall include front doors with concealed hinges and flush lock assemblies, covering feeder circuit breakers conforming to the following:

.1 Bolt-on moulded case circuit breaker having a thermal-magnetic trip mechanism.

.2 Frames constructed of a high-strength, moulded, glass-reinforced polyester case and cover.

.3 With an over-center, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation.

.4 Common tripping of all poles.

.5 Suitable for reverse feeding.

.6 With ON and OFF position clearly marked on escutcheon and including a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.

.7 Including factory-installed mechanical lugs, CSA or ULC listed and rated as required.

.8 Continuous rating of 80% rated nameplate current.

.9 Provided with a padlockable hasp for locking the breaker in the open position.

.2 The generation equipment panels shall have the following ratings and characteristics:

.1 Enclosure Rating - Type 12 or 3R.

.2 Main Bus Continuous Rating - To be determined based on load.

.3 Voltage - 120/208 V, 3-phase, 4-wire.

.4 Bus Short Circuit Rating - 20 kA_{rms} sym.

.5 Branch Feeders - Bolt-on moulded-case circuit breakers.

.6 Circuit breaker interrupting rating - 14kAIC (fully rated).

.7 Temperature Rise Limitation on all current carrying parts 65°C over a 40°C ambient.

.3 Standard of acceptance: Eaton Pow-R-Line or Purchaser's approved equivalent.

.4 All 120/208 V generation equipment panels shall be supplied from the same manufacturer and preferably from the same manufacturer as supplied the 120/208 V lighting panels. Only one style of circuit breaker shall be used, and preferably the same style as used in the 600 V distribution panels, unless prior authorization is granted by the Engineer.

2.8 600 V:600/347 V ISOLATION TRANSFORMERS

.1 In accordance with the Purchaser's Drawings, a minimum of two 600:600/347 V isolation transformers shall be supplied and installed for supplying the 347 V lighting panels.

.2 The lighting transformers shall have the following ratings and characteristics:

.1 Type - 3-phase, dry-type, indoor.

.2 Primary Volts - 600 V, ±2.5%, ±5%.

.3 Primary Winding Configuration - delta.

.4 Secondary Volts - 600-347 V.

.5 Secondary Winding Configuration - Wye-grounded neutral.

.6 Rated Capacity - 45 kVA and up.

.7 Cooling - AA.

.8 Frequency - 60 Hz.

.9 Insulation system - 220°C (80°C rise).

.10 Winding material - copper.

.11 Enclosure type - Heavy duty, ventilated, NEMA Type 3R Suitable for indoor installation.

.3 Standard of acceptance: Hammond Power Systems Sentinel series or Purchaser's approved equivalent.

.4 All 600 V:600/347 V lighting transformers shall be supplied from the same manufacturer.

.5 The transformers shall be front accessible, primary and secondary terminals, complete with connectors suitable for copper conductors.

.6 Transformer cores shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed.

.7 The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly shall be installed on vibration-absorbing pads.

.8 All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

.9 The maximum temperature of the transformer enclosure shall not exceed 90°C.

.10 The core of the transformer shall be grounded to the enclosure.

.11 Lighting transformers shall be designed for wall mounting.

.12 The following standard factory tests shall be performed on each transformer in accordance with the latest version of ANSI and CSA standards:

.1 Ratio tests at the rated voltage connection and at all tap connections.

.2 Polarity and phase relation tests on the rated voltage connection.

.3 Applied potential tests.

.4 Induced potential test.

.13 No-load and excitation current at rated voltage on the rated voltage connection.

2.9 600 V:120/208 V LIGHTING TRANSFORMERS

.1 In accordance with the Purchaser's Drawings, a minimum of twenty 600 V:120/208 V lighting transformers shall be supplied and installed for supplying the 120/208 V lighting and generation equipment panels.

.2 The lighting transformers shall have the following ratings and characteristics:

.1 Type - 3-phase, dry-type, indoor.

.2 Primary Volts – 600 V, ±2.5%, ±5%.

.3 Primary Winding Configuration - delta.

.4 Secondary Volts - 120/208 V.

.5 Secondary Winding Configuration - Wye-grounded neutral.

.6 Rated Capacity - 45 kVA and up.

.7 Cooling - AA.

.8 Frequency - 60 Hz.

.9 Insulation system - 220°C (80°C rise).

.10 Winding material - copper.

.11 Enclosure type - Heavy duty, ventilated, NEMA Type 3R Suitable for indoor installation.

.3 Standard of acceptance: Hammond Power Systems Sentinel series or Purchaser's approved equivalent.

.4 All 600 V/120/208 V lighting transformers shall be supplied from the same manufacturer.

.5 The transformers shall be front accessible, primary and secondary terminals, complete with connectors suitable for copper conductors.

.6 Transformer cores shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed.

.7 The core and coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture. The assembly shall be installed on vibration-absorbing pads.

.8 All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.

.9 The maximum temperature of the transformer enclosure shall not exceed 90°C.

.10 The core of the transformer shall be grounded to the enclosure.

.11 Lighting transformers shall be designed for wall mounting.

.12 The following standard factory tests shall be performed on each transformer in accordance with the latest version of ANSI and CSA standards:

.1 Ratio tests at the rated voltage connection and at all tap connections.

.2 Polarity and phase relation tests on the rated voltage connection.

.3 Applied potential tests.

.4 Induced potential test.

.13 No-load and excitation current at rated voltage on the rated voltage connection.

2.10 120 V ESSENTIAL DISTRIBUTION PANELBOARDS

.1 In accordance with the Purchaser's Drawings, two wall-mounted 120 V, 1-phase, 3-wire, distribution panels shall be supplied and installed, generally for critical computer loads. The distribution panels shall include flush-mounted front panel with feeder circuit breakers conforming to the following:

.1 Bolt-on moulded case circuit breaker having a thermal-magnetic trip mechanism.

.2 Frames constructed of a high-strength, moulded, glass-reinforced polyester case and cover.

.3 With an over-centre, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation.

.4 Common tripping of all poles.

.5 Suitable for reverse feeding.

.6 With ON and OFF position clearly marked on escutcheon and including a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.

.7 Including factory-installed mechanical lugs, CSA or ULC listed and rated as required.

.8 Continuous rating of 80% rated nameplate current.

.9 Provided with a padlockable hasp for locking the breaker in the open position.

.2 The distribution panels shall have the following ratings and characteristics.

.1 Enclosure Rating - Type 12 or 3R.

.2 Main Bus Connection - Lugs or main moulded case circuit breaker.

.3 Main Bus Continuous Rating - To be determined based on load.

.4 Voltage - 120 V, 1-phase, 3-wire.

.5 Bus Short Circuit Rating - 20 kA_{rms} sym.

.6 Branch Feeders - Bolt-on moulded-case circuit breakers.

.7 Circuit breaker interrupting rating - 14 kAIC (fully rated).

.8 Temperature Rise Limitation on all Current Carrying Parts 65°C over a 40°C ambient.

.3 Standard of acceptance: Hammond Power Systems Sentinel series or Purchaser's approved equivalent.

.4 The 120 V essential distribution panels shall be supplied from the same manufacturer as the 120/208 V lighting panels. Only one style of circuit breaker shall be used, and preferably the same style as used in the 120/208 V lighting panels, unless prior authorization is granted by the Engineer.

2.11 600 V/120/208 V STEP-DOWN TRANSFORMERS

.1 In accordance with the Purchaser's Drawings, two 600 V/120/208 V wall-mounted step-down transformers shall be supplied and installed for supplying the 120/208 V emergency distribution panelboard.

.2 The step-down transformers shall have the following ratings and characteristics:

.1 Type - 3-phase, dry-type, indoor.

.2 Primary Volts - 600V, ±2.5%, ±5%.

.3 Primary Winding Configuration - Delta.

.4 Secondary Volts - 208 - 120 V.

.5 Secondary Winding Configuration - Wye-Grounded.

.6 Rated Capacity - 45 kVA and up.

.7 Cooling - AA.

.8 Frequency - 60 Hz.

.9 Insulation system - 220°C (80°C rise).

.10 Winding material - Copper.

.11 Enclosure type - Heavy duty, ventilated, NEMA Type 3R suitable for indoor installation.

.3 Standard of acceptance: Hammond Power Systems Sentinel series or Purchaser's approved equivalent.

.4 The 600 V/120/208 V step-down transformers shall be supplied from the same manufacturer as the lighting transformers and shall be constructed and tested to the same standard and technical criteria.

.5 The transformer shall have front accessible, primary and secondary terminals, complete with connectors suitable for copper conductors and shall be designed for wall mounting.

2.12 SAFETY DISCONNECT SWITCHES

.1 Safety switches shall be supplied and installed for the maintenance isolation of motor loads in accordance with the stipulations of CEC.

.2 Safety switches shall be CSA accepted, fused, 3-pole, 600 V manual disconnect rated in accordance with CEC at no less than 115% of the full load current of the motor being isolated.

.3 Each switch shall have a window that will allow visual confirmation of the position of the switch blades.

.4 Switch operating mechanism shall be non-teasable, positive quick-make/quick-brake type. Bail type mechanisms are not acceptable.

.5 Switch blades and jaws shall be plated copper.

.6 Switches shall have a handle that is padlockable in the OFF position.

.7 Switches shall have tool-defeatable door interlocks that prevent the door from opening when the handle is in the ON position. Defeater mechanism shall be front accessible.

.8 Standard of acceptance for safety disconnect switches are Cutler Hammer and Square D or Purchaser's approved equivalent.

2.13 WELDING AND POWER RECEPTACLES

.1 All receptacles shall conform to the requirements of CSA Standard C22.1 "Canadian Electrical Code, Part 1".

.2 Receptacles shall be of the make and model identified in the following list:

.1 CO1: Single phase general 120 Vac NEMA 5-15R duplex receptacle shall be 15 A, 120 Vac, CSA approved, U ground, Brown, specification grade c/w single gang FS device box and sheet steel cover. Hubbell HBL5262 or Purchaser's approved equivalent.

.2 CO2: Single phase outdoor 120 Vac receptacle shall be 15A, 120 Vac, CSA approved, Class A, Brown, GFCI protected with a 5 mA sensitivity; conforming to CSA Standard C22.2 No. 144 - Ground Fault Interrupters" c/w single gang FS device box and aluminum weatherproof cover. Hubbell GFR5262TR or Purchaser's approved equivalent.

.3 CO3: Single phase general 120 Vac NEMA 5-15R duplex receptacle shall be 15 A, 120 Vac, CSA approved, U ground, Orange, specification grade c/w single gang FS device box and sheet steel cover. Hubbell IG5262 or Purchaser's approved equivalent.

.4 CO4: Single receptacle, CSA configuration 14-30R, 30 A, 125/250 Vac, U ground specification Grade c/w single gang FS device box and sheet steel cover. Hubbell HBL9430A or Purchaser's approved equivalent.

.3 Exterior outlets and outlets in wet interior locations will have Ground-Fault Interrupter (GFCI) devices for personnel protection.

.4 GFCI Receptacles shall be duplex type for mounting in standard outlet box. Devices shall be capable of detecting current leak of 5 mA or less and tripping per requirements for Class A GFCI devices. Provide screw-type, side-wired wiring terminals or pre-wired (pigtail) leads.

.5 600 V, 60 A welding receptacles shall be Cooper Crouse Hinds model W2SR Interlocked Arktite Receptacles with enclosed disconnect switch or Appleton type WSRD interlocked receptacle with enclosed disconnect switch or Purchaser's approved equivalent.

.6 600 V, 200 A power receptacles shall be Cooper Crouse Hinds, model AREA 20426, 200 A type with adjacent or directly coupled 200 A disconnect switch or Purchaser's approved equivalent.

.7 Twist lock equipment receptacles for disconnectable fluorescent lights shall be NEMA type L5-15R, utilizing Hubbell/Bryant fittings 4716MB for the male plug and 4715ER for the female receptacle, or Purchaser's approved equivalent.

.8 Twist lock switched receptacles for 347 V high bay lighting fixtures shall be Hubbell Switched Twist-Lock Enclosure SETL3 with NEMA Type L9-30R, utilizing Hubbell HBL2651 for the male plug and HBL2650 for the female receptacle, or Purchaser's approved equivalent.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, programming instructions, and datasheet.

3.2 INSTALLATION

.1 The Contractor shall locate, install and secure the panelboards, low-voltage distribution transformers, safety switches and receptacles in accordance with the Purchaser's Drawings and the manufacturer's instructions.

.2 The Contractor shall install and terminate all cable interconnections to each panelboard, low-voltage distribution transformer, safety switch and receptacle.

.3 The Contractor shall install and terminate grounding and bonding connections to each panelboard, low-voltage distribution transformer, safety switch and receptacle.

.4 Cable orientation shall be A-B-C top to bottom, front to back and left to right, viewing from the front of the panelboards.

.5 Use torque wrench to adjust internal connections in accordance with manufacturer's recommended values.

.6 For the panelboards, directory-card information shall be typewritten in capital letters to indicate outlets controlled, equipment or rooms served etc., by each circuit and shall be mounted in holders behind protective covering.

.7 Receptacle cover plates shall be marked indicating voltage, supply panel and circuit number.

.8 All receptacles shall be directly bonded to the grounding system by means of a bonding conductor of a size not less than that required by the CEC. If insulated, the ground conductor insulation shall be coloured green and FT4 rated.

.9 The Contractor shall inspect and clean each completed panelboard, low-voltage distribution transformer, safety switch and receptacle installation, correct any installation deficiencies and touch-up any minor scratches or surface damage with appropriate paint. The completed panel installation shall be covered, protected and kept clean pending completion of all surrounding construction Work and the start of equipment testing and commissioning.

3.3 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Managment of the General Specification.

.2 Perform tests in accordance with Section 26 05 00 Wire and Cable Systems.

.3 Panelboards

.1 Perform final equipment tests and commissioning of the panelboards, including visual and mechanical inspections and checks and electrical installation and equipment tests to verify the installation Work, in accordance with the manufacturer's recommendations and NETA specifications.

.2 Visual and Mechanical Inspection:

.1 Compare equipment nameplate information with the Contractor’s Documents.

.2 Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

.3 Perform operational test.

.4 Perform specific inspections and mechanical tests as recommended by manufacturer.

.3 Electrical Tests:

.1 Internal circuit continuity tests, using dc bell or buzzer, etc. for 600 V, 347 V and 120/208 V panelboards.

.2 Internal insulation resistance tests for 600 V, 347 V and 120/208 V panelboards.

.3 All test data and checks shall be recorded and shall include the location and identification of equipments and megohm readings versus time for insulation tests.

.4 Low-Voltage Distribution Transformers

.1 Perform final equipment tests and commissioning including visual and mechanical inspections and checks, and electrical installation and equipment tests, to verify the installation Work, in accordance with the manufacturer's recommendations and NETA specifications.

.2 Inspect all bolted electrical connections for high resistance using low-resistance ohmmeter, verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method.

.3 Perform turns-ratio tests at the selected tap position.

.4 Verify that as left tap connections are as specified.

.5 After energization, measure primary and secondary phase to phase and phase to neutral voltages. Check phase rotation and inspect for unusual or excessive noise.

.6 Verify proper operating voltages under load and proper neutral to ground bonding.

3.4 CLEANING

.1 Shall be in accordance with the requirements set out in Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Leave Work area clean at end of each Working Day.

.3 Upon completion and verification of performance of installation, remove surplus Materials, excess Materials, rubbish, Tools and equipment.

.1 Remove from Site and dispose of all packaging materials at appropriate recycling facilities.

.2 Collect and separate for recycling in accordance with Waste Management Plan.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 Supply, installation, testing, and commissioning of enclosed 600 Vac Starters with ratings of NEMA Size 1 through 5 shall be supplied from a single manufacturer as a complete factory assembly within a factory certified and tested enclosure.

.2 Supply, installation, testing, and commissioning of control stations shall be as detailed on the Purchaser's Drawings, as determined by the Engineer and specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsection of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wire and Cable Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Works shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Canadian Standards Association (CSA):

.1 C22.1 - Canadian Electrical Code Part 1, Safety Standard for Electrical Installations.

.2 C22.2 No. 14 - Industrial Control Equipment.

.3 CSA C22.2 No. 0.4 - Grounding.

.4 CSA C22.2 No. 0.12 - Wire Bending Space.

.2 NEMA:

.1 NEMA ICS 1 - Industrial Controls and Systems.

.2 NEMA ICS 2 - Starters, Contactors, Overload Relays.

.3 NEMA 250 - Enclosures.

.3 Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's

Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.1 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 26 29 10 (a)i to 26 29 10 (c)v will be based on the number of Items shown on the Purchaser's Drawings, and as directed by the Engineer.

.3 Unit Price

.1 The unit prices for Items 26 29 10 (a) to 26 29 10 (c) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, shipment to Site, storage, Site handling, installation including mounting channels/hardware for wall mounting, cable and grounding connections including fittings and terminals, testing and pre-commissioning, commissioning, touch-up painting, and turn over documentation, as specified herein and as follows:

.1 Items 26 29 10 (a)i to 26 29 10 (b)ii shall cover control stations.

.2 Items 26 29 10 (c)i to 26 29 10 (c)v shall cover motor starters.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Provide manufacturer's printed product literature, specifications and datasheet and include product characteristics, performance criteria, physical size, finish and limitations.

.3 Shop Drawings

.1 Provide shop drawings for each type of starter to indicate:

.1 General arrangement.

.2 Mounting method and dimensions.

.3 Starter size and type.

.4 Layout and components.

.5 Schematics and wiring diagram.

.2 Provide Shop Drawings for each type of control station to indicate:

.1 Mounting method and dimensions.

.2 Layout and components.

.3 Wiring diagram.

.3 All test reports results - shop and field.

1.6 CLOSEOUT SUBMITTALS

.1 Provide and include information package including specification, data and drawings into the operation and maintenance manual.

.2 Submit as-built record drawings.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspections of Deliveries to Site and Storage of the General Specification.

.2 Deliver materials to Site in original factory packaging.

1.8 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Managment of the General Specification.

Part 2 Products

2.1 GENERAL

.1 Panel construction shall be in accordance with the above referenced standards.

.2 Wiring and terminations shall be as specified in Section 26 05 21 Wire and Cable Systems.

2.2 DRAINAGE GALLERY CONTROL STATION

.1 Drainage Water/Clear Water Control Stations in the Drainage Gallery: A control station provides local control for two drainage or two clear water pumps in conjunction with the associated motor control center. The control station can be used by an operator if operation of a pump is required from the drainage gallery and selector switch in the MCC is selected in “Manual”.

.2 A control station for two pumps shall include:

.1 Four pushbuttons.

.2 Four pilot lamps for the pump “ON” and “OFF” status.

.3 One Lot of terminals, Entrelec Type M10/RS10, assume 20 terminals.

.3 Enclosure shall be NEMA4X suitable for mounting on the wall.

2.3 ELECTRICAL GALLERY CONTROL STATIION

.1 Drainage Water/Clear Water Control Stations in the Electrical Gallery: A control station selects the operation in “Lead” or “Lag”, provides local control for two drainage or two clear water pumps in conjunction the motor control center. The control station will be used by an operator if operation of a pump is required from the electrical service gallery. An operation from this station is possible if the MCC A-O-M switch is selected in “Manual”.

.2 A control station for two pumps shall include:

.1 Four pushbuttons.

.2 Four pilot lamps for the pump “ON” and “OFF” status.

.3 One Lag/Lead two position selector switch, minimum 16 contacts.

.4 Two Lead and Lag seal relays.

.5 One Lot of terminals, Entrelec Type M10/RS10, assume 20 terminals.

.3 Enclosure shall be NEMA 12 with drip shield over the panel suitable for mounting on the wall.

.4 Contacts wired for the UCMS monitoring

.1 Pump 1 selected as Lead.

.2 Pump 2 selected as Lead.

2.4 FVNR MOTOR STARTERS

.1 System: 3-phase, 600 V, resistance grounded.

.2 Enclosure: NEMA Type 12 with drip shield over the top, suitable for wall mounting.

.3 Type: Fusible combination magnetic starter. Locking in "OFF" position with up to three padlocks independent of door lock.

.4 Overload relay: solid state overload relay, manually reset from outside enclosure. A communication module is not required.

.5 Contactor: solenoid operated, rapid action type with two sets of auxiliary contacts.

.6 Single phase, dry type, control transformer with primary voltage as indicated and 120 Vac secondary, complete with primary and secondary fuses, installed within the starter.

.7 Indicating light: heavy duty, oil tight type, red for “ON” and green for “OFF”.

.8 Pushbuttons: heavy duty, oil tight and labeled.

.9 Selector switch: heavy duty Auto-Manual-Off selector switch.

.10 Loss of supply relay, picks up at 80% of the rated voltage.

.11 Contacts wired for UCMS monitoring

.1 Contactor closed status (input).

.2 Motor starter supply healthy (input).

.3 Not in auto status (input).

.4 Overload trip.

2.5 EXTRA MATERIALS AND SPARE PARTS

.1 Spare Part

.1 Provide a list of recommended spare parts of each type, including:

.1 Size 1 FVNR starter unit, complete.

.2 Size 2 FVNR starter unit, complete.

.3 Size 3 FVNR starter unit, complete.

.4 Size 4 FVNR starter unit, complete.

.5 Size 5 FVNR starter unit, complete.

2.6 FINISHES

.1 Apply finishes to enclosure in accordance with Section 26 05 00 Electrical General Requirements.

2.7 EQUIPMENT IDENTIFICATION

.1 Provide equipment identification in accordance with Section 26 05 00 Electrical General Requirements.

Part 3 Execution

3.1 INSTALLATION

.1 Install starters and control stations in accordance with manufacturer's instructions.

.2 Install and wire starters and control stations in accordance with Section 26 05 00 Electrical General Requirements.

3.2 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Perform visual and mechanical inspection for any damage or defect.

.3 Operate switches and contactors to verify correct functioning.

.4 Perform starting and stopping sequences of contactors and relays.

3.3 CLEANING

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-up and Removal of Plant, Surplus Material and Debris of the General Specification.

.2 Upon completion and verification of performance of installation, remove surplus Materials, rubbish, Tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, material, and plant and performing all Work necessary, including receiving, unloading and site handling, storage, installation, field testing, pre-commissioning, commissioning and performing all Work necessary as shown on the Purchaser's Drawings and as determined by the Engineer and as specified herein, for the installation of the following Purchaser supplied equipment:

.1 Standby diesel generator sets.

.2 Silencer.

.2 Furthermore, the Work to be performed under this Section shall consist of supplying all labour, materials, and plant and performing all Work necessary as shown on the Drawings and as determined by the Engineer and as specified herein, for the supply, transportation, handling, installation, testing, flushing (as applicable), marking, pre-commissioning and commissioning of the following:

.1 External diesel fuel oil tanks.

.2 Piping for fuel fill, vent, supply and return lines.

.3 Exhaust piping.

.4 Generator cooling air system.

.3 Work performed by the Purchaser

.1 Supply and delivery of standby diesel generator sets and silencers.

.4 Refer to the Purchaser's Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 21 13 00 - Fire Suppression Sprinkler System.

.4 Section 22 14 00 - Clearwater Drainage System.

.5 Section 23 30 00 - Heating, Ventilation and Air Conditioning System.

.6 Section 26 05 00 - Electrical General Requirements.

.7 Section 26 05 21 - Wire and Cable Systems.

.8 Section 26 36 23 - Automatic Transfer Switches.

.9 Section 28 31 00 - Fire Detection and Alarm System.

.10 Section 26 05 28 - Surface Grounding.

.11 Section 25 11 00 - Unit Control and Monitoring System.

.12 Section 40 05 00 - General Mechanical & Piping Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 As a minimum, the Works shall be performed in accordance with:

- .1 American Petroleum Institute (API):
  - .1 API Std. 650 - Welded Steel Tanks for Oil Storage 11th Edition.
  - .2 API Std. 2000 - Venting Atmospheric and Low Pressure Storage Tanks.
- .2 American Society of Mechanical Engineers - ASME:
  - .1 ASME B31.1 - Power Piping.
- .3 ASTM International:
  - .1 ASTM D975 - Standard Specification for Diesel Fuel Oils.
- .4 Canadian General Standards Board (CGSB):
  - .1 CAN/CGSB 3.6 - Regular Sulphur Diesel Fuel.
- .5 Canadian Environmental Protection Act (CEPA):
  - .1 CCME PN 1326 - Environmental Code of Practice for Aboveground and Underground Storage Tank Systems for Petroleum Products and Allied Petroleum Products.
- .6 CSA International:
  - .1 CSA-C22.1 - Canadian Electrical Code Part 1.
  - .2 CSA-C22.2 No. 14 - Industrial Control Equipment.
  - .3 CSA-B139 - Installation Code for Oil Burning Equipment.
  - .4 CSA Z460-05 - Control of Hazardous Energy.
  - .5 CSA C282 - Emergency Electrical Power Supply for Buildings.
  - .6 CSA B51 - Boilers, Pressure Vessels and Pressure Piping.
  - .7 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.
  - .8 CSA W59 - Welded Steel Construction (Metal Arc Welding).
- .7 National Electrical Manufacturers Association (NEMA):
  - .1 NEMA MG 1 - Motors and Generators.
  - .2 NEMA ICS 1 - Industrial Control and Systems General Requirements.
- .8 National Fire Protection Association:
  - .1 NFPA 110 - Emergency and Standby Power Systems.
  - .2 NFPA 30 - Flammable and Combustible Liquids Code.

.3 NFPA 37 - Installation and Use of Stationary Combustion Engines and Gas Turbines.

.9 Manufacturers Standardization Society of the Valve and Fitting Industry (MSS):

.1 SP-80 - Bronze Gate, Globe, Angle and Check Valves.

.10 Underwriters' Laboratories of Canada (ULC):

.1 CAN/ULC-S601 - Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids.

.4 Purchaser's Drawings.

.5 Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Equipment Items 26 32 13 00 (a)i to 26 32 13 00 (a)iii will be based on the number of Items as shown in the Purchaser's Drawings and Contractor's Documents.

.1 The supply and installation of tank vents and emergency vents (excluding vent piping); fill station accessories such as weatherhood and lockbox (but excluding piping and valves); shut-off cock, renewable cartridge filter; and fuel cooler (if required), are considered incidental to the Work and no separate measurement or calculation of Target Prices shall be made. The cost for these Items shall be included in the unit prices for the Items to which they apply.

.2 No separate measurement will be made for the following Items:

.1 26 32 13 (b) - Cooling Air System.

.2 26 32 13 (c) - Exhaust System.

.3 Measurement for Piping Items 26 32 13 (d)i to 26 32 13 (d)iii will be based on the length of pipe in metres shown in the Purchaser's Drawings, from fitting to fitting, excluding the fitting(s).

.4 Measurement for Fitting and Valve Items 26 32 13 (e)i to 26 32 13 (f)ii will be based on the number of Items shown in the Purchaser's Drawings.

.5 No separate measurement will be made for the following Items:

.1 26 32 13 (g) - Instrumentation.

.2 26 32 13 (h) - Testing, Flushing and Cleaning.

.3 26 32 13 (i) - Pre-commissioning.

.3 Unit Price

.1 The unit prices for equipment Items 26 32 13 (a)i to 26 32 13 (a)ii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving, unloading and site handling, storage, and installation of the equipment specified herein.

.2 Include costs for the switchgear associated with the diesel generators in the Target Prices proposed in Section 26 36 23 Automatic Transfer Switches.

.3 The unit price for equipment Item 26 32 13 (a)iii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, transportation, storage, handling, and installation of the equipment specified herein.

.4 Include costs for concrete spill containment associated with the fuel oil storage tanks in the Target Prices proposed in Section 03 30 00 Cast In-place Concrete.

.5 The Estimated Cost for Items 26 32 13 (b) to 26 32 13 (c) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, transporting, unloading, handling, and installation of the Items as specified herein. The installation of exhaust silencers, and supply and installation of exhaust piping, are considered incidental to the Work and no separate measurement or calculation of Target Prices shall be made. Include the costs for these Items in the Estimated Cost of Item 26 32 13 (c).

.6 The unit prices for the following Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein:

.1 26 32 13 (d)i to 26 32 13 (d)iii - Fuel Oil - Exposed Piping.

.2 26 32 13 (e)i to 26 32 13 (e)iii - Fuel Oil - Exposed Fittings.

.3 26 32 13 (f)i to 26 32 13 (f)ii - Fuel Oil - Valves.

.7 The Estimated Cost for Instrumentation Item 26 32 13 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by the Purchaser's Vendors. Installation of instrumentation supplied by the Purchaser's Vendors shall be included in the associated cost for the equipment.

.8 The Estimated Cost for Testing, Flushing and Cleaning Item 26 32 13 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's

Submission shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system.

.9 The Estimated Cost Pre-Commissioning Item 26 32 13 (i) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the equipment and systems as specified herein. The provision of close-out activities specified (e.g. site training) is considered incidental to the Work. Include costs for these Items in the Estimated Cost of Item 26 32 13 (i) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission.

1.5 SUBMITTALS

.1 The requirements shall be in accordance to Subsection 21.7 Contractor's Documents of the General Specification.

.2 Submit for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification: product data, shop drawings, installation manuals including installation and test plans, testing procedures, flushing procedures, marking procedures and pre-commissioning procedures.

.3 Source Quality Control

.1 Inspection and test plans and test summary sheets.

.4 Site Quality Control

.1 Schedule and detailed pre-commissioning test procedures.

.5 Provide list of recommended spare parts.

.6 Pre-commissioning test reports.

.7 Submit all Installation, Operation and Maintenance manuals to the Purchaser, in accordance with Subsection 21.7.12 Operation and Maintenance Manuals of the General Specification.

.8 Provide as-built drawings or mark-ups as applicable to Contractor's scope for part of the instruction and as required by Subsection 21.7.10 "As-Built Drawings" of the General Specification.

.9 The Contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment, in accordance with Subsection 21.7.7 3D Model Standards of the General Specification.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 All fittings require a Canadian Registration Number (CRN).

.3 Obtain a registration number for the diesel fuel tank and piping from the Office of the Fire Commissioner Inspection and Technical Services Manitoba (if required).

.4 Compliance with CSA Z460-05 Control of Hazardous Energy - Lockout and Other Methods.

.1 Read, understand and apply all of CSA Z460-05 Lockout and other methods:

.1 Contractors are not exempt from following provincial regulation. Therefore, Contractor must have a lockout program that complies completely with the lockout program stipulated in MR 217, Part 16.14 -17, Part 38.9 (b) and Part 38.14.

1.7 DELIVERY, STORAGE AND HANDLING

.1 The requirements shall be in accordance with Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

.3 Materials delivered to the Site shall be clearly tagged for easy identification.

.4 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.5 All items shall be handled with care to avoid damage prior to installation.

.6 The Contractor shall be responsible for receiving, offloading and handling the standby diesel generators. It is intended that the diesel generators will arrive at site after their permanent locations have been prepared and they can be directly offloaded and positioned in those locations.

.7 Delivery and acceptance requirements: deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.8 Packaging waste management: remove for reuse in accordance with the requirements of Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.9 During shipping and in storage, the equipment may be exposed to temperatures as low as -45°C.

.10 The assembled engine-generator set will be prepared by the manufacturer for short-term outdoor storage (not more than twelve months) at the Site. Piping and ventilation openings shall be capped or covered to keep out dirt. The Purchaser will provide the manufacturer’s recommended storage procedures.

Part 2 Products

2.1 SYSTEM

.1 Generating system comprising:

.1 Diesel generator set (supplied by others), which includes:

.1 Diesel engine (Heavy duty, 4 cycle, compression-ignition type, V-type).

.2 Alternator (600 V, 3ph).

.3 Silencer.

.4 Alternator control panel.

.5 Battery charger and starting battery.

.6 Fuel system (includes engine mounted fuel transfer pumps, primary and secondary fuel filters, air cleaner, fuel solenoid rack, and fuel pressure regulating valve).

.7 Lubrication system.

.8 Cooling system (includes coolant pumps, radiator, temperature sensors, and thermostatic control valve).

.9 Steel mounting base with vibration isolators.

.10 Synchronizing panel, refer to Section 26 36 23 Automatic Transfer Switches.

.11 Automatic transfer switches (Powerhouse Complex has two black-start switchgear and four automatic transfer switches, and Spillway has one automatic transfer switch), refer to Section 26 36 23 Automatic Transfer Switches.

.12 Alternator circuit breaker part of the diesel generator assembly.

.13 Engine controls.

.14 Neutral grounding resistor to limit the let through current to 5A under a phase to ground fault.

.2 Automatic engine ventilation system.

.3 Fuel tanks and piping.

.4 Exhaust system (except silencer as noted above).

.2 Systems will operate as emergency standby with the ability to synchronize to the 600 V station service and operate in parallel with station service for load exercising.

2.2 BACKGROUND DESCRIPTION

.1 The following background description is to provide the Contractor with general knowledge of the system design and arrangement in absence of detailed drawings:

.1 The capacity of each blackstart diesel generator will be sized for the life safety systems of the Powerhouse Complex and for blackstart loads of one unit. The units will be located as indicated on the Purchaser's Drawings. One diesel generator will act as a backup to the other.

.2 The Spillway Complex diesel generator is for standby power required to operate the spillway for an extended period of time. The spillway diesel generator is located in the spillway north transition as shown on the Purchaser's Drawings.

.3 The Purchaser-supplied diesel generator sets have the following preliminary ratings:

.1 Powerhouse blackstart diesel generator#1: 750 kW, standby power.

.2 Powerhouse blackstart diesel generator#2: 750 kW, standby power.

.3 Spillway standby diesel generator: 600 kW, continuous power.

.4 Exhaust systems:

.1 The Purchaser supplied silencer will be located inside each of the genset rooms horizontally mounted. The exhaust piping will connect the flexible exhaust connection from the generator set to the silencer and from the silencer to the exterior of the enclosure. The exhaust piping and silencer inside the room will not be insulated as the unit will run infrequently and the room is not typically occupied. An insulating thimble will be used to protect the genset room walls from the high exhaust temperatures. The exhaust piping will be located away from the intake and/or extended a sufficient amount above the intake to ensure that engine exhaust does not get re-circulated into the rooms.

.5 Diesel generator set ventilation:

.1 Each cooling air exhaust will be vented to the outside through a duct extending straight out from the radiators. This exhaust will be on the east wall for the genset in the control building and on the north wall for the genset in the service bay. The exhaust duct will consist of three sets of dampers, flexible connectors and controls to maintain room temperature.

.2 The air intake for the genset in the control building will be located near floor level on the north wall, but high enough to avoid getting blocked by snow, and as far as practical from the exhaust outlet (east wall). The air intake for the genset in the service bay will be located above the exhaust outlet as the room has only one exterior wall with limited width available for ducting (part of this wall supports the powerhouse crane wheel loads). Hence, the arrangement is unavoidable with this room location. During detail design, the ventilation scheme will be reviewed to ensure there is no cross flow between the intake and exhaust fittings.

.3 Air outlet and intake dampers will be sized in accordance with the manufacturer's requirements. As a minimum, the air outlet will be sized such that the "free area" of the ducts are as large as the exposed area of the radiator and the "free area" of the intakes will be 1.5 times larger.

.6 Fuel tanks:

.1 Each fuel storage tank shall be sized for a minimum of 24 hour operation at 100% rated load.

.2 The storage tanks shall be single wall and a concrete secondary containment curb (110% volume) for possible fuel oil leaks shall be provided for the tank, piping and valves. The floor drains in the diesel generator rooms will also route to the station oil/water separator system in case of breach of both the fuel tank and the secondary containment.

.3 Each of the fuel tanks are located on the same floor as the diesel generators and in the same room for spillway and control building diesel generators or in the next room at very close proximity for the upstream service bay diesel generator.

.7 Switchgear and controls:

.1 Each genset will be controlled by its own local generator control panel containing the following minimum functions and components:

.1 Generator start and stop logic including interfacing with switchgear assemblies and generator ventilation system.

.2 Local alarm module.

.3 Generator electrical protection relay.

.4 Mechanical and electrical control switches and indicators.

.5 Electronic governor, voltage regulator and load controller.

.2 Frame mounted 600V circuit breaker.

.3 The generators will be capable of remotely-initiated, automatic starting and stopping from the station auxiliary PLC.

.4 The generators will be provided with the ability to be self-tested by synchronizing and loading onto the station service. A load controller will perform the loading and unloading sequence by controlling the synchronizing and signalling of the governor to pick up the target load.

.5 Two black-start switchgear (BSSG) and four automatic transfer switch (ATS) assemblies will be provided by the Purchaser for installation in the Powerhouse Complex. The ATS assemblies will automatically route load from the diesel generators to the essential unit and MCCs to enable black-starting of the selected black-start hydro unit.

.6 One ATS assembly will be provided (by others) on the Spillway Complex. The assembly will automatically transfer essential loads to the spillway diesel generator set if the normal supply is lost.

2.3 FUEL SYSTEM AND PIPING

.1 Fuel: to ASTM D975 No. 2-D S15.

.2 The fuel system for the engine-generator set shall conform to the requirements of NFPA 30 and NFPA 37.

.3 Fuel storage tanks: to API Standard 650 and ULC-S601, ULC labelled.

.1 Horizontal above ground tank:

.1 Single wall, welded steel construction.

.2 Provided with connections for fuel supply line, fuel return line, local fuel fill port, gauge, vent line, and level indicator transmitter.

.3 Capacity to run the diesel generator set a minimum of 24 hours at 100% rated load (currently estimated tank capacity: 4,000 L).

.4 Mounted indoors on elevated stand, complete with appurtenances and hold down lugs.

.2 Fuel level gauge and vent alarm.

.3 Fuel fill port and vent lines on the tank shall be extended to an external location outside of building, fitted with weatherhoods, as shown on the Purchaser's Drawings. To be included:

.1 Lock-box protection.

.2 Spill containment for minor spillage.

.3 Means for grounding.

.4 Low and high fuel level alarms and remote indication.

.1 Refer to Section 40 90 25 Instrumentation for Piping Systems for details on instrumentation.

.1 Alarm settings:

.1 Low level alarm to be set at 50% of low fuel level condition.

.2 High level alarm to be set at 95% of rated tank capacity.

.5 Venting:

.1 Normal venting shall be sized in accordance with the American Petroleum Institute Standard No 2000, venting atmospheric and low pressure storage tanks, not less than 32 mm (1-1/4 in.) nominal inside diameter.
A 32 mm (1-1/4 in.) atmospheric mushroom cap shall be furnished. (The installing contractor shall pipe above the highest fill point as a minimum.)

.6 Emergency venting:

.1 The emergency vent opening shall be sized to accommodate the total capacity of both normal and emergency venting and shall be not less than that derived from NFPA 30, Table 2-8, and based on the wetted surface area of the tank. The wetted area of the tank shall be calculated on the basis of 100% of the primary tank. A zinc plated emergency pressure relief vent cap shall be furnished for the primary tank. The vent is spring-pressure operated: opening pressure is 0.5/psig and full opening pressure is 2.5 psig. Limits shall be stamp marked on top of each vent.

.7 Lifting lugs:

.1 Each tank shall be provided with lifting lugs of adequate size and strength, properly located for lifting the tanks during shipping and installation.

.8 Welding:

.1 All welding shall conform to the requirements of CSA Standard W59 and shall be undertaken by fabricators and operators who are qualified under CSA Standard W47 and are approved by the Canadian Welding Bureau.

.4 Secondary containment, sized for 110% capacity of the tank, to be a fabricated and galvanized steel containment tub provided around the tank. Containment tub shall be watertight.

.5 Floor drains in diesel generator rooms to route to station oil/water separator system in case of breach of both the fuel tank and the secondary containment. Refer to Section 22 14 00 Clearwater Drainage System.

.6 Drain and end plug.

.7 A fuel return line cooler shall be provided as recommended by the manufacturer and assembler. The temperature of the fuel returning to the tank shall be below the flash point of the fuel.

.8 Shut-off cock.

.9 Renewable cartridge filter.

.10 Jamesbury Firesafe valve Figure 1075, or Purchaser accepted equivalent.

.11 Isolating valves on lines serving auxiliaries.

2.4 EXHAUST SYSTEM

.1 The diesel generator provided by the Purchaser will be provided with an exhaust flange for connection of the following components:

.1 Exhaust piping, fittings and accessories as required.

.2 Use insulating thimble to protect the genset room walls from the high exhaust temperatures.

.3 Flexible exhaust expansion joints: stainless steel, corrugated, of suitable length, to absorb both vertical and horizontal expansion.

.4 Eyebolts, lugs, flanges, or other Items shall be provided to support the Silencer (supplied by others) as necessary for support in the location and position indicated by the Contractor's Drawing.

2.5 COOLING AIR SYSTEM

.1 Engine ventilating system

.1 The engine ventilation system includes three types of dampers assemblies with modulating motors to allow for temperature control:

.1 Air intake damper (qty. 1).

.2 Cooling exhaust air damper (qty. 1).

.3 Recirculating air dampers (qty. 2).

.2 The cooling air exhaust includes a duct from generator set radiator to building wall, a flexible duct for interface between generator set and wall, and two recirculating air dampers before the cooling exhaust air damper.

.3 Air discharge and intake gooseneck weatherhoods.

.4 Modulating thermostat.

.5 Replaceable air intake filters.

.6 Dampers to operate from the line side of automatic transfer switch. Dampers will include intake, exhaust; and recirculation.

.7 With the diesel generator energized, the air damper system shall be enabled to operate. Once enabled, the intake air dampers shall move to a minimum position for combustion air under the influence of a minimum position switch. A space thermostat shall modulate the intake air and exhaust air dampers from minimum to full intake air as required, should the space temperature rise above an adjustable set point. As the intake air and exhaust air dampers move from minimum to

maximum, the recirculating air damper will operate inversely, moving from maximum to minimum. The dampers will be supplied from the generator battery system to ensure system is self contained and the diesel generators can be started when the utility supply is not available.

.8 Refer to the Purchaser's Drawings for arrangement ducts and dampers.

2.6 GUARDING

.1 Guards to protect personnel from hot parts, moving parts and electrically live parts and parts that may be a hazard to operating personnel during normal operation. Note: Guards required on the diesel generator set shall be provided by manufacturer.

.1 Locate guards so that normal daily maintenance inspections can be undertaken without their removal.

.2 Withstand a 200 N point load.

.3 Be thermally or electrically insulated as required.

2.7 PIPING, FITTINGS AND SUPPORTS

.1 Piping

.1 Exhaust piping with flanged couplings as required.

.1 Design pressure 100 kPa (14.5 psi).

.2 Piping Material Specification similar to Class A (see applicable Pipe Class Material Specification in Section 40 05 00 Mechanical and Piping General Requirements) except gaskets will be Garlock Flexseal Wound with filler material suitable for exhaust gas temperatures.

.3 Code of construction to be ASME B31.1.

.2 Fill and vent line piping as follows:

.1 Design pressure 100 kPa (14.5 psi).

.2 Piping Material Specification Class C (see applicable Pipe Class Material Specification in Section 40 05 00 Mechanical and Piping General Requirements).

.3 Refer to Part 2 of Section 40 05 00 Mechanical and Piping General Requirements for additional material requirements.

.4 Code of construction to be ASME B31.1.

.3 Fuel supply and return lines, with flexible terminations at engine. Piping as follows:

.1 Design Pressure 100 kPa (14.5 psi).

.2 Piping Material Specification Class C (see applicable Pipe Class Material Specification in Section 40 05 00 Mechanical and Piping General Requirements).

.3 Refer to Part 2 of Section 40 05 00 Mechanical and Piping General Requirements for additional material requirements.

.4 Code of construction to be ASME B31.1.

.2 Miscellaneous fittings not specified.

.1 Threaded fittings: ASME B16.3, Class 150.

.2 Valves: MSS SP-80, Class 150.

.3 Gaskets: manufacturer's standard.

.3 Connections at equipment shall be flanged except that connections to the diesel engine may be threaded if the diesel-engine manufacturers standard connection is threaded. Except where otherwise specified, welded flanged fittings shall be utilized to allow for complete dismantling and removal of each piping system from the facility without disconnecting or removing any portion of any other system's equipment or piping.

.4 Connections to equipment shall be made with vibration-isolation-type flexible connectors.

.5 Piping and tubing shall be supported and aligned to prevent stressing of flexible hoses and connectors.

.6 Pipe hangers

.1 Refer to Section 40 05 00 Mechanical and Piping General Requirements.

2.8 INSTALLATION MATERIALS

.1 Diesel generator set mounting

.1 The diesel generator set will be provided with:

.1 Spring type isolators with adjustable side snubbers and adjustable for levelling.

.2 Sound insulation pads for installation between isolators and concrete base.

.2 Install Hilti-type anchor bolts for securing and anchoring the diesel generators to their designated foundations and concrete housekeeping pads.

.2 Provide non-corroding metal shim stock of varying thickness for the levelling of the assemblies at the anchor and support points as required for proper installation of the diesel generators.

2.9 IDENTIFICATION AND MARKING

.1 Provide equipment identification in accordance with Section 40 05 00 Mechanical and Piping General Requirements and Section 26 05 00 Electrical General Requirements as applicable.

.2 Each major component shall have the manufacturer's name, type or style, model or serial number, and rating number on a plate secured to the equipment. Nameplates shall indicate approval by CSA, ULC, or other acceptable approval agency. As a minimum, nameplates shall be provided for:

.1 Fuel tank

.3 Nameplates shall be non-corrosive nameplate and permanently attached with non-corrosive hardware in locations where the details may be readily visible after installation.

2.10 FINISHES

.1 Apply finishes in accordance with Section 09 90 00 Painting and Coating.

2.11 SOURCE QUALITY CONTROL

.1 General

.1 The Purchaser reserves the right to inspect the Work during manufacture and to witness tests after assembly at the factory or factories.

.2 Fuel Tank

.1 Inspection and Testing:

.1 Factory inspection and testing of the storage tanks shall be in accordance with the Underwriters Laboratories of Canada.

.2 Tanks shall be factory-tested in the horizontal position, to a test pressure meeting the requirements of ULC-S601.

.3 Notify Purchaser's Representative 10 days in advance of date of factory test.

Part 3 Execution

3.1 GENERAL

.1 General execution of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, testing, pre-commissioning and site quality control, shall be completed in accordance with Section 40 05 00 Mechanical and Piping General Requirements and Section 23 30 00 Heating Ventilation and Air Conditioning System, in addition to any specific requirements indicated below.

3.2 PREPARATION

.1 On receipt of the equipment at Site, inspect the shipment, note any missing or damaged components and notify the Engineer of any deficiencies.

3.3 INSTALLATION

.1 General

.1 The Purchaser will provide a qualified field service representative from the original equipment manufacturer (OEM) to supervise the installation of the diesel-generator set.

.2 Arrangement shall provide clear space for operation and maintenance in accordance with The Manitoba edition of the Canadian Electrical Code Part I. Installation of armoured cable, pipe, duct, conduit, and ancillary equipment shall be configured to facilitate easy removal and replacement of major components and parts of the emergency power supply system.

.2 Standby Diesel Generator

.1 Position, align and level the 600 V diesel generator in accordance with the Purchaser's Drawings; and anchor designated anchoring points of the diesel generator assembly base, securely to designated foundations on the concrete floor of the diesel room.

.2 Install and complete all diesel generator ancillary system components and systems including the exhaust system, the fuel storage and transfer system, fuel filling and the facility cooling system and ventilating air duct system as indicated.

.3 Install and terminate all cable interconnections to the 600 V standby diesel generator in accordance with the Purchaser's Drawings and Section 26 05 21 Wire and Cable System and Section 26 05 00 Electrical General Requirements.

.4 The Contractor shall install and terminate grounding and bonding connections to the 600 V standby diesel generator in accordance with the Purchaser's Drawings and Section 26 05 28 Surface Grounding.

.5 All wiring connections at the generator set (power, grounding, control, and annunciating) shall be installed in flexible metallic tubing, flexible metal conduit, or liquid tight flexible metal conduit sections, at least 450 mm long.

.6 Install control and signal wiring, from the generator set to the transfer switch and other remote devices, in separate raceway(s) from power conductors to minimize power circuit interference.

.7 Inspect and clean the completed diesel generator and ancillary systems installation, correct any installation deficiencies and touch-up any minor scratches or surface damage with appropriate paint.

.8 Cover and protect the completed installation and keep clean pending completion of all surrounding construction works and the start of equipment testing and commissioning.

.3 Fuel Tank

.1 It shall be installed in accordance with NFPA 30, NFPA 37, and NFPA 110.

.2 Provide clearance around systems, equipment and components for observation of operation, inspection, servicing, maintenance and as recommended by manufacturer and CSA-B139.

.3 Provide fuel for pre-commissioning and leave tanks full on acceptance.

3.4 PRE-COMMISSIONING TESTS

.1 The Purchaser will provide a qualified field service representative from the original equipment manufacturer (OEM) to supervise the pre-commissioning of the engine-generator set.

.2 Perform electrical tests in accordance with Section 26 05 00 Electrical General Requirements.

.3 Perform tests in conjunction with blackstart ATS switchgear specified in Section 26 36 23 Automatic Transfer Switches.

.4 Notify the Engineer twelve Working Days in advance of the testing date.

.5 Prior to filling fuel tank with diesel fuel, perform a leak test of the containment tub to demonstrate that it is watertight.

.6 The Contractor shall provide a schedule and detailed pre-commissioning test procedures for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. The testing and precommissioning to be completed will be

witnessed by the Engineer and shall allow the Purchaser's Vendor to proceed with its commissioning. The Purchaser will arrange the connections with emergency power supply system and perform stand-alone tests on other systems required during site pre-commissioning tests. At a minimum, commissioning to be performed by the Purchaser's Vendor will include:

.1 Pre-start inspection of engine generator set and associated piping and equipment, verifying presence, type, features, accessibility and condition (in addition to those identified in the Contractor's procedure).

.2 Fuel, lubrication oil and coolant shall be checked for conformity to manufacturer's recommendations.

.3 Accessories that function while the unit is standing by shall be checked before cranking the engine. These accessories shall include block heaters, battery charger, alternator strip heaters, etc.

.4 Start-up under test mode (without Purchaser's load connected) to check for exhaust leaks, path of exhaust gas outside the building, cooling air flow, movement and vibration, normal source and emergency source line-to-line voltage and frequency, phase rotation.

.5 Perform cycle crank test. The engine shall be prevented from running and the cranking cycle specified in "Starting System; Capacity" shall be observed and recorded.

.6 Verify operation and set points of all shutdown devices, demonstrate shutdown on high engine temperature, low lubricating oil pressure, and verify operation of shutdown manual switch.

.7 Engine stand-alone load run test; Unit paralleled with the station distribution system. Depending on the time of year, climatic conditions, and construction sequencing, actual load fed through the emergency switchgear may be insufficient. Utility protection and transfer switch settings may need to be modified to allow export in to the distribution system. A minimum requirement will be to run the unit for one hour at a minimum of 75% loading. Remove load and shutdown. Restore switch and protection relay settings.

.8 Demonstrate: Unit start, transfer to load, retransfer to normal power, unit shut down, on "Automatic" control.

- .1 Unit start and shut down on "Manual" control.
- .2 Unit start and transfer on "Test" control.
- .3 Unit start on "Engine start" control.
- .4 Operation of manual bypass switch.
- .5 Operation of automatic alarms and shut down devices.

.9 Run unit on load for minimum period of 12 hours to show load carrying ability, stability of voltage and frequency, and satisfactory performance of dampers in ventilating system to provide adequate engine cooling.

.10 At end of test run check battery voltage to demonstrate battery charger has returned battery to fully charged state.

.11 Upon successful completion of tests, replace all the filters.

3.5 CLEANING

.1 All waste shall be disposed of in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification. This shall include, but not be limited to the following:

.1 Surplus batteries.

.2 Waste lubricating oil.

.3 Waste antifreeze.

3.6 COMMISSIONING

.1 The Purchaser shall perform its own commissioning tests on the standby diesel generators as part of the station commissioning.

.2 Contractor shall provide commissioning support as requested in accordance with Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

3.7 CLOSE-OUT ACTIVITIES

.1 Purchaser will arrange for instruction by the manufacturer's technical representative to perform on-site training of the Purchaser's staff. Contractor is requested to assist diesel generator set OEM representative with onsite training. Supply all tools, equipment and personnel to assist in demonstrate and instruct operating and maintenance personnel in operation, control, adjusting, trouble shooting, and servicing of all systems and equipment during regular Work hours, prior to acceptance by the Purchaser.

.2 Where appropriate, the Purchaser may record these demonstrations for future reference and training.

.3 Provide any special tools required for operation and/or maintenance in relation to the scope of supply specified herein.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supply, installation and testing and commissioning of the 125 Vdc battery systems and distribution, 125 Vdc to 120 Vac inverters and distribution system, emergency lighting UPS and 120 Vac UPS distribution, 48 Vdc communication system batteries, and 24 Vdc Spillway Area battery systems for the Keeyask Generating Station.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wires and Cables.

.4 Section 26 05 28 – Surface Grounding.

1.3 REFERENCES

.1 The Work shall be performed in accordance with the latest edition of the standards mentioned, except where specified otherwise.

.2 The Works shall conform to all registrations applicable to this type of Work in effect at the time the Work is performed.

.3 As a minimum, the Work shall be performed in accordance with:

.1 American National Standards Institute (ANSI)/Underwriters Laboratories (UL):

.1 ANSI/UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

.2 C37.20 - Standard for Switchgear Assemblies.

.3 C37.90.2 - Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.

.4 ANSI/NETA ATS-2009 Standard for Acceptance Testing Specification for Electrical Power Equipment and Systems.

.2 Canadian Standards Association (CSA International):

.1 CAN/CSA-G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.

.2 C22.1 - Canadian Electrical Code Part 1 Safety Standard for Electrical Installations.

.3 C22.2 - No. 5 Molded Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.

.4 C22.2 - No. 0.12 Wiring Space and Wire Bending Space in Enclosures for Equipment.

.5 C22.2 - No 14 Industrial Control Equipment.

.6 C22.2 - No. 29 Panelboards and Enclosed Panelboards.

.7 C22.2 - No. 31 Switchgear Assemblies.

.8 C22.2 - No. 107.2 Battery Chargers.

.9 C22.2 - No. 107.3 Uninterruptible Power Supplies.

.10 C22.2 - No. 178 Automatic Transfer Switches.

.3 Institute of Electrical and Electronic Engineers (IEEE):

.1 IEEE 484 - IEEE Recommended Practices for Installation Design and Implementation of Vented Lead-Acid Batteries for Stationary Applications.

.2 IEEE 485 - IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.

.3 IEEE 450 - Recommended Practice for Maintenance, Testing and Replacement of Vented Lead-Acid Batteries for Stationary Applications.

.4 IEEE 946 - Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Stations.

.5 C37.14 - IEEE Standard for Low-Voltage DC Power Circuit Breakers Used in Enclosures.

.6 IEEE 1375 - IEEE Guide for the Protection of Stationary Battery Systems.

.7 IEEE-1188 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications.

.8 IEEE-1189 - IEEE Guide for Selection of Valve-Regulated Lead-Acid Batteries for Stationary Applications.

.9 IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Application.

.4 NEMA:

.1 ICS 1 - Industrial Control and Systems.

.2 ICS 6 - Enclosures for Industrial Controls and Systems.

.3 ICS 10 - Part 2, Static AC Transfer Equipment.

.4 PE-5 - Utility Type Battery Chargers.

.5 PB-2 - Deadfront Distribution Switchboard.

.5 Transport Canada (TC):

.1 Transportation of Dangerous Goods Act (TDGA), 1992, c. 34.

.6 IEC:

.1 IEC60896-2 - International Standard for Stationary Lead-Acid Batteries: General Requirements and Methods of Test (Valve-Regulated Types).

.4 Design Information (to be provided following detailed design)

.1 Battery duty load cycle (8 hours) of the facility 125 Vdc loads in the Powerhouse Area and 24 Vdc loads in Spillway Area.

.2 Battery duty load cycle (12 hours) of the facility 48 Vdc loads.

.3 Powerhouse Battery Room 1 Layout.

.4 Powerhouse Battery Room 2 Layout.

.5 Communication Battery Room Layout.

.6 Spillway Electrical Room Layout.

.5 Purchaser’s Drawings.

.6 3D Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for equipment Items 26 33 00 (a) to 26 33 00 (e) will be based on the quantity as shown on the Purchaser's Drawings, the Contractor's Documents and as determined by the Engineer.

.3 Unit Price

.1 The unit prices for the following Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, shipment to the site, storage, site handling, installation and installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, commissioning, touch-up painting, and hand over documentation as specified herein and as determined by the Engineer:

.1 26 33 00 (a) – Supply and Installation of 125 Vdc Battery Systems.

.2 26 33 00 (b) – Supply and Installation of 125 Vdc to 120 Vac Inverters.

.3 26 33 00 (c) – UPS for Emergency Lighting Supply.

.4 26 33 00 (d) – 48 Vdc Communication Battery System.

.5 26 33 00 (e) – 24 Vdc Spillway Battery System.

1.5 SUBMITTALS

.1 The requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Battery:

.1 Submit WHMIS MSDS.

.2 Individual battery cells:

.1 Type.

.2 Size, dimensional drawings including weights for container, cover, separators, retainers, posts and inter-cell connectors.

.3 Capacity tables for 1 minute to 24 hour constant current discharge for final cell voltages of 1.65 to 1.95V/cell.

.4 Specific gravity at full charge and 25° C.

.5 Cell charge and discharge curves of voltage, current, time and capacity.

.6 Derating factor for temperature range (minus 30°C to plus 40°C).

.7 Maximum short circuit current.

.8 Maximum charging current remmended for fully discharged condition.

.9 Hydrogen generation and ventilation requirements.

.10 Shipping weights.

.2 Other Equipment:

.1 Equipment specification.

.2 Operational features where applicable.

.3 Battery System Sizing

.1 125 Vdc battery system sizing calculations.

.2 Emergency lighting UPS battery sizing calculations.

.3 48 Vdc battery sizing calculations.

.4 24 Vdc battery system sizing calculations.

.4 Drawings submitted in the Contractor's Documents are to include:

.1 For each Battery:

.1 Dimensioned drawing showing battery rack, individual battery cells, recommended aisle space, headroom, assembly and anchoring of rack.

.2 Bill of materials.

.2 For each Charger:

.1 General arrangement drawing.

.2 Schematics.

.3 Bill of material.

.4 Wiring Diagram.

.3 For each Uninterrupted Supply and Inverter Assembly:

.1 General arrangement drawing.

.2 Schematics.

.3 Bill of material.

.4 Wiring Diagram.

.4 For each Switchboard and DC Panel Board:

.1 General arrangement and assembly drawing.

.2 Schematics.

.3 Bill of material.

.4 Wiring Diagram.

.5 Quality Management submittals

.1 Type Test Report: submit type test report by third party certifying that materials comply with specified performance characteristics and physical properties.

.2 Factory Inspection and Test Plan: submit factory inspection and test plan for review and acceptance covering material procurement, factory assembly, factory testing, and packing and shipment.

.3 Factory inspection and Test Report: submit factory inspection and test reports for review and acceptance.

.4 Field Inspection and Test Plan: Submit field inspection and test plan covering receipt of material at site, storage, field installation, testing, connections to integrate with the other systems, and commissioning.

.5 Field Inspection, Test and Commissioning Reports: Submit field inspection, test and commissioning reports for review and acceptance.

.6 Closeout Submittals

.1 Provide equipment manuals in accordance with Subsection 21.7.12 Operation and Maintenance Manuals of the General Specification, indicating selection and details including:

.2 Contents:

.1 Device manuals indicating selection and details including:

.1 Technical specification.

.2 Storage instructions.

.3 Operation and maintenance instructions concerning design elements, construction features, component functions and maintenance requirements to permit effective operation, maintenance and repair.

.4 Installation details.

.5 Replacement instructions for parts or cells.

.6 Hazardous material handling.

.7 Parts lists with catalogue numbers, and names and addresses of suppliers.

.8 Available features and functions available including guidance on setting of functions and typical applications where applicable.

.9 Programming details where applicable.

.10 Communication features and details of interfacing and configuring communication with remote devices if applicable.

.11 Testing and commissioning instructions.

.3 Drawings:

.1 Drawing List.

.2 As-built record drawings.

.4 Test Reports:

.1 Type test reports.

.2 Record of factory tests.

.3 Record of field tests and pre-commissioning tests.

.5 Programming Software:

.1 Provide programming software, field as built record of program setup files and documentation if applicable.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 The engineers, technologists, technicians and assemblers assigned to the job shall be certified and experienced in systems used for the project.

.2 The contractor shall have qualified staff trained in project control, quality assurance, and to support quality surveillance.

.3 Extra Materials

.1 Installation and commissioning spares to be supplied by the Contractor.

1.7 DELIVERY STORAGE AND DISPOSAL

.1 The requirements shall be in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer's name and address.

.3 Waste Management and Disposal shall:

.1 Place materials defined as hazardous or toxic waste in designated containers.

.2 Handle and dispose of hazardous materials in accordance with TDGA.

.3 Ensure emptied containers are sealed and stored safely.

1.8 WARRANTY

.1 The requirements shall be in accordance with Section 25 Warranty of the General Specification, and as specified in this Section of the Technical Specification.

.2 The Contractor shall provide a 20 year warranty on battery cells, which shall be full replacement within the first year after installation and startup, and pro-rated for the next 19 years. Basis for a claim will be failure to provide at least 80% of rated ampere-hour capacity to rated end voltage at any time during the warranty period.

Part 2 Products

2.1 SCOPE

.1 The supply, manufacture, quality control, factory assembly and testing, preparation for shipping, delivery and storage at site, and installation of:

.1 125 Vdc Battery Systems:

.1 One 3,600 AH, 125 Vdc Powerhouse Battery 1 (BB-PH1) comprised of 60 flooded lead acid cells.

.2 One 3,600 AH, 125 Vdc Powerhouse Battery 2 (BB-PH2) comprised of 60 flooded lead acid cells.

.3 Four 125 Vdc free standing battery chargers.

.4 Two fused disconnect switches for 125 Vdc batteries.

.5 Two DC Switchboards with metering equipment.

.6 One Tie switch for tie between the systems.

.7 Fourteen DC panel boards with voltage monitoring relays for individual circuit breakers.

.2 125 Vdc to 120 Vac Inverters:

.1 Two Inverters of 6,000 VA ratings in free standing enclosures, each assembly complete with:

.1 125 Vdc to 120 Vac converters.

.2 Static transfer switch.

.3 Manual bypass switch.

.4 Circuit protection and monitoring devices.

.5 Single-phase panelboard.

.3 UPS system for Emergency Lighting supply:

.1 Valve Regulated Lead Acid (VRLA) battery (BB-UPS1) of rating 800 Ah comprised of 60 cells.

.2 Assembled cubicles complete with:

.1 Three 125 Vdc to 120 Vac inverter with controls for synchronization.

.2 One 600-208/120 V, 100 kVA Delta-Y Grounded isolation transformer for normal ac supply.

.3 One 3-phase static transfer switch.

.4 Metering and main feeder protection devices.

.5 One 3-phase 208/120 Vac panel board.

.4 48 Vdc Battery System:

.1 One 48 Vdc Communication Bank 1 (BB1C) of 600 AH rating comprised of 24 cells.

.2 One 48 Vdc Communication Bank 2 (BB2C) of 600 AH rating comprised of 24 cells.

.3 Two fused disconnect switches for 48 Vdc batteries.

.4 One fused disconnect switch for emergency hook-up.

.5 24 Vdc Battery Systems for Spillway:

.1 Two VRLA batteries of 100AH each comprised of 12 cells.

.2 Two Battery Metering panel complete with shunt and transducers and meters.

.3 Two wall mounted 24 Vdc battery chargers.

.4 Two Fused disconnect switches for the batteries.

.5 Two Panel boards with monitoring units.

.6 One Tie disconnect switch for tie between the systems.

.2 Raceways and cable trays from main cable trays runs and in between the battery system equipment for wire and cable installations.

.3 Cable connections including supply and installation of cable fittings and lugs, organization of cable in the trough in the equipment panels if applicable and conductor terminations as per Issued for Construction Drawings.

.4 Field assembly, installation and testing of the battery systems; the Powerhouse batteries BB-PH1 and BB-PH2 are installed in separate rooms in the Electrical Gallery, one near Unit 1 and other near Unit 7. The communication batteries are located in a communication battery room near the communication room. The UPS and inverters are located in the Service Bay Area. The 24 Vdc battery system is located in the Spillway Area.

.5 Commissioning of the battery systems with the rest of plant including integration into the Unit Control and Monitoring System (UCMS) system.

.6 Battery sizes are preliminary and the Contractor shall confirm based on load cycle to be provided at later stage using design margin (Kd) 1.15, age factor (Ka) 1.25, and initial electrolyte temperature 20°C. The battery chargers, switchboard and other components will be sized to suit the battery rating and requirement specified herein.

.7 Work Excluded

.1 Load profile for the batteries.

.2 Engineering for battery system layout plan.

.3 Interfacing engineering of battery systems with the facility.

.4 48 Vdc Battery System:

.1 Rack mounted shelves with charger and controller modules.

.2 Rack mounted charge panel, metering and control panel, and load panels.

.3 Positive and negative splitter panels.

2.2 DESCRIPTION

.1 The 125 Vdc battery systems are not grounded and are comprised of flooded lead acid batteries, fused disconnects for batteries, free standing battery chargers, dc switchboard, and dc panel boards. The systems supply the critical protection and control systems and some other critical and essential loads.

.2 125 Vdc to 120 Vac inverters are for servers and other critical loads supplied from 120 Vac, and each inverter is comprised of a 1-phase converter, a 1-phase static transfer switch and a 1-phase manual bypass switch.

.3 An uninterrupted power supply assembly for emergency lighting is comprised of one 125 Vdc charger, one 125 Vdc valve regulated lead acid battery bank, battery metering, one 3-phase inverter, one 3-phase static transfer switch, one 600-208/120 V dry type transformer, and one 3-Phase AC distribution panelboard.

.4 The 48 Vdc communication battery systems are grounded, and are comprised of flooded lead acid batteries, fused disconnect switches, rack mounted charger shelves with charger and controller modules, splitter panels, rack mounted charge panel, rack mounted meter and control panel, and rack mounted discharge/load panel boards.

.5 A 24 Vdc DC battery systems for spillway UCMS and critical loads is comprised of valve regulated lead acid batteries, rack mounted charger selves with charger and controller modules, metering panels for batteries, and dc distribution panel boards.

2.3 BATTERIES

.1 125 Vdc Flooded Lead Acid Battery Characteristics and Ratings

.1 Nominal battery voltage: 125 Vdc.

.2 Minimum end voltage: 105 Vdc under load, after discharge of rated cell capacity at 1C discharge rate.

.3 Battery Configuration: 60S1P.

.4 Capable of being recharged to at least 85% of rated capacity in a period of 8 hours after being fully discharged, with no harmful effects on battery, including leaking or foaming of electrolyte.

.2 125 Vdc Valve Regulated Lead Acid UPS Battery Characteristics and Ratings

.1 Nominal battery voltage: 125 Vdc.

.2 Minimum end voltage: 105 Vdc under load, after discharge of rated cell capacity at 1C discharge rate.

.3 Battery Configuration: 60S1P.

.4 Capable of being recharged to at least 85% of rated capacity in a period of 8 hours after being fully discharged, with no harmful effects on battery.

.3 48 Vdc Flooded Lead Acid Battery Characteristics and Ratings

.1 Nominal battery voltage: 48 Vdc.

.2 Minimum end voltage: 42 Vdc under load, after discharge of rated cell capacity at 1C discharge rate.

.3 Battery Configuration: 24S1P.

.4 Capable of being recharged to at least 85% of rated capacity in a period of 8 hours after being fully discharged with no harmful effects on battery, including leaking or foaming of electrolyte.

.4 24 Vdc Valve Regulated Lead Acid Battery Characteristics and Ratings

.1 Nominal battery voltage: 24 Vdc.

.2 Minimum end voltage: 21 Vdc under load, after discharge of rated cell capacity at 1C discharge rate.

.3 Battery Configuration: 12S1P.

.4 Capable of being recharged to at least 85% of rated capacity in a period of 8 hours after being fully discharged with no harmful effects on the battery.

.5 Flooded Lead Acid Battery Design

.1 Type: Flooded vented lead-acid cell with lead-calcium grid.

.2 Electrolyte: solution of sulphuric acid.

.3 Cell containers: Fire resistant plastic.

.4 Electrolyte level lines: high and low on container surfaces.

.5 Cover: one piece molded plastic, flame retardant to ANSI/UL 94.

.6 Plate retainers: Vendor standard design, adequate space shall be provided under the plates for sediments.

.7 Plate separators: Vendor standard design.

.8 Vents: Vendor standard design.

.9 Posts: bolted type with lead covered brass nuts and bolts, provision of additional connections shall be available for bypassing of test connections.

.10 Bolt holes slightly oversized to facilitate cell replacement.

.11 Connectors, bolts and nuts:

.1 Connectors to be lead-covered copper.

.2 Covered or insulated design.

.3 Flexible type to avoid stress on cell terminal post.

.4 Connection sized to have a voltage drop less than 0.02 V at 1C discharge current.

.5 Corrosion resistant.

.12 Cells: of identical construction and from same production run, cells shall be suitable for 50 deep discharge cycles to 80% of nominal capacity during their warranty period.

.13 Batteries: in clean state with no evidence of electrolyte on outside of cell containers.

.14 Battery Racks:

.1 Two tier. Bottom tier minimum 120 mm above floor, top of battery cells on highest tier not more than 2 m above floor.

.2 Steel for battery racks: to CAN/CSA-G40.20.

.3 Frames: angle iron with welded joints ground smooth.

.4 Rails: steel channels, bolted to frames.

.5 Rubber strips to insulate rails from cells.

.6 Primed and epoxy painted to prevent corrosion.

.7 Corrosion resistant bolts and hardware.

.8 Configuration permitting any one cell to be removed without removing any other cell.

.9 Dimensions of space 7.3 m x 4.4 m for a 125 Vdc battery and 5.5 m x 3.2 m for 48 Vdc battery. Adequate access and aisle space shall be considered.

.6 Valve Regulated Lead Acid Battery Design

.1 Type: Absorbed Glass Mat (AGM) technology.

.2 Electrolyte: Lead acid immobilized in glass mat.

.3 Cell containers: Fire resistant plastic of single piece construction.

.4 Cover: one piece molded plastic, flame retardant to ANSI/UL 94.

.5 Plate and Plate retainers: Vendor standard design.

.6 Plate separators: Vendor standard design.

.7 Vents: Individual cells shall be fitted with relief valves that operate at 3-10 psi and are complete with integral flame arrestor.

.8 Posts:

.1 Cast lead with copper inserts to maximize conductivity.

.2 Double-seal design.

.9 Connectors, bolts and nuts:

.1 Connectors to be lead-covered copper and bolted directly to copper insert post.

.2 Covered to avoid shorts.

.3 Bolts and nuts and washer shall be stainless 316 grade stainless steel.

.10 Cells: of identical construction and from same production run.

.11 Battery Racks:

.1 Racks shall be steel can (module) design.

.2 One can for each cell.

.3 Steel for battery racks: to CAN/CSA-G40.20.

.4 Frames: angle iron with welded joints ground smooth.

.5 Primed and epoxy painted to prevent corrosion.

.6 Corrosion resistant bolts and hardware.

.7 Configuration permitting any one cell to be removed without removing any other cell, and steel can grid to be decided based on available space and maintenance requirements.

.12 Dimensions of space 3.5 m x 2 m for a 125 Vdc battery and 1m x 1 m for 24 Vdc battery.

2.4 FUSED DISCONNECT SWITCH

.1 Type: NEMA 12, 2-pole.

.2 Size: Suitable for continuous and short duty load and shall be sized such that it will withstand the available short circuit current.

.3 Mounting and cable entry: Wall mounted with cable entry from top as well bottom.

.4 Voltage rating: Maximum voltage 160 Vdc for all fused disconnects.

.5 Operational Features

.1 Operating handle suitable for padlocking in open position.

.2 Viewing window for external verification of switch contact position.

.3 Form C auxiliary contacts wired to terminal blocks for remote monitoring.

2.5 BATTERY CHARGERS

.1 Battery Charger Characteristics and Ratings

.1 Battery chargers shall be solid-state, regulated constant current / constant voltage type capable of operation without the battery connected in the system.

.2 The Powerhouse battery charger enclosures shall be NEMA 12 free standing gasketted type with a drip shield over the top of the enclosures and cable entry from top or side of the cabinet. The UPS charger shall be part of UPS assembly and the Spillway 24 Vdc charger shall be wall mounted.

.3 Input voltage: 600 Vac, +5/-10%, 60 Hz, 3-phase, 3-wire, high resistance grounded, 208Vac, +5/-10%, 60 Hz, 3-phase, 3-wire, solidly grounded, or 120Vac, +5/-10%, 60 Hz, 1-phase, 2-wire, as indicated on the drawings.

.4 Nominal output voltage: 125 Vdc, 48Vdc, or 24Vdc to match battery nominal voltage.

.5 Charger Current Rating: Capable of recharging the battery bank to at least 85% of rated capacity in 8 hours.

.6 Regulation: ±0.5% output voltage over full range of output current with input voltage variation of +5/-10 % and frequency variation of ±5%.

.7 Output ripple voltage: Not greater than 2% rms.

.8 Power Factor: Not less than 80% between 10% and 100% of full load.

.9 Efficiency: Not less than 85% (at rated load).

.10 Reverse Current Limiting: A reverse-current-limiting device shall be provided within the charger to prevent discharge of the battery on removal of the AC supply; this shall limit reverse current to no more than 0.2% of rated output or 0.1 A, whichever is greater.

.11 Cooling: Self cooled without fans.

.12 Input and output circuit protection:

.1 The battery charger shall have input and output circuit breakers for protection of the charger and battery.

.2 The incoming AC circuit breaker shall be connected between the power supply and isolating transformer.

.3 The DC output breaker shall be connected to the output terminals and shall be set at between 1.5 and 2.0 times the rated output current, with an interrupting capacity of 20 kA DC, or the available fault current from the DC system, whichever is larger.

.4 Both AC input and DC output circuit breakers shall be operable and visible from the front of the cabinet with the doors closed, and shall include viewing windows and padlockable hasps.

.5 Each battery charger shall be equipped to limit maximum current to no more than 125% of rated current, without tripping the AC or DC circuit breakers.

.13 Battery charger controls and metering:

.1 Equalize switch on the front of charger cabinet.

.2 Equalize time switch on the front of charger cabinet, set times in hours.

.3 Voltage adjustments (float and equalize) inside the cabinet, sets float and equalize voltage at 25°C. The float voltage adjustment range at nominal AC input voltage and half load at an ambient temperature of 25°C shall be 110 - 140 Vdc. The equalize voltage range at minimal AC input voltage and half load at an ambient temperature of 77°F (25°C) shall be 120 - 154 Vdc.

.4 Voltmeter on the front of charger cabinet showing voltage at charger output terminals with accuracy better than 2%.

.5 Voltmeter on the front of charger cabinet showing voltage at charger output terminals with accuracy better than 2%.

.14 Alternating Current (AC) Input Characteristics:

.1 Phase Failure: The loss of any phase of the AC line voltage shall not damage the battery charger.

.2 Input Surge Withstand Capability: These surges may occur from line to line, line to neutral, and line to ground. The battery charger shall meet the requirements of ANSI/IEEE C37.90.1 with both the oscillatory and fast transient waveforms with a 2,500 V peak.

.3 Electromagnetic Interference (EMI): The charger shall meet the requirements for radiated and conducted EMI contained in FCC rules and regulations Part 15, Subpart B, Class A.

.4 Low Input Voltage Protection: The operation of the battery charger with the line voltages below the minimum limits including zero shall not cause permanent damage to the battery charger. If protective devices are activated when a charger operates into a low/zero line voltage, this shall not result in any degradation of performance after proper voltage levels have been restored.

.15 Start-up Behaviour: When tested in accordance with PE-5 9.1.15 energizing the charger with a connected load of 10% or more of the charger rating shall not result in output voltage greater than 106% of the voltage setting, shall not activate the overvoltage shutdown, and shall stabilize to within the deviation limits specified in PE-5 5.5 within 15 seconds.

.16 Restoration of AC Service: The charger shall be capable of automatically returning to service upon restoration of the AC power supply after interruption.

.17 Selective High Output Voltage Shutdown:

.1 The selective high voltage shutdown shall turn off and lockout the faulty charger in a system of parallel connected chargers. It shall shutdown and lock out only the battery charger producing an output voltage exceeding a preset value. The operating point of the high voltage shutdown or the preset value shall be adjustable within a range of 100% to 125% of terminal voltage.

.2 The selective high voltage shutdown may be designed to restart the charger up to two times after a shutdown prior to lockout. This is done to separate high voltage conditions caused by transients from high voltage conditions caused by charger faults. Such designs will turn off the charger output for a fixed time period, then restart the charger, and will only shut down and lockout the charger if the high voltage condition recurs within a fixed (relatively short) time period.

.18 Communication interface: The Contractor shall indicate the availability of, and price separately, an optional Modbus communication interface (RS-485) for charger alarms, current and voltage. The requirement for alarm relays and hardwired alarm connections shall remain the same regardless of whether or not the Modbus communications are provided.

.19 Standard Alarm Package:

.1 Alarms shall be Form “C” contacts with a minimum rating of 0.2 A at 125 Vdc.

.2 Alarms shall be equipped with front panel indication.

.3 Alarms shall be protected by properly sized control fuses on all input lines.

.4 Alarms shall be designed so that the failure of any active alarm circuit component causes the function to fail in the “alarm” position.

.5 Alarm shall feed into a common alarm point for connection to the UCMS system.

.6 Alarms to be included:

.1 High output voltage alarm:

.1 The operating point of the high output voltage alarm shall be adjustable from the nominal battery voltage to nominal +40%.

.2 The high output voltage alarm device shall have a minimum 2 second time delay on pickup, and shall dropout within a minimum of 1% of pickup.

.3 The high output voltage alarm reference voltage shall be supplied from the load side of the DC output breaker to ensure that the alarm is not isolated from the battery when the circuit breaker opens.

.4 The high output voltage alarm shall be provided with fused test terminals whereby an external test voltage may be injected for testing, unless the charger provides its own means for checking the high output voltage alarm. A charger which does provide its own means for checking the high output voltage alarm is preferred but not required.

.5 The high output voltage alarm shall not depend on the charger AC supply for its operation.

.2 Low output voltage alarm:

.1 The operating point of the low output voltage alarm shall be adjustable from the nominal battery voltage to nominal -35%.

.2 The low output voltage alarm device shall have a minimum 2 second time delay on pickup, and shall dropout within a minimum of 1% of pickup.

.3 The low output voltage alarm reference voltage shall be supplied from the load side of the DC output breaker to ensure that the alarm is not isolated from the battery when the circuit breaker opens.

.4 The low output voltage alarm shall be provided with fused test terminals whereby an external test voltage may be injected for testing, unless the charger provides its own means for checking the low output voltage alarm. A charger which does provide its own means for checking the low output voltage alarm is preferred but not required.

.5 The low output voltage alarm shall not depend on the charger AC supply for its operation.

.3 Ground fault alarms:

.1 The ground fault alarm’s detection circuit shall detect both positive and negative battery ground faults.

.2 The detection circuit shall be preset by the Vendor to alarm at 26% on both the positive and negative circuit and shall be accurate to ±20%.

.3 There shall be a minimum time delay of 4 seconds on pickup.

.4 The ground fault detection circuit alarm reference voltage shall be supplied from the load side of the DC output beaker to ensure that the alarm is not isolated from the battery when the circuit breaker opens.

.5 There shall be separate indication provided for both positive and negative ground faults.

.4 AC fail alarm:

.1 The AC fail alarm shall provide an alarm if any phase of the AC power fails causing the input voltage to drop to a low value, or upon operation of the input AC protection device.

.2 The AC fail alarm device shall have a minimum 4 second delay on pickup and be connected to the load side of the input AC breaker.

.5 DC breaker trip alarm: The DC breaker trip alarm shall provide an alarm if the output DC circuit breaker is in the open or tripped position.

.6 Rectifier Fail Alarm: The rectifier failure alarm shall provide an alarm if the control or power circuits of the battery charger fail. It shall also have a minimum 4 second delay on pickup.

2.6 125 Vdc to 120 Vac INVERTER ASSEMBLIES

.1 An assembly shall comprise of:

.1 An inverter (DC/AC converter).

.2 An electronic control unit.

.3 A 1-phase Static transfer switch.

.4 A Manual bypass switch.

.2 Enclosure: NEMA 12 gasketted enclosure with a drip shield over the top of enclosure and cable entry from the side or top.

.3 Surge protection shall be included.

.4 Inverter (DC/AC converter)

.1 Inverters shall be self-cooled solid-state industrial heavy-duty converters, suitable for continuous service, providing 1-phase 120 V ac 60 Hz from the battery voltage and shall not ground either polarity of the incoming DC source.

.2 Output AC circuit shall be isolated from input DC terminals so that the AC output may be grounded. The output AC waveform shall be approximately sinusoidal.

.3 The inverter shall capable of operating as a free-running unit or synchronized with the Purchaser's AC supply. The inverter shall track the AC reference source. Upon failure or excessive frequency deviation (±0.5%) of the reference, the inverter shall automatically switch to its free-running mode.

.4 The inverter shall shut down if DC input is higher than 160 Vdc or less than 105 Vdc and load will be transferred to standby AC supply.

.5 The inverters shall have front panel mounted meters (better than 2% accuracy) for the following functions:

.1 Inverter output current.

.2 Inverter output voltage.

.3 Inverter output frequency.

.6 Characteristics and Ratings:

.1 Input voltage range: 105-160 Vdc.

.2 Output voltage and regulation: 120 V ac ±2% single phase over full load, DC input range, and ambient temperature ranges.

.3 Free-running output frequency: 60 Hz ±0.1% over full load, DC input range, and ambient temperature ranges.

.4 Output waveform: Less than 5% THD sinusoid with either linear or switch-mode power supply loads, crest factor 3.0 or less.

.5 Output rating: assume 4,800 W (6000 kVA 80% power factor) continuous rating.

.6 Efficiency at rated load: Not less than 80%.

.7 Input protection: Circuit breaker.

.8 Output Protection: Fuse (between inverter and static switch).

.9 Input filtering: Inverters shall inject less than 0.5 A total ripple current into the supply DC system.

.10 Audible noise: Less than 65 dBA measured at 1.5 m.

.5 Static Transfer Switch

.1 The static switch shall be a 1-phase high-speed transfer device. The control of the unit shall provide an automatic or manual transfer of the load from the inverter source to the bypass source.

.2 The static switch shall be rated for continuous operation at 125% of full rated inverter output and have a switching time of less than 4 ms.

.3 Control features:

.1 Automatic Transfer - The static switch shall automatically transfer the critical load after the control logic senses one of the following conditions.

.1 Inverter failure.

.2 Inverter overcurrent.

.3 Inverter output over/under voltage (+/-10%) >16 ms.

.4 Low/High DC voltage disconnect.

.2 Manual Transfer via front panel push button.

.3 Automatic Retransfer - If the transfer control switch is set for automatic retransfer, the control circuit shall be capable of retransferring the critical load to the inverter output when the overload is removed and the inverter output is within specification.

.4 Manual Retransfer - If the transfer control switch is set for manual retransfer, upon manual command the critical load shall be transferred to the inverter.

.5 Transfer Lockout - The transfer logic shall not allow a transfer to the bypass source if one of the following conditions exists:

.1 Bypass source out of sync with inverter output (except for upon inverter failure or low DC voltage disconnect).

.2 Bypass source not available.

.6 Manual bypass switch

.1 A manual bypass switch shall transfer the loads to standby AC source and isolate the inverter and transfer switch.

.2 The switch shall be rated for 120 V ac station supply and 6,000 VA load.

.7 AC Panel Board

.1 Voltage: 120 Vac, 1-phase.

.2 Short circuit rating: 22 kA.

.3 Number of overcurrent devices: 42.

.4 Mains: Bolt on type.

.5 Breakers: Moulded circuit breaker with thermal and magnetic trip.

.6 Ground and Neutral Buses: shall be part of the panel and the ground bus shall have external grounding terminal for connections to the ground.

.7 Of same make and model as normal distribution panelboards.

.8 Alarm and Status

.1 Dry alarm contacts shall be provided for connection to the UCMS system for:

.1 General fault.

.2 Load on bypass.

.3 Load on inverter.

.4 Low DC volts.

.2 LED indications of assembly status and alarms shall be provided on the control unit front panel.

.3 Modbus Communication Interface: The Contractor shall indicate the availability of, and price separately, an optional Modbus communication interface (RS-485) for inverter alarms, and current and voltage if available. The requirement for alarm relays and hardwired alarm connections shall remain the same regardless of whether or not the Modbus communications are provided.

2.7 EMERGENCLY LIGHTING UPS

.1 An assembly shall comprise of:

.1 A VRLA battery.

.2 A battery charger.

.3 A 3-phase inverter (DC/AC converter) assembly.

.4 An electronic control unit.

.5 A 3-phase Static transfer switch.

.6 A 3-phase AC panel board.

.2 Equipment enclosures: NEMA 12 gasketted enclosure with a drip shield over the top of enclosure and cable entry from the side or top.

.3 Battery: The battery shall comply with the VRLA battery specification Section 2.3.2.

.4 Inverters (DC/AC converter)

.1 Inverters shall be self-cooled solid-state industrial heavy-duty converters, suitable for continuous service, providing 3-phase 208/120 Vac 60 Hz from the battery voltage and shall not ground either polarity of the incoming DC source.

.2 Output AC circuit shall be isolated from input DC terminals so that the AC output may be grounded. The output AC waveform shall be approximately sinusoidal.

.3 The inverter shall capable of operating as a free-running unit or synchronized with the Purchaser's AC supply. The inverter shall track the AC reference source. Upon failure or excessive frequency deviation (±0.5%) of the reference, the inverter shall automatically switch to its free-running mode.

.4 The inverter shall shut down if DC input is higher than 160 Vdc or less than 105 Vdc and load will be transferred to standby AC supply.

.5 The inverters shall have front panel mounted meters (better than 2% accuracy) for the following functions:

.1 Inverter output current.

.2 Inverter output voltage.

.3 Inverter output frequency.

.6 Characteristics and Ratings:

.1 Input voltage range: 105-160 Vdc.

.2 Output voltage and regulation: 120 V ac ±2% single phase over full load, DC input range, and ambient temperature ranges.

.3 Free-running output frequency: 60 Hz ±0.1% over full load, DC input range, and ambient temperature ranges.

.4 Output waveform: Less than 5% THD sinusoid with either linear or switch-mode power supply loads, crest factor 3.0 or less.

.5 Output rating: assume 4800 W (6000 kVA 80% power factor) continuous rating.

.6 Efficiency at rated load: Not less than 80%.

.7 Input protection: Circuit breaker.

.8 Output Protection: Fuse (between inverter and static switch).

.9 Input filtering: Inverters shall inject less than 0.5 A total ripple current into the supply DC system.

.10 Audible noise: Less than 65 dBA measured at 1.5 m.

.5 Static Transfer Switch

.1 The static switch shall be a 3-phase high-speed transfer device. The control of the unit shall provide an automatic or manual transfer of the load from the inverter source to the bypass source.

.2 The static switch shall be rated for continuous operation at 125% of full rated inverter output and have a switching time of less than 4 ms.

.3 Control features:

.1 Automatic Transfer - The static switch shall automatically transfer the critical load after the control logic senses one of the following conditions.

.1 Inverter failure.

.2 Inverter overcurrent.

.3 Inverter output over/under voltage (+/-10%) >16 ms.

.4 Low/High DC voltage disconnect.

.2 Manual Transfer via front panel push button.

.3 Automatic Retransfer - If the transfer control switch is set for automatic retransfer, the control circuit shall be capable of retransferring the critical load to the inverter output when the overload is removed and the inverter output is within specification.

.4 Manual Retransfer - If the transfer control switch is set for manual retransfer, upon manual command the critical load shall be transferred to the inverter.

.5 Transfer Lockout - The transfer logic shall not allow a transfer to the bypass source if one of the following conditions exists:

.1 Bypass source out of sync with inverter output (except for upon inverter failure or low DC voltage disconnect).

.2 Bypass source not available.

.6 Alarm and Status

.1 Dry alarm contacts shall be provided for connection to the UCMS system for:

.1 Inverter:

.1 General fault.

.2 Load on bypass.

.3 Load on inverter.

.4 Low DC volts.

.2 Battery Charger: Alarms in accordance with charger specification.

.3 Miscellaneous:

.1 Main AC breaker trip.

.2 Main DC Breaker trip.

.3 Panel board breaker trip.

.4 Digital output voltmeter with capability of displaying line-to-line and Line-neutral voltage.

.5 Digital output current meter.

.2 LED indications of inverter status, common alarm for charger, common alarm for inverter shall be provided on the control unit front panel.

.3 Modbus Communication Interface: The Contractor shall indicate the availability of, and price separately, an optional Modbus communication interface (RS-485) for assembly alarms, and currents and voltages if available. The requirement for alarm relays and hardwired alarm connections shall remain the same regardless of whether or not the Modbus communications are provided.

.7 AC Panel Board

.1 Voltage: 208/120 Vac, 3-phase.

.2 Short circuit rating: 22 kA.

.3 Number of overcurrent devices: 42.

.4 Mains: Bolt on type.

.5 Breakers: Moulded circuit breaker with thermal and magnetic trip.

.6 Ground and Neutral Buses: Dedicated grounded and neutral buses shall be provided for the panel board.

.7 Of same make and model as normal distribution panelboards.

2.8 DC SWITCHBOARD

.1 The switchboard shall be non-service entrance type equipment, intended for use as a main distribution switchboard for a 125 Vdc system.

.2 The switchboard shall comprise of two sections, one (Main Section) for the battery breaker and metering devices and a second section for the charger and distribution feeder breakers.

.3 Construction and Equipment

.1 The switchboard shall be fully self-supporting, free-standing, dead-front type low voltage distribution switchboard with 90 in. tall vertical sections.

.2 The switchboard shall be an indoor deadfront NEMA 12 gasketed drip-proof enclosure.

.3 The vertical sections shall be bolted together to form a rigid assembly. The sides and rear shall be covered with removable bolt-on covers. All edges of front covers or hinged front panels shall be formed. Adequate ventilation shall be provided within the enclosure. The switchboard frame shall be die formed, 12 gauge steel with reinforced corner gussets. Frame shall be rigidly bolted to support cover plates (code gauge steel), bus bars, and installed devices during shipment and installation. The switchboard shall be capable of being bolted directly to the floor without the use of floor sills.

.4 All sections of the switchboard shall be front aligned with maximum depth of 48 in. All protective devices in the Distribution section shall be group mounted. All devices shall be front removable and load connections front and rear accessible. Rear access shall be provided.

.5 All covers shall be fastened by hex head bolts.

.6 Hinged doors shall be provided over the Metering Compartment and the main breaker compartment. All doors shall have concealed hinges and be fastened by hex head bolts.

.7 The group mounted feeder breaker and main device within the switchboard shall be circuit breakers only. Mounting for the individually and group mounted devices shall be by bolted connections. No plug-in type connections shall be used for current carrying components.

.8 The Main section shall contain the Metering Compartment and comprise of the Supply bus, the DC shunt, the section and through bus, the Metering Compartment, and the main breaker compartment. The Supply bus shall be tin-plated copper and CSA or UL listed for use with copper cable. Selection of lugs shall be based on the incoming cable size and insulation type.

.9 The Distribution section shall be connected to the Main section via the splice bus and comprise of the section bus, all branch, tie and spare circuit breakers (other than the main) and provisions for future devices in the available unused portion.

.10 All power, control, and instrumentation cables shall be top entry. All switchboard sections shall have removable top plates to install cables.

.11 Ventilation openings shall be covered with corrosion-resistant insect-proof screens on the inside of each opening.

.12 Internal supports and components shall not make a hole or visible protrusion in the front panel.

.13 All panels shall be thoroughly cleaned by degreasing and abrasive blasting or other equivalent means to suit the particular application. All rough edges and burrs shall be removed. Care shall be taken at all stages to ensure that all rough spots are thoroughly cleaned and painted, including the removal of weld splatter and flux. Interior and exterior surfaces shall have a rust-resistant phosphatizing treatment before painting. The exterior of the structure shall be painted the manufacturer's standard grey.

.14 Switchboard Bus:

.1 The connections for battery bank shall include main lugs and a shunt for dc current measurement.

.2 Polarities on the switchboard shall be arranged positive, negative, front to back, top to bottom, or left to right as viewed from the front of the switchboard.

.3 All bus bars shall be tin-plated copper. All hardware used on bus joints shall be high tensile strength (SAE Grade 5), zinc-plated, and shall use Belleville-type washers.

.4 Bus supports shall be flame-retardant, track-resistant glass-reinforced polyester or other suitable material that does not absorb moisture. Bus joints and splices for field assembly shall be secured with at least two bolts.

.5 Bus sizing shall be based on NEMA standard temperature rise criteria of 65°C over a 40°C ambient (outside the enclosure). The bus bars shall have sufficient cross sectional area to meet UL 891 temperature rise requirements through actual tests.

.6 Main horizontal bus bars shall be fully rated and arranged for future extensions.

.7 The section, splice and through buses shall have the same continuous current ratings as the rating of the switchboard.

.8 All energized bus (Positive and Negative) shall be insulated between phases and each phase to ground for personnel protection and to minimize the probability of bus faults.

.9 Each Branch bus shall be rated in accordance with NEMA PB-2. All feeder device line and load connection straps shall be rated to carry current rating of device frame (not trip rating).

.15 Metering Compartment:

.1 The switchboard shall have a Metering Compartment used to house the meters, relays, transducers, terminals and associated equipment. It will be part of the main section.

.2 The Metering Compartment shall be provided with a front facing hinged door.

.3 All meters, relays and transducers shall be industry standard with ratings and ranges suitable for the application. The meters and relays shall be of 2% accuracy for full range of system parameters. The devices in the metering compartment include:

.1 Meters:

.1 Battery bank current (Positive only).

.2 Switchboard bus voltage c/w selector switch (Pos.-Gnd, Neg-Gnd, Pos-Neg).

.2 Relays:

.1 Switchboard Bus undervoltage and overvoltage.

.2 Switchboard bus ground fault detector.

.3 Transducer:

.1 Battery bank current (Pos. only).

.2 Switchboard bus voltage (Pos-Neg).

.4 Fuses: Fuses for the Metering Compartment shall be HRCII Class C high rupturing capacity in dead-front fuse holders, Fusetek Red Spot RS series. Current ratings of fuses shall be selected based on the protection and load requirements of the connected equipment.

.16 Wiring:

.1 All control wiring shall be stranded copper with flame-retardant insulation. Wire size shall not be less than #14AWG. Internal wiring of components shall be in accordance with industry standards.

.2 Wire terminations shall be insulated crimp terminal lugs, AMP, Burndy, or Engineer's approved equivalent. Each terminal lug crimp shall have only one wire. Crimp-on lugs shall be installed according to the manufacturer's instructions using approved tools and dies.

.3 Wiring shall be point to point, with all wires terminating at devices or terminal blocks. No more than two wires shall terminate on any device terminal. Wire ducts shall be provided for wire management in metering cabinet.

.4 All wires shall be identified at both ends with the wire numbers shown on the approved wiring diagrams and schematics.

.5 All wiring connections shall be readily accessible and removable for test and inspection.

.17 Terminals:

.1 Terminal blocks for analog or digital signal circuits shall be Entrelec test/disconnect type M6/8/STP, catalog #115227.20 and Entrelec non-disconnect type M6/8/STP3, catalog #115500.25 or Engineer's approved equivalents, with marking strips.

.2 Three terminal blocks shall be provided for analog signals for connection to the UCMS system. One test/disconnect type terminal block shall be provided for the positive wire, and two non-disconnect type terminal blocks shall be provided for the negative wire and the shield wire (one each).

.3 Sufficient terminals blocks shall be provided for each circuit with an additional 20% spare terminals blocks distributed over the terminals strips.

.4 Alternating current and direct current circuits shall not be mixed on the same terminal block strip. Terminal blocks shall be grouped by voltage level and function, and arranged sequentially by wire number within

each group. Low-level metering circuits shall not be intermixed with higher-power circuits.

.18 Circuit Breakers:

.1 The circuit breaker shall be a moulded case circuit breaker and shall have a thermal-magnetic trip mechanism. The circuit breaker shall be a stationary mounted device (i.e., bolt-in style).

.2 The circuit breaker shall be provided with a viewing window to enable visual confirmation that the electrical circuit has been opened from outside the front of the switchboard.

.3 Circuit breaker frames shall be constructed of a high-strength, moulded, glass-reinforced polyester case and cover. Breakers shall have an overcenter, toggle handle-operated, trip free mechanism with quick make, quick break action independent of the speed of the toggle handle operation. The design shall provide common tripping of all poles. Breakers shall be suitable for reverse feeding.

.4 Breakers shall have ON and OFF position clearly marked on escutcheon. Breakers shall include a trip-to-test means on the escutcheon for manually tripping the breaker and exercising the mechanism and trip latch.

.5 Breakers shall include factory installed mechanical lugs. Lugs shall be CSA or UL listed and rated as required. Breakers shall be 80 % rated.

.6 All circuit breakers shall be provided with a padlockable hasp for locking the breaker in the open position.

.7 The circuit breaker shall have 2-poles, one each for Positive and Negative.

.8 The circuit breaker shall be provided with a form ‘C’ dry contact for indication of the breaker position (open or closed) to the UCMS system. The contact shall be rated for 0.5 A at 125 Vdc (minimum requirements). Two wires (common, normally-open) shall be wired to terminal blocks located in the Metering Compartment and shall be available for connection Purchaser’s field wiring.

.9 Current rating as shown on the preliminary SLDs.

.10 Interruption rating of breakers shall be based on expected and vendor shall estimate based on the charger and battery ratings.

2.9 DC PANEL BOARD ASSEMBLY

.1 The DC panel boards shall comprise:

.1 DC panel board assembly shall comprise of:

.1 DC distribution panel.

.2 Enclosure housing voltage monitoring relays and terminals for interfacing with the UCMS.

.2 The DC distribution panel and the voltage monitoring relays shall be arranged in separate sections.

.3 The dc monitoring relays shall be mounted on the door for an operator interface and door shall be provided with a switch wire to terminals in the monitoring relay section enclosures for monitoring in the UCMS system.

.4 Enclosure shall be NEMA 12 gasketed of #12 gauge sheet construction.

.5 Voltage Monitoring Relay and Terminals:

.1 Ephatec Part #330178 suitable for flush mounting.

.2 Relay shall be suitable for 48 Vdc, 125 Vdc and 250 Vdc applications.

.3 Terminals to be SAK type mounted on DIN rails with 20% spare terminals.

.6 DC Panelboard:

.1 Voltage: 125 Vdc, 2-Wire.

.2 Short circuit rating: 22 kA.

.3 Number of overcurrent devices: 40.

.4 Mains: Bolt on type.

.5 Breakers: Moulded circuit breaker with thermal and magnetic trip with two terminals per pole.

.6 Of same make and model as normal distribution panelboards.

2.10 ACCESSORIES

.1 Accessories

.1 One electrolyte thermometer for each battery.

.2 One electrolyte hydrometer syringe for each battery.

.3 One Cell lifter for each battery.

.4 One insulated wrenched for each battery.

.2 Two spare intercell connectors, nuts and bolts for each battery.

.3 Two spare inter-tier connectors, nuts and bolts for each battery.

.4 Touch-up paints for enclosures, 1-liter container for each type finish.

2.11 SOURCE QUALITY CONTROL

.1 To CAN3-Z299.3.

.2 The vendor shall provide type test reports of the equipment of similar design or conduct type test in accordance with applicable standards.

.3 The supplier shall submit a factory inspection and test plan for factory testing for review and acceptance in accordance with the guidance provided below.

.1 Flooded Lead Acid Batteries: The test shall be in accordance with IEEE 450 and the capacity test shall be completed at site after installation.

.2 Valve Regulated Lead Acid Batteries:

.1 IEEE-1188 - IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid Storage Batteries for Stationary Applications.

.3 Battery Charger:

.1 NEMA PE5 - Utility Type Battery Chargers.

.2 CSA C22.2 No. 107.2 - Battery Chargers.

.4 Inverter:

.1 NEMA ICS 10 - Part 2 Static AC Transfer Equipment.

.5 UPS:

.1 CSA C22.2 No. 107.3 - Uninterruptible Power Systems.

.6 DC Distribution Boards and DC Panel Boards:

.1 ANSI/IEEE C37.90.1 - Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus Uninterruptible Power Systems.

.2 Other Test:

.1 Wiring checks for compliance to approved drawings.

.2 Wiring insulation checks.

.3 Phasing checks.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, programming instructions, and datasheet.

3.2 INSTALLATION

.1 Battery Banks

.1 Assemble and erect battery rack.

.2 Install battery cells in/on rack.

.3 Clean posts and connectors and apply no-oxide grease.

.4 Install inter-cell and inter-tier connectors, and hand tighten nuts in accordance with Manufacturer's instructions.

.5 Using torque wrenches, tighten nuts in accordance with manufacturer's recommended value.

.6 Connect battery to load fused disconnect switches including rigid metal conduit raceways.

.7 Bond the racks to the station grid.

.2 Battery Charger

.1 Install battery charger.

.2 Connect input terminals to AC mains.

.3 Connect output terminals to DC distribution switchboard/DC panel board.

.4 Connect the alarms and statuses to the UCMS.

.5 Connect the charger assembly to the station grid.

.3 Inverter Assemblies

.1 Install inverter assembly.

.2 Connect to main AC and DC inputs terminals to the upstream panel boards.

.3 Connect AC output to distribution panel board.

.4 Connect the alarms and statuses to the UCMS.

.5 Connect the assembly to the station grid.

.6 Connect AC distribution panelboard to the critical loads.

.4 UPS Assembly

.1 Install UPS assembly.

.2 Connect to main AC and DC inputs terminals to the upstream panel boards.

.3 Connect the alarms and statuses to the UCMS.

.4 Connect the assembly to the station grid.

.5 Connect AC distribution panelboard to the emergency supply fixture.

3.3 FIELD QUALITY CONTROL

.1 The requirements shall be in accordance with Subsection 7.13 Project Quality Management of the General Specification.

.2 The Contractor shall develop site testing and commissioning plan and submit for review and acceptance using the following requirements as guidance:

.1 Flooded Lead Acid Battery Bank:

.1 Perform visual mechanical checks in accordance with NETA ATS Section 7.18.1.1.1.

.2 Perform electrical test in accordance with NETA ATS Section 7.18.1.1.2 including battery capacity test and battery ohmic resistance measurement.

.3 Commissioning: Check operation of batteries with other equipment for various configurations.

.2 VRLA Battery Bank:

.1 Perform visual mechanical checks in accordance with NETA ATS Section 7.18.1.3.1.

.2 Perform electrical test in accordance with NETA ATS Section 7.18.1.3.2 including battery capacity test.

.3 Commissioning: Check operation of batteries with other equipment for various configurations.

.3 Battery Chargers:

.1 Perform visual mechanical checks in accordance with NETA ATS Section 7.18.2.1.

.2 Perform electrical test in accordance with NETA ATS Section 7.18.2.2 and confirm dynamic response of the charger.

Commissioning: Confirm charger integration into the UCMS, and operation with other equipment for various configurations.

.4 UPS:

.1 Perform visual mechanical checks in accordance with NETA ATS Section 7.22.2.1.

.2 Perform electrical test in accordance with NETA ATS Section 7.22.2.2, and additional tests specified for inverter.

.3 Commissioning: Confirm UPS integration into the UCMS, and operation with other equipment for various configurations.

.5 Inverter:

.1 Visual and Mechanical Inspections:

.1 Check name plate information against drawings and specifications.

.2 Confirm the equipment is set in accordance with the approved settings.

.3 Inspection mechanical and physical condition.

.4 Inspect anchorage, alignment, grounding and placement.

.5 Verify connections are in accordance with the approved Drawings.

.2 Electrical Test:

.1 Confirm contact resistance of main power circuits.

.2 Confirm transfer functions.

.3 Perform load test.

.4 Check performance under frequency variation.

.5 Confirm synchronization functions.

.6 Perform harmonic measurements.

.3 Commissioning: Confirm inverter integration into the UCMS, and operation with other equipment for various configurations.

.6 DC Switchboard:

.1 Perform visual mechanical checks in accordance with NETA ATS Section 7.1.1.

.2 Perform electrical test in accordance with NETA ATS Section 7.1.2.

.3 Commissioning: Confirm DC switchboard integration into the UCMS, and operation with other equipment for various configurations.

.7 DC Panelboard:

.1 Perform visual mechanical to confirm correct installation and connections in accordance with approved drawings.

.2 Electrical tests:

.1 Check voltage monitoring relays for pick-up and drop out voltages and proper operation of auxiliary contact.

.2 Perform:

.1 Dielectric test on wiring.

.2 Test mounded case circuit breaker per NETA ATS guidance.

.3 Commissioning: Confirm DC panelboard integration into the UCMS.

3.4 CLEANING

.1 The requirements shall be in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion and verification of performance of installation, remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section of the Technical Specification defines the technical requirements related to the installation of 600 V automatic transfer switches and black start switchgear assemblies, including all Site handling, storage, setting in place, interconnection and commissioning.

.2 Equipment to be installed:

.1 Powerhouse transfer switch assemblies ATS1, ATS2, ATS3, ATS4.

.2 Spillway transfer switch ATS5.

.3 Blackstart switchgear assemblies BSDG1, BSDG2.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 32 13 - Standby Diesel Generators.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ANSI/IEEE:

.1 IEEE 446 - Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.

.2 ANSI/IEEE C37.13 - Low Voltage AC Power Circuit Breakers Used in Enclosures.

.2 CSA:

.1 CSA C22.2 No. 5 - Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures.

.2 CSA C22.2 No. 178 - Automatic Transfer Switches.

.3 CSA C22.1 - Canadian Electrical Code, Part 1, Safety Standard for Electrical Installations.

.3 National Electrical Manufacturers Association (NEMA):

.1 NEMA ICS 10 - AC Automatic Transfer Switches.

.4 Purchaser's Drawings.

.5 3D Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for equipment Items 26 36 23 (a) to 26 36 23 (c) shall be based on the quantity shown on the Purchaser's Drawings, and as directed by the Engineer.

.3 Unit Price

.1 The unit prices for the following Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving equipment supplied by the Purchaser, storage, Site handling, installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, commissioning, touch-up painting, and hand over documentation as specified herein and as directed by the Engineer:

.1 26 36 23 (a) – Powerhouse Transfer Switches.

.2 26 36 23 (b) – Spillway Transfer Switch ATS5.

.3 26 36 23 (c) – Black Start Generator Switchgear Assemblies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Field Installation and Testing

.1 Inspection and testing plan covering equipment handling, storage, installation and pre-commissioning for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 Field inspection and test reports for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

1.6 CLOSEOUT SUBMITTALS

.1 Shall be in accordance with the requirements set out in Subsection 21.7 Contractor's Documents of the General Specification.

.2 Provide

.1 Field inspection and test report.

.2 Site as-built record drawings of connections and equipment plans.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Storage and Handling Requirements:

.1 Receive equipment shipped by the Purchaser at Site.

.2 Handle using proper equipment for lifting and handling, use when necessary lifting eye and/or brackets and/or spreader bars supplied for that purpose.

.3 Store and protect from scratches and blemishes.

.4 Replace defective or damaged materials with new.

.3 Packaging Waste Management: remove and dispose of in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 DESCRIPTION

.1 The two required black start switchgear assemblies shall provide distribution of 600 V power from blackstart generators BSDG1 and BSDG2 to automatic transfer switches ATS1, ATS2, ATS3, and ATS4.

.2 The black start switchgear assemblies shall consist of low-voltage power circuit breakers, protective equipment, and control equipment. Refer to the Purchaser's for more detailed information.

.1 BSSG1 and BSSG2:

.1 600 V, 3-Phase, 3-Wire, Resistance grounded.

.2 48 kA Interrupting Capacity.

.3 Ampacity as shown on the Purchaser's Drawings.

.4 Connection types:

.1 Incoming - Cable, parallel multi-conductor Teck.

.2 Outgoing - Cable, parallel multi-conductor Teck.

.3 The transfer switch assemblies shall consist of low-voltage power circuit breakers or contactors, protective equipment, and control equipment. Refer to the Purchaser's Drawings for more detailed information. Transfer switches shall be equipped with bypass isolation to allow maintenance to be performed on the transfer switch while the load remains energized.

.1 Three source transfer switches: ATS1, ATS2, ATS3, and ATS4.

.1 600 V, 3-Phase, 3-Wire, Resistance grounded.

.2 48 kA Interrupting Capacity.

.3 Ampacity as shown on the Purchaser's Drawings.

.4 Digital synchronization and load control (DSLC) system.

.5 Closed transition switching.

.6 Three input sources:

.1 Normal - Station Service Power.

.2 Emergency 1 - Blackstart Diesel Generator 1 (BSDG1).

.3 Emergency 2 - Blackstart Diesel Generator 2 (BSDG2).

.7 Connection types:

.1 Normal - Cable, parallel multi-conductor Teck.

.2 Emergency 1 - Cable, parallel multi-conductor Teck.

.3 Emergency 2 - Cable, parallel multi-conductor Teck.

.4 Load - Cable, parallel multi-conductor Teck.

.2 Two-source transfer switch: ATS5.

.1 600 V, 3-Phase, 3-Wire, Resistance grounded.

.2 28 kA Interrupting Capacity.

.3 Ampacity as shown on the Purchaser's Drawings.

.4 Digital synchronization and load control (DSLC) system.

.5 Closed transition switching.

.6 Two input sources:

.1 Normal - Station Service Power.

.2 Emergency 1 - Spillway Diesel Generator 1 (SPDG1).

.7 Connection types:

.1 Normal - Cable, parallel multi-conductor Teck.

.2 Emergency 1 - Cable, parallel multi-conductor Teck.

.3 Load - Cable, parallel multi-conductor Teck.

.4 The three-source transfer switches ATS1, ATS2, ATS3 and ATS4 are used to provide the essential control and auxiliary power required to blackstart the hydro electric generators. Redundant and fully independent blackstart diesel generators and emergency distribution systems are installed to provide the high reliability required for a blackstart capable generating station. The two diesel generators are run independently of each other and will not normally be synchronized with one another.

.5 The two-source transfer switch ATS5 is used to provide essential power to the spillway gate heating and control systems. The spillway is equipped with a backup diesel generator and ATS5 provides switching between the backup generator and the station service distribution system.

Part 3 Execution

3.1 INSTALLATION

.1 Locate and install transfer switches and switchgear assemblies in accordance with manufacturer's instructions.

.2 Obtain the authorization of the Engineer before setting in place.

.3 Set and secure transfer switches and switchgear assemblies in place, rigid, plumb, and square.

.4 Connect incoming and outgoing power cables to equipment terminals.

.5 Connect control circuit wiring.

.6 Check factory-made connections for mechanical security and electrical continuity.

.7 Run two 4/0 AWG bare copper bonding conductors from the embedded ground system or station ground bus to the transfer switch ground bar. Connect one bonding conductor to each end of the transfer switch ground bus.

.8 After finishing this aspect of the Work, remove foreign material including dust before energizing the equipment.

.9 Use torque wrench to adjust internal connections in accordance with manufacturers' recommended values.

3.2 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Managment of the General Specification.

.2 Perform pre-commissioning tests in accordance with Section 26 05 00 Electrical General Requirements.

.3 The Contractor shall perform final equipment checks and pre-commissioning of the transfer switches and switchgear assemblies. The Contractor shall be responsible for the following typical and all other required visual and mechanical inspections and checks and electrical installation and equipment tests to verify the installation Work, in accordance with the manufacturer's recommendations and NETA.

.4 Perform visual internal and external inspection and checks on equipment, enclosure, buswork and insulators, breaker racking and mounting systems, grounding and bonding connections, LV and control cabling and terminations, etc.

.5 Check all factory and field-installed electrical connections. Confirm torque values are as provided consistent with NETA published values unless otherwise specified by the manufacturer.

.6 Confirm correct operation and sequencing of electrical and mechanical interlock systems.

.7 Check the rigidity of all bushing and cable supports.

.8 Fasten all barriers and covers in place.

.9 Verify correct shutter installation and operation.

.10 Verify that all grounding connections are correctly made.

.11 Perform internal primary and secondary control circuit continuity tests, using multimeter.

.12 Perform switchgear resistance measurements, megger tests and phasing tests.

3.3 CLEANING

.1 Shall be in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Leave Work area clean at end of each Working Day.

3.4 PROTECTION

.1 Protect installed products and components from damage during construction.

.2 Repair damage to adjacent materials caused by installation.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section includes the design, supply, installation and testing of lighting and control system for the Powerhouse Complex and Spillway Complex. The lighting and control system is defined as interior and exterior lights, outlets, fittings, fixtures, emergency lighting units, exit lights, receptacles, mounting hardware, control system and all necessary materials for complete lighting and distribution systems.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 01 51 00 – Temporary Utilities.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 26 05 21 - Wire and Cable System.

.5 Section 26 05 28 - Surface Grounding.

.6 Section 26 05 29 - Cable and Wire Support System.

.7 Section 26 22 13 - Low Voltage Distribution System.

1.3 REFERENCES AND STANDARDS

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 As a minimum, this aspect of the Work shall be performed in accordance with:

.1 ANSI C82.1 - Specifications for Fluorescent Lamp Ballasts.

.2 CSA C22.1 - Canadian Electrical Code Part I.

.3 CSA C22.2 No. 0.5 - Threaded Conduit Entries.

.4 CSA C22.2 No. 5.1 - Moulded Case Circuit Breakers.

.5 CSA C22.2 No. 14 - Industrial Control Equipment.

.6 CSA C22.2 No. 29 - Panelboards and Enclosed Panelboards.

.7 CSA C22.2 No. 35 - Thermoset Insulated Wire and Cable.

.8 CSA C22.2 No. 42 - General Use Receptacles, Attachment Plugs and Similar Wiring Devices.

.9 CSA C22.2 No. 43 - Lampholders.

.10 CAN/CSA E598 - Luminaires.

.11 C22.2 No. 141 - Exit Lights.

.12 Eligible Product List - Manitoba Hydro Power Smart Program.

.4 Purchaser’s Drawings.

.5 3D Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurements

.1 Measurement for design Item 26 50 00 (a) shall be based on accepted design deliverables.

.2 Measurement for equipment Items 26 50 00 (b) to 26 50 00 (d) shall be based on the quantity shown on the Purchaser's Drawings and Contractor's Documents. Boxes, conduits, conduit fittings, supports and hardware required for shall be incidental to the installation; no separate measurement will be made for these Items.

.3 Unit Price

.1 The estimated cost proposed for Items 26 50 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall include development of design concept for review by the Engineer, general arrangements, schematics, wiring diagrams where applicable, and bills of material drawings as specified herein, and as determined by the Engineer.

.2 The estimated costs proposed for the following Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission, shall be for supply, delivery to site, site handling and storage, installation including mounting hardware, supports, conduits and boxes as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, and turn over documentation as specified herein and as directed by the Engineer.

.1 26 50 00 (a) – Lighting System Design.

.2 26 50 00 (b) – Exterior Lighting.

.3 26 50 00 (c) – Emergency Lighting.

.4 26 50 00 (d) – Exit Signs.

1.5 SUBMITTALS

.1 The requirements shall be in accordance to Subsection 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit Manufacturer's printed product literature, specifications and datasheets.

.3 Shop Drawings and Factory As-Built Record

.1 Submit factory as built record of the fabrication Drawings for individual panels:

.1 Panel GA Drawings.

.2 AC Schematics.

.3 DC Schematics.

.4 Wiring Diagrams.

.5 Bills of Materials.

.4 Quality assurance submittals: submit following in accordance to Subsection 7.13 Project Quality Management of the General Specification.

.1 Type Test Report: submit type test report for equipment and fixtures signed by third party certifying that materials comply with specified performance characteristics and physical properties.

.2 Material Purchase Orders: submit the material procurement order to ensure the material is in line with the Engineer requirements specified in the tender Drawings.

.3 Factory Inspection and Test Plan: submit factory inspection and test plan for review and acceptance covering material procurement, factory assembly, factory testing, and packing and shipment.

.4 Factory inspection and Test Report: submit factory inspection and test reports for review and acceptance, and release for shipment certificate.

.5 Field Inspection and Test Plan: Submit field inspection and test plan covering receipt of material at site, storage, field installation, testing, connections to integrate with the other systems, and commissioning.

.6 Field Inspection and Test Reports: Submit field inspection and test reports for review and acceptance.

.5 Closeout Submittals

.1 Provide equipment manuals in accordance to Subsection 21.7 Contractor’s Documents of the General Specification, indicating selection and details including:

.1 Technical specification.

.2 Descriptive bulletin on all accessories.

.3 Installation/mounting details including hardware required.

.4 Maintenance Instructions.

.5 Guide to Inspection frequency and troubleshooting.

.6 Testing and commissioning instructions

.7 Contractors recommended spare parts.

.6 Drawings

.1 List of Drawings.

.2 Complete set of all as-built record Drawings.

.3 Complete list of panel schedules.

.7 Test Reports

.1 Record of factory tests.

.2 Record of field tests and pre-commissioning tests.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification Requirements.

.2 Qualifications

.1 The engineers, technologists, technicians and assemblers assigned to the job shall be certified and experienced in facility LV lighting design and installation.

.2 The contractor shall have qualified staff trained in project control and quality assurance, and to support quality surveillance.

1.7 DELIVERY, STORAGE AND HANDLING

.1 The requirements shall be in accordance with Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with the manufacturer's written instructions.

.2 Deliver materials to site in original factory packaging, labelled with manufacturer’s name and address.

Part 2 Products

2.1 FABRICATION AND MANUFACTURE

.1 Design Requirements

.1 The Contractor shall be responsible for design and planning the installation of all lighting fixtures, controls and accessories as indicated on the drawings for the normal and emergency lighting systems.

.2 The Contractor shall be responsible for all materials and hardware required for proper installing, securing, aligning and grounding of all lighting fixtures, control and accessories as indicated on the Drawings.

.3 The Contractor shall be responsible for itemizing and quantifying the normal and emergency lighting system components (Fixtures, Luminaires, ballast, etc.) for the purpose of supplying and installing.

.4 Contractor shall be responsible for the design of occupancy sensors layout and arrangement. All sensors shall have a sensitivity adjustment feature to “tune in” for proper operation.

.2 Efficiency and Illumination Levels

.1 The normal and emergency lighting systems shall be controlled by a centralized lighting control system. This shall be in addition to the local switching control devices. In non-essential areas, occupancy sensors shall be used to reduce energy consumption. Occupancy sensors are restricted for use with fluorescent fixtures with program start ballasts only (instant start ballasts may not be used for frequent switching application).

.2 Fluorescent lighting equipment shall be selected from the Manitoba Hydro 'Premium Power Smart" program requirements at the time of order.

.3 High efficiency light sources such as pulse start metal halide, high-pressure sodium (for roadways only), and fluorescent lamps shall be preferred. Lighting controls shall be provided to shut off lamps when not needed.

.4 Exit signs shall be high-efficiency LED pictogram types compliant with CSA standard C22.2 No. 141.

.5 Illumination levels shall be based on the Illuminating Engineering Society handbook and Manitoba Hydro practices.

.6 Average maintained light levels shall be as follows:

.1 Generator floor - 250 lux.

.2 Turbine floor - 250 lux.

.3 Drainage galleries, turbine pit, access tunnels - 100 lux.

.4 Mezzanine - 250 lux.

.5 Battery room - 300 lux.

.6 Workshops, terminal rooms, washrooms, corridors - 300 lux.

.7 Electrical and mechanical galleries, equipment rooms - 500 lux.

.8 Communications rooms - 500 lux.

.9 Tailrace deck and transformers - 50 lux.

.10 Control room - 500 lux.

.11 Offices - 500 lux.

.12 Roadways, parking lots - 20 lux.

.13 Draft tube gate gallery - 50 lux.

.14 Emergency exit routes - 10 lux.

.3 Lamps and Luminaires

.1 Fluorescent lamps shall be cool white, with a minimum average lamp life of 24,000 hours. Fluorescent luminaire ballasts shall be rapid-start or program start type with single phase, high-power factor, low noise level, high-efficiency Premium, Manitoba Hydro Power Smart Electronic ballasts, having thermal non-resetting protection. Fluorescent luminaires shall have reflectors and diffuser panels.

.2 High efficiency light sources such as pulse start metal halide and T8 fluorescent lamps shall be preferred. Incandescent lighting shall not be used.

.3 High-intensity discharge lamps shall be pulse start metal halide (PSMH) with a rated minimum life of 20,000 hours. Luminaires shall have high power factor, auto-reg and mag-reg type ballasts. Each luminaire shall have its own fuse. Lamps within high-bay fixtures shall be enclosed within the luminaire.

.4 Luminaires in areas containing control or instrument panels shall have diffusers to prevent glare and evenly distribute light.

.5 Luminaires for areas of high humidity and moisture, such as drainage galleries and sewage treatment rooms, shall have sealed vapor tight enclosures.

.6 Exterior lighting fixtures shall be weatherproof and rated for satisfactory operation from -40ºC to +40ºC.

.4 Interior Lighting

.1 Luminaires and lamps shall be selected from the “Premium” products listed in the current Eligible Product List in Manitoba Hydro’s "Power Smart" program.

.2 The interior lighting system shall use 120 Vac lamps and luminaires (with exceptions as per below), fed from AC lighting distribution panels. Lamps in office areas shall be controlled by motion sensors. The control room lighting shall incorporate electronic dimmable controls.

.3 The High-bay lighting in the generator hall shall use 347 V lamps and luminaires and be controlled by contactors. All 347V luminaires shall have a Hubbell Circuit-Lock Unfused Safety-Shroud Twist Lock System (combination disconnect and receptacle) adjacent to each fixture to facilitate maintenance. Luminaires for high-bay lighting shall be hook mounted, so that the luminaires can be easily removed for maintenance. To maintain uniform light level and appearance, high-bay luminaires shall be mounted with reflectors at the same height. High bay lighting installation shall be designed to allow for maintenance to be performed from a platform on overhead crane. The Contractor shall mount each luminaire on trade Size 21mm metric threaded rigid galvanized steel (RGS) conduit with hook eye for mounting.

.4 Each luminaire shall be tagged with hard plastic lamacoid indicating the source power circuit number.

.5 Luminaires with incandescent lamps shall not be allowed.

.6 The Contractor shall design, specify and supply all accessories required for mounting fixtures.

.7 Contractor shall supply spare lamps for commissioning, minimum of four lamps of each type or 10%, whichever is greater, for each type of lamp.

.8 Contractor shall supply spare ballasts, 10% of each type. These shall be turned over to the Owner and used for future maintenance.

.9 Fixture and luminaires shall be of the description identified in the following list, and selected from the Manitoba Hydro Power Smart Eligible product list or an approved equal:

.1 LF1: Pulse start metal halide high bay lighting fixture, 1,000 W, 347 Vac, CSA approved, c/w integral ballast, sufficient length of cord and 30 A Hubbell Watertight Safety-Shroud twist lock plug & disconnect assembly. Keene catalogue number 718P1000-PSL-T.

.2 LF2: 2 ft. ceiling mounted enclosed 120 Vac fluorescent lighting fixture, CSA approved, suitable for wet location c/w 2 Phillips T8 lamps, Electronic T8 ballast.

.3 LF3: 2 ft. wall mounted enclosed 120 Vac fluorescent lighting fixture, CSA approved, c/w 2 Philips T8 lamps, Electronic T8 ballast.

.4 LF4: 4 ft. Industrial 120 Vac fluorescent lighting fixture, CSA approved c/w 2 Philips 32W T8 lamps, Electronic T8 ballast and hanging chain to suit mounting height as shown on the Drawings.

.5 LF5: 4 ft. enclosed with gasket 120 Vac fluorescent lighting fixture, CSA approved c/w 2 Philips 32 W T8 lamps, Electronic T8 ballast and hanging chain to suit mounting height as shown on the drawings.

.6 LF6: 2 ft x 4 ft recessed 120 Vac fluorescent lighting fixture complete with K12 lens, suitable for use with inverted T-Bar, CSA approved c/w 2 Philips 32 W T8 lamps, Electronic T8 ballast and hanging chains to suit mounting height as shown on the drawings.

.7 LF7: 4 ft wall mounted restroom fluorescent lighting fixture, CSA approved c/w 2 Philips 32 W T8 lamps, Electronic T8 ballast.

.8 LF8: (Not Used).

.9 LF9: 4 ft clean room 120 Vac fluorescent lighting fixture, CSA approved c/w 1 Philips 32 W T8 lamp, Electronic T8 ballast.

.10 LF10: Wall mounted 120 Vac pulse start metal halide lighting fixture, CSA approved c/w 50 W pulse start metal halide bulb. Hubbell catalogue number NRG-350B.

.5 Exterior Lighting

.1 Exterior lighting shall use 120 Vac lamps and luminaires fed from AC lighting distribution panels and shall be controlled by photoelectric cells in the individual luminaires or in lighting contactors. There shall be a dedicated 120/208 Vac distribution panel for the outdoor parking area.

.2 Building exterior lighting shall be wall mounted; pulse start metal halide (PSMH) fixtures, or metal halide (MH) CSA approved. Roadway lighting shall be High Pressure Sodium luminaires. Fixture and luminaires shall be as per the following list or Engineer's accepted equivalent:

.1 LF11: Exterior wall mounted 120Vac pulse start metal halide lighting fixture, CSA approved c/w 150 W clear mogul lamp, photoelectric control and integral ballast. Hubbell catalogue number PVL-150P-128LP-RS and photoelectric catalogue number PBT-1.

.2 LF12: Ceiling mounted 120 Vac Metal Halide lighting fixture, CSA approved c/w 50W HPS, Stanpro lighting catalogue number IFE-M-0050-A-H.

.3 LF13: Roadway 208 Vac HPS lighting fixture, CSA approved c/w 150 W clear mogul HPS lamp and photoelectric control, Hubbell catalogue number RMD-15S28-3 or approved equivalent to be used with 6.10 m aluminum pole with 1.83 m aluminum arm, Hubbell catalogue number RTA02.

.6 Emergency Lighting

.1 The emergency lighting shall utilize standard fluorescent fixtures supplied from an AC Central Lighting On-Line UPS system, comprising a DC battery supply, a battery charger and inverter system. The emergency lighting fixtures will normally be energized, fed from normal power. On failure of the normal lighting power, the emergency lighting shall automatically transfer to the UPS supply.

.2 The emergency lighting system shall provide light for the Powerhouse facilities and access ways for the complete 8-h DC system duty cycle. Lamps shall be turned off automatically after 30 and 90 minutes to reduce the demand on battery capacity while still providing suitable emergency light. Lighting around critical switchgear and equipment shall be maintained for the full duty cycle.

.3 The emergency lighting system UPS shall utilize a 125 V sealed, maintenance free, lead acid battery bank, a 3-phase 208/120 V inverter, and a transfer switch.

.4 The Contractor to supply and install emergency light fixtures, without battery back-up, which shall match the normal fixtures identified on the Interior Lighting Fixtures list.

.7 Receptacles

.1 All receptacles shall conform to the requirements of CSA Standard C22.1 "Canadian Electrical Code, Part 1".

.2 Exterior outlets and outlets in wet interior locations shall have Ground Fault Circuit Interrupter (GFCI) devices for personnel protection.

.3 All conduit and cabling installations shall be in accordance with Section 26 05 29 Cable and Wire Support Systems.

.8 Occupancy Sensors and Switches

.1 Lighting switches shall be heavy duty suitable for heavy industrial installation.

.2 Light switch type S1 shall be a single-pole, 15 A, 120 V type as per the Purchaser's Drawings and Contractor's Documents.

.3 Light switch type S2 shall be a 3-way, single-pole, 15 A, 120 V type as per the Purchaser's Drawings and Contractor's Documents.

.4 Occupancy sensors shall operate on the basis of passive IR energy, ultrasonic energy response or a combination of both, and be of commercial quality only, with a minimum one-year warranty.

.5 Occupancy sensors shall be either wall-mounted type for the replacement of conventional wall switches, or ceiling-mounted version, and shall be suitable for application on fluorescent and HID lighting systems.

.6 Occupancy sensor switches shall have "off-automatic" selector modes with no "on" position conveniently located on the faceplate. An adjustable "on" time feature shall be provided with a minimum continuous range of one to 15 minutes.

.7 Occupancy "scan" frequency shall be at least once every two seconds, with automatic timing function reset and an LED indicator to show activity detection.

.9 Exit Signs

.1 Contractor to supply exit lights, base on CSA C22.2 No. 141, fed from emergency AC supply (Inverter).

.2 Contractor to supply and install exit signs identified on the following list or approved equal:

.1 LF20: Single face pictogram Exit lighting fixture, CSA approved c/w universal mount, LED illumination, 120 Vac operation. Lumacell catalogue number LS-1-W-U00.

.2 LF21: Double face pictogram Exit lighting fixture, CSA approved c/w universal mount, LED illumination, 120 Vac operation. Lumacell catalogue number LS-2-W-U00.

.10 Lighting Distribution Panels

.1 Refer to Section 26 22 13 Low Voltage Distribution System.

.11 For all supplied equipment and components in which cables and wires will be terminated:

.1 The arrangement and location of terminal blocks for the incoming connections shall be such that the incoming cables can be adequately supported and the individual wires conveniently connected to the terminal blocks.

.2 Parallel rows of terminal blocks shall be spaced at least 200 mm apart.

.3 All terminal blocks shall be identified according to the Purchaser's Drawings and approved Contractor's Documents using the terminal manufacturer's labels.

.4 Sufficient terminal blocks shall be provided for all circuits plus 20% spare, suitably distributed.

.12 Lighting Control System

.1 The Contractor shall be responsible for design, supply, installation and commissioning of the lighting control system including the network devices, cables and all other required accessories.

.2 The lighting control system shall be CSA approved. Panelboards with Integral Intelligence shall be UL listed under UL 916 Energy Management Equipment, as well as CSA C22.2 No. 29 Panelboards.

.3 The Lighting Control System shall be networkable and consist of smart panelboards for zone power switching. The system shall be capable of utilizing smart application specific controllers to provide application specific control of daylight harvesting of fluorescent lighting, manual switch override of automated system functions, telephone override of automated system functions, remote access, and historical data logging.

.4 The system shall be capable of remote monitoring and programming through a remotely located personal computer with modem capability.

.5 On-site programming and monitoring shall be through a networked central operator's station or through a laptop PC. In addition, each panelboard must be able to be locally accessed by a mobile device. The panel must be able to carry out all switching functions without the use of the PC or mobile device.

.6 The programming software, for both PC and mobile device, shall be Microsoft Windows-based and be capable of programming and monitoring all system functions. Factory service and associated wiring to allow control of the facility shall be supplied.

.7 The Central Operator's Station shall be located in the powerhouse control room.

.8 Contractor shall be responsible for all programming, commissioning and integration of the lighting control system.

.9 Contractor shall provide all programs on CD-ROM and three copies of the system's O&M manual, System User's Guide and Programmer's Guide.

.10 Provide single line drawing showing control connections for each system component.

.11 All communication wiring and routing, for lighting control system, shall be per the Manufacturer's recommendations and as shown on the Purchaser's Drawings.

Part 3 Execution

3.1 INSTALLATION AND ERECTION

.1 The Contractor shall be responsible for supply and installation of lighting to meet requirements of Section 26 05 00 Electrical General Requirements.

.2 Any questions pertaining to mounting heights shall be referred to the Engineer for clarification or decision. Luminaires shall be installed in such a manner that they shall not obstruct or impair the clearances of passageways for workers or equipment.

.3 The design and location of luminaire mounting shall consider ease and safety of re-lamping and periodic maintenance.

.4 The Contractor shall co-ordinate the final location of all luminaires with the work of other trades. The final location of each luminaire shall be such that the light output for its intended purpose is not obstructed.

.5 Luminaire mounting brackets and wiring shall be bolted to the roof steel/deck and erected with the roof steel/deck.

.6 All luminaires shall be installed level and true with proper fitting canopies and appurtenances. Fastening and suspensions shall be made so that rows shall not be distorted by handling incidental to normal maintenance.

.7 The ceiling structure, piping, all related equipment and construction status shall be checked in all areas in which luminaires are to be installed to verify that suitable mounting and luminaire types have been provided.

.8 Spring loaded mechanical type fasteners or other equally secure methods of attachment shall be used.

.9 Where chain hangers are used the chain shall be closed link type capable of supporting ten times the luminaire weight. "U" bolts shall be used at chain ends. "S" hooks shall not be used unless noted otherwise.

.10 Where bracketing is required between structural members; metal channels shall be used and securely fastened to the building structure. Wood shall not be used to support any luminaire.

.11 Recessed, surface mounted or suspended luminaires shall be supported from the surrounding structure; the ceiling suspension system shall only be used where approved for luminaire support.

.12 Luminaires shall not be suspended from ductwork, piping, mechanical equipment or their supports.

.13 Field welding shall not be permitted for the purpose of luminaire installation.

.14 Luminaires shall be cleaned at the time of installation and protected from construction dirt accumulation. Lenses shall be installed last to ensure dust-free installation. Only products and procedures as outlined in the literature of the manufacturer shall be used for cleaning.

.15 Products as delivered shall be securely wrapped and packaged, clearly identified with manufacturer product or component number, and job fixture type. Products shall be stored in a clean, dry and secure storage area and shall be handled in a manner to prevent breakage of packaging and damage of contents.

.16 Wiring for lighting circuits shall be minimum 12 AWG power wire supplied in accordance with Section 26 05 21.

.17 All lighting circuit power cables shall be identified at each panel board, junction box, luminaire socket etc.

.18 Wall mounted luminaires shall have bottom or side cable entry only.

.19 Receptacles and convenience outlets shall be located in all working areas of the project facilities. The spacing, mounting heights and locations and number of outlets shall be suitable for regular operation and maintenance activities anticipated for the specific areas.

.20 Separate circuits shall be provided for lighting, space heating, and convenience outlets.

.21 Light fixtures, switches, boxes and receptacles shall be surface-mounted, unless otherwise specified and except in office areas.

.22 Receptacle cover plates shall be marked indicating voltage, supply panel and circuit number.

.23 All lighting fixtures and receptacles shall be directly bonded to the Powerhouse grounding system by means of a bonding conductor of a size not less than that required by the CEC. If insulated, the ground conductor insulation shall be coloured green and FT4 rated.

.24 Contractor shall be responsible for all programming, commissioning and integration of the lighting control system.

.25 Contractor shall provide all programs on CD-ROM and three copies of the system's O&M manual, System User's Guide and Programmer's Guide.

.26 Provide single line drawing showing control connections for each system component.

.27 All communication conductor wiring and routing, for lighting control system, shall be per the manufacturer's recommendations and as shown on the Purchaser's Drawings.

3.2 FIELD QUALITY CONTROL

.1 The requirements shall be in accordance with Subsection 7.13 Project Quality Management of the General Specification.

.2 Contractor shall perform field tests in accordance with Section 26 05 00 Electrical General Requirements.

.3 Testing shall include, but not be limited to the following:

- .1 Continuity testing.
- .2 Meggering of all lighting supply cables.
- .3 Functional testing.

.4 On completion of installation, replace any burned out lamps.

.5 Confirmation of lighting levels:

- .1 Measure lighting levels at locations in the station as directed by the Engineer.
- .2 Improve lighting levels to specified levels where required.
- .3 Provide measurement records to the Engineer.

3.3 CLEANING

.1 The requirements shall be in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Leave Work area clean at end of each Work Day.

.3 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment.

.4 Remove from site and dispose of all packaging materials at appropriate recycling facilities.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of the design, supply, installation, testing and commissioning of the Communication system for the Powerhouse and project site.

.2 The Communication system shall comprise communication equipment, network and cables, cable trays, panels, paging system, telephone handsets, telephone system, termination and patch panels, routers, switches, in the Powerhouse complex, Intake and Spillway.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 25 11 00 - Unit Control and Monitoring System (UCMS).

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 26 05 21 - Wire and Cable Systems.

.5 Section 26 05 29 - Cable and Wire Support System.

.6 Section 26 33 00 - Battery Systems, UPS and Inverters.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 As a minimum, the Work shall be performed in accordance with:

.1 ANSI-J-STD-607-A-2002 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

.2 ANSI/TIA-569-B - Commercial Building Standard for Telecommunications Pathways and Spaces.

.3 CCITT - International Telegraph and Telephone Consultative Committee.

.4 CCIR - International Radio Consultative Committee.

.5 CSA C22.1 - Canadian Electrical Code, Part I.

.6 CSA C22.2 No. 14 - Industrial Control Equipment.

.7 CSA S37 - Antennas, Towers, and Antenna-Supporting Structures.

.8 CSA Z462 - Workplace Electrical Safety.

.9 CAN/CSA T529-95 - Telecommunications Cabling Systems in Commercial Buildings.

.10 Purchaser’s Drawings.

.11 3D Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 No separate measurement will be made for the following Items:

.1 27 00 00 (a) – Communication System Design.

.2 27 00 00 (c) – Paging System.

.3 27 00 00 (d) – Patch panels and junction boxes.

.2 Measurement for Items 27 00 00 (b)i to 27 00 00 (b)iii inclusive, 27 00 00 (f), 27 00 00 (i)i, and 27 00 00 (i)ii will be based on the number of Items as shown on the Purchaser's Drawings.

.3 Measurement for Items 27 00 00 (e)i to 27 00 00 (e)xii inclusive, 27 00 00 (g) and 27 00 00 (h) will be in metres based on the neat lines shown on the Purchaser's Drawings and as determined by the Engineer.

.4 No separate measurement will be made for boxes, conduits, conduit fittings, supports, and hardware.

.3 Unit Price

.1 The estimated cost proposed for Item 27 00 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate included in the Contractor's Submission shall be for the design of the communication system as specified herein and as determined by the Engineer.

.2 The unit price proposed for Items 27 00 00 (b)i to 27 00 00 (b)iii in the Bill of Quantities, Unit Prices and Target Price Estimate included in the Contractor's Submission shall be for the supply and installation of telephone and data network equipment as specified herein, as determined by the Engineer, as follows:

.1 Item 27 00 00 (b)i shall cover wiring closets.

.2 Item 27 00 00 (b)ii shall cover wiring cubicles.

.3 Item 27 00 00 (b)iii shall cover telephone/data receptacles.

.3 The estimated cost proposed for Item 27 00 00 (c) in the Bill of Quantities, Unit Prices and Target Price Estimate included in the Contractor's Submission shall be for the supply and installation of the paging system as specified herein and as determined by the Engineer.

.4 The estimated cost proposed for Item 27 00 00 (d) in the Bill of Quantities, Unit Prices and Target Price Estimate included in the Contractor's Submission shall be for the supply and installation of patch panels and junction boxes as specified herein and as determined by the Engineer.

.5 The unit price proposed for Items 27 00 00 (e)i to 27 00 00 (e)xii inclusive, in the Bill of Quantities, Unit Prices and Target Price Estimate included in the Contractor's Submission shall be for the supply and installation of communication cables as specified herein and as determined by the Engineer.

.6 The unit price proposed for Item 27 00 00 (f) in the Bill of Quantities, Unit Prices and Target Price Estimate included in the Contractor's Submission shall be for the supply and installation of wireless data network access points as specified herein and as determined by the Engineer.

.7 The unit price proposed for Item 27 00 00 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate included in the Contractor's Submission shall be for the supply and installation of communication system cable trays including all bends, crosses, tees, supports and miscellaneous hardware as specified herein and as determined by the Engineer.

.8 The unit price proposed for Item 27 00 00 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate included in the Contractor's Submission shall be for the supply and installation of the communication room Fibre Guide infrastructure including all bends, sprouts, support brackets and miscellaneous hardware as specified herein and as determined by the Engineer.

.9 The supply and installation of boxes, conduits, conduit fittings, supports, and hardware are considered incidental to the Work. Include costs for such Work in the unit prices proposed for the Items to which this Work applies.

1.5 SUBMITTALS

.1 The requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Electrical Components

.1 Submit a hard copy of manufacturer's product literature, specifications and datasheet.

.3 Shop Drawings and Factory As-Built Record

.1 Submit factory as-built record drawings for individual panels. At minimum include:

.1 Panel General Arrangement Drawings.

.2 AC Schematics.

.3 DC Schematics.

.4 Wiring Diagrams.

.5 Bill of Material.

.4 Closeout Submittals

.1 Operation and Maintenance Manual: Submit an operation and maintenance manual, per Subsection 21.7.12 Operation and Maintenance Manuals.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 Installer: company or person specializing in telecommunications system installations.

.3 Provide services of representative or technician from manufacturer of systems, experienced in installation and operation of type of system being provided, to supervise installation, adjustment, preliminary testing, and final testing of system and to provide instruction to project personnel.

.4 System

.1 Subject to the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.5 Spares

.1 Submit a list of recommended spare parts.

.6 Maintenance Service

.1 Include warranty in accordance with Section 27 Warranty of the General Specification.

1.7 DELIVERY, STORAGE AND HANDLING

.1 The requirements shall be in accordance with Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading in accordance with manufacturer's written instructions.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with the requirements set out in Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris.

Part 2 Products

2.1 SUMMARY

.1 The communications infrastructure is comprised of the following systems and equipment:

.1 Industrial Data Network (IDN) LAN.
.2 Unit Control and Monitoring System (UCMS) LAN.
.3 Corporate LAN.
.4 Internal telephone (PBX) system.
.5 Paging (PA) system.
.6 VHF radio system.
.7 Cellular radio.
.8 Telecontrol channels to the System Control Centre (SCC) to provide remote control and monitoring.

.9 48 Vdc Battery System, including rectifiers, and UPS system.

.10 Wireless Data Network.

.2 Computers, programmable controllers and intelligent electronic devices will communicate over several types of control networks with differing performance levels and protocols. In each case, control networks will be physically separated from the general purpose IT networks used for business automation functions.

.3 The Contractor shall be responsible for the following Work:

.1 Detailed engineering of all communications systems described in Paragraph 2.1.1 excluding the systems identified in Sub-paragraph 2.1.4.1. This shall include development of the design concept with the Purchasers input, panel general arrangements, ac schematics, dc schematics, wiring diagrams, riser diagrams, and bills of material Drawings.

.2 Supply and install MH Corporate LAN network and telephone system cables, patch panels and receptacles as per the Drawings.

.3 Supply and install the Cisco Lightweight wireless data network access points (AP) and required cables and accessories as noted on the drawings. The APs will connect to the Purchaser's existing wireless controllers.

.4 Supply, install, test, and pre-commission the following telephone system and data network components:

.1 Wiring closets/Cubicle.

.2 Network Switches (MH IT will program switches).

.5 Supply and install an audible paging system with an interface circuit to the telephone system comprising of:

.1 Base control station.

.2 Amplifier.

.3 Indoor and outdoor paging horns located throughout the Powerhouse complex and intake, dam Spillway areas.

.6 Supply, install, and terminate all communication and data cables and cable trays in the powerhouse complex and spillway.

.7 Supply all fibre optic cables except for the 24 strand single mode cable from the PH2 Fiber Termination panel to the Spillway Fiber termination panel, the 48 strand SM cable from the communication room to the A-frame on the roof and the 72 strand SM cable from the communication room to the Powerhouse complex extent on the north side (these cables will be supplied by the Purchaser).

.8 Install, terminate, test, and commission all indoor and outdoor fibre optic cables in the powerhouse complex including Communications Room, intake, spillway and switchyard.

.9 Supply and install communication cable trays in Communications Room as indicated on the Drawings (to be provided later), and fibre guide infrastructure.

.10 Supply and install Caddy (CableCAT 12) or Cooper B-Line BCH32 or BCH64 cable hooks or approved equivalent where no cable trays or conduits are specified. J-hooks are to be spaced at a maximum of 1.5 m apart.

.11 Supply and install standard Gang wall boxes with suitable cover plates at locations and shall be finished flush to the finished wall for all surface mounted data/voice ports.

.12 Supply and install one backbone copper cable, Berk-Tek, 25 pair CAT6 riser cable to be installed in conduit between the communication room and the wiring closet in each area.

.13 Supply all materials, tools, and equipment required for the proper installation and wiring of the identified communication system and equipments.

.14 Provide Operation and Maintenance manuals and site as-built record Drawings of the installed communication systems.

.4 Work Excluded

.1 Supply and installation of the following equipment:

.1 All Purchaser supplied communication and data network equipment within the communication room.

.2 Cellular/VHF tower.

.3 IDN and MH corporate LAN gateways.

.4 Satellite Phone.

.5 VHF radio system and cellular repeater.

.6 External trunk fibre cables into the powerhouse communication room

.7 Telephone PBX.

.2 Programming of the switches located in the wiring closets and Communications room.

.3 Satellite Clock antenna and cable installation from tower to Communication room.

2.2 DESIGN

.1 The communication systems outside of the communication room shall be designed, supplied, assembled, tested, installed and commissioned in accordance with these Specifications, and the latest revision of the standards and codes specified herein.

.2 The following equipment/panels/cubicles will be located in the communication room:

.1 Two Fibre Termination Cubicles.

.2 One 48 Vdc Power Cubicle.

.3 Two Telephone Equipment Cubicles.

.4 One IDN Cubicle.

.5 One Corporate LAN Cubicle.

.6 One VHF Radio Cubicle.

.7 One Cellular Radio Cubicle.

.8 Two MH Telecom Cubicles.

.9 A Video Surveillance (CCTV) Cubicle.

.10 A Security System Cubicle.

.11 A Paging Address System Cubicle.

.12 Station RTU Cubicle.

.13 Station Telemetering Cubicle .

.14 Two Optical Transport Cubicles

.3 Fibre Optic Network

.1 For the control networks, a tree topology using redundant trunks between the switches servers and workstations will be used. The network link from individual devices or PLCs to the switches will be without any redundancy.

.2 Within the Powerhouse complex and Spillway, multi-mode fibres shall be used to interconnect devices and panels, except otherwise noted.

.3 For long-haul communications to places remote from the site, single-mode fibres terminating in the communications room will run to overhead ground wires with optical fibre (OPGW) or to buried fibre cables.

.4 Any unused strands shall be coiled at termination panels or terminated on spare terminals for future use.

.5 Where redundant fibres are installed, primary and secondary fibres shall not run in the same cable tray to increase the reliability of the network.

.6 Spare fibres shall be supplied in all cables to allow for future expansion.

.7 The Contractor shall supply SC type fibre optic connectors.

.8 Within the plant, network cables shall be color-coded to distinguish between industrial and IT networks.

.1 Blue for UCMS control network.

.2 Yellow for non UCMS control network.

.3 Purple for security network.

.9 Fibre Optic Cables shall be coded as follows:

.1 Yellow - Single Mode.

.2 Orange - Multimode.

.3 Blue - Multimode (50 μm).

.10 These color cables shall not be terminated in the same equipment unless that equipment contains a gateway to control the data interchange.

.11 No Splice shall be acceptable between device/UCMS cubicles and fibre optic termination panels.

.12 The maximum allowable attenuation for any splice or termination is 0.3 dB.

.4 Networks

.1 IDN LAN:

.1 The contractor shall supply, install, terminate, and test all data network, equipment, cables and accessories identified in the Drawings (to be provided later) for the IDN LAN network to purchaser standards.

.2 Contractor shall connect the following systems to the IDN LAN network in addition to the UCMS related devises:

.1 Closed Circuit Television (CCTV) system.

.2 Access Control System.

.2 UCMS LAN:

.1 Ethernet will be extensively used to interconnect processors within the station. Each programmable controller will be connected to a managed Ethernet switch, so that each processor is on its own Ethernet segment.

.2 All field-mounted Ethernet switches will be connected to two (primary and secondary) "head-end" Ethernet switches mounted in HMI server cubicles.

.3 Two "head end" switches will be interconnected to implement the separate HMI and PLC VLANs.

.4 The contractor shall install, terminate, and test Ethernet fibre network cables and accessories to purchaser standards identified in the drawings (to be provided later).

.5 In addition to the UCMS LAN, the contractor shall install Line Protection system fibre termination panels/cables and terminate the fire cables.

.3 ProfiNet LAN:

.1 ProfiNet LAN will be used to communicate with remote I/O and with auxiliary equipment.

.2 The ProfiNet LAN utilizes a ring topology to provide high availability.

.3 The Contractor shall be responsible to supply and install ProfiNet LAN.

.4 Manitoba Hydro Corporate LAN:

.1 A redundant network topology shall be used for the corporate network.

.2 The backbone network shall be capable of sustaining a single fibre optic cable or switch failure while retaining full functionality.

.3 Managed network equipment shall be used as required to provide a network backbone.

.4 The contractor shall supply and install distributed managed Ethernet switches located in wiring closets (WCs) as part of the MH corporate LAN system.

.5 Wide Area Network (WAN):

.1 Purchaser will design, supply, install and terminate the external trunk fibre cables into the Powerhouse Communications Room.

.6 Network Switches:

.1 Managed Ethernet Switches shall be Cisco Systems equipment.

.2 The switches shall be equipped with redundant power supplies, each power supply being fed from a different inverter.

.3 The switches shall be equipped with Power over Ethernet (PoE) for VOIP handsets and equipment or other network-powered devices.

.4 The LAN equipment shall be powered from the 125 V Station Battery systems via the UPS Inverters.

.7 Fibre Optic Connectors:

.1 The contractor shall use SC type fibre optic connector except otherwise noted.

.8 Telemetry System:

.1 A serial communications link using DNP3 will provide supervisory control and data acquisition between the RTU and the System Control Center (SCC).

.2 Communication equipment for primary station voice, control and data will be designed and installed by the purchaser and will be located in the powerhouse in the communications room.

.3 Any communication port outside of the communication room to the telemetry system shall be installed by the contractor, including cable, and termination.

.9 Satellite Clock System:

.1 The station master clock will be derived from a Global Positioning System (GPS) receiver installed in the Communications room which will be supplied and installed by the Purchaser.

.2 The time signals will be distributed to all elements which require millisecond-resolution synchronization to real time.

.3 The network file servers, operator HMI workstations, and programmable controllers will have access the master clock time over the station Ethernet LAN.

.4 Devices such as protection relays, the governors, exciters, transient fault recorders, and the station RTU shall be connected by cables carrying Inter-Range Instrumentation Group (IRIG) time codes.

.10 Ethernet Cable:

.1 Refer to Section 26 05 21 - Wires and Cables.

.11 Telephone System:

.1 Two options are currently being considered for the telephone system. It will be determined during the detailed design which one shall be implemented.

.1 Conventional PBX.

.2 This will consist of a private branch exchange (PBX), extension telephones, interconnecting cabling, and accessories such as ringers and lamps.

.2 Voice Over Internet Protocol (VOIP) System:

.1 This will consist of a VOIP/SIP PBX server sharing the MH internal powerhouse corporate LAN. Extension telephone handsets and accessories would be connected to the VOIP/SIP server via the powerhouse corporate LAN which would utilize power-over-Ethernet (PoE) enabled switches to provide power for the handsets.

.3 Handsets:

.1 Approximately 80 handsets will be installed throughout the complex, some 20 of which will be waterproof, and 5 of which will require local ringers. Approximately 30 spare jack receptacles will be required.

.12 Paging Address (PA) System:

.1 Depending on the PBX option selected, either a conventional or an IP Network-attached PA (Paging) System will be provided. The function of the system will allow Public Address announcements to be made from a number of audio sources. The contractor shall supply, install, and commission PA system.

.2 Conventional PA system:

.1 The PA system shall include:

.1 A master amplifier equipped with microphone, PABX input, VHF radio input.

.2 Paging Horns.

.3 Speakers.

.4 Volume control switch.

.5 Interconnecting cabling and accessories.

.2 System must include a redundant hot swappable power amplifier that can be put into service via a panel switch with all components residing within the same rack or cubicle.

.3 The interface to the PBX must accept up to four digits.

.4 System should be expandable to accommodate more than 1 input from the PBX.

.5 System should be easily configured via a laptop or PC.

.6 System should support Reader Boards/Visual displays.

.7 The paging horn call system shall be capable of reproducing speech announcements throughout the station with a high degree of intelligibility.

.8 Paging horns shall be provided for the Powerhouse, Service Bay, Intake, galleries, Spillway, and Tailrace deck.

.9 A zone system shall allow control room operators to select which speakers will be enabled, so that outdoor speakers are only enabled when needed.

.10 The main amplifier shall be a rack-mounted, modular unit equipped with input channels for a microphone, auxiliary audio signals and a telephone extension.

.11 It shall be possible for discrete alarms to be annunciated via an alarm monitor unit.

.12 The amplifier units shall have input level controls and tone control equalizers.

.13 The paging horns shall include ceiling-mounted, horn type, modular units for both indoor and outdoor mounting, selected for the climatic and noise environment of the location.

.14 The paging horns system shall produce sound levels at least 10 dB above an ambient noise level of 90 dB.

.3 IP-based Network Attached PA system:

.1 An IP-based PA system would be implemented in conjunction with a VOIP/SIP-based IP-PBX and Paging Controller, using PoE to power LAN-connected speakers and audible and visual alterters.

.2 This type of system shall provide similar functionality to the conventional system with the advantage of full integration into the unified IP-based communications system.

.4 Paging Horns, Speakers and Volume Control Switches:

.1 Approximately 90 paging horns and 10 speakers will be required.

.13 Wiring Closets and Wiring Cabinets:

.1 Wiring closets are small rooms used to accommodate the managed Ethernet switches and power supplies for the Corporate LAN and telephone system.

.2 Wiring cabinets are free-standing enclosures installed in general powerhouse and spillway areas.

.3 Contractor shall supply and install all wiring closets as shown on the GA drawings (to be provided later). Wiring closets will be located at various locations throughout the powerhouse complex.

.4 Wiring closets shall have the following basic features/devices:

.1 A free-standing 19” x 44U rack.

.2 Door covers.

.3 120 Vac receptacle.

.4 Fibre patch panel.

.5 Wire and cable management.

.6 Termination panel.

.7 One 24 port Data Switch.

.8 Power bar.

.5 Wiring cabinets shall have the following basic features/devices:

.1 Hoffman cabinet.

.2 Middle Atlantic wall-mount racks.

.3 Door covers.

.4 120 Vac receptacle.

.5 Fibre patch panel.

.6 Wire and cable management.

.7 Termination panel.

.8 One 24 port Data Switch.

.9 Power bar.

.6 The contractor shall supply and install, in conduit, one copper backbone cable Berk-Tek 25 Pairper wiring closet and wiring cabinet.

.14 120 Vac Power Distribution Panels:

.1 The Contractor shall supply and install the following power panels which will be mounted on the walls of the communications room:

.1 One 120 - 208 Vac panel for powering the rectifiers, dehydrator, lighting panel, in-rack convenience outlets, and AC powered equipment.

.2 One 120 Vac UPS distribution panel for essential AC powered communications loads.

.15 Cable Tray:

.1 Cable tray installed in the communications room shall be telecom ladder-type with pans and fibre guides.

.16 48 Vdc System:

.1 Refer to Section 26 33 00 - Battery Systems, UPS and Inverters.

2.3 MATERIALS

.1 Fibre Optic Cables

.1 Refer to Section 26 05 21 Wire and Cable Systems.

.2 Ethernet CAT6

.1 Refer to Section 26 05 21 Wire and Cable Systems.

.3 Telephone Riser Cable

.1 The telephone riser cable shall be 25 pair, copper, Berk-Tek Cat5e per C22.2 No. 214-02 standard.

.4 48 Vdc Battery and Battery charger

.1 Refer to Section 26 33 00 Battery Systems, UPS and Inverters.

.5 Paging Address System

.1 One Paging Address system consists of:

.1 Two PA system interfaces to the telephone system for paging.

.2 30W dual paging horns.

.3 15W single paging horns.

.4 8W speakers.

.5 Volume control switch.

.6 Interconnecting cabling and accessories.

.6 Field-mounted Telephone handsets

.1 Guardian Telecom, Heavy duty weather resistance telephone, type ACT-40 and accessories including Guardian Telecom, Water tight telephone, type WTT-40-H and accessories.

.7 Wiring Closets and Wiring Cabinets

.1 Wiring Cabinets:

.1 Middle Atlantic, wall mount racks 18RU c/w door covers, model DWR-18-22.

.2 Middle Atlantic, wall mount racks 12RU c/w door covers, model DWR-12-22.

.3 Hoffman cabinets, type Ultrex 4X, model UU605025 and accessories.

.2 Wiring Closets:

.1 19”x 44 RU Rack RF Mote Part # 1944TBS or equivalent.

.3 Associated wire, cable and fibre management.

.4 24 Port Cisco Data Switch series 38XX.

.5 One AMPTRAC CAT6, patch panel (48 ports for 18RU rack and 24 ports for 12RU racks).

.6 Power bar.

.7 Terminal blocks.

.8 Fuse and fuse holder.

.8 Communication room cable tray system

.1 Chatsworth, 12” wide telecommunication cable tray 9’ 11-1/4” length.

.2 Cooper B-LINE, Aluminum tray pan for 12" tray 10' length.

.3 Cable tray radius bend - 90° outside bend.

.4 Butt splice kit.

.5 Butt-swivel splice kit.

.6 Junction-swivel splice.

.7 Wall angle support.

.8 Triangular support bracket steel.

.9 6" Retaining post.

.10 Slotted support bracket 5/8".

.11 Threaded drop rod 5/8"-11 - UNC-2A-8'.

.12 L Brackets.

.9 Fibre Guides

.1 The fibre guide system shall include all straight sections, bends, fittings, flex tubes, junction boxes and supports required for complete routing fibbers from fibre termination racks to various equipment in the communications room.

.2 The size of guide system shall meet the application requirements.

.3 The Fibre guide system shall be ADC data center optical raceway system or the Purchaser's approved equivalent.

2.4 SOURCE QUALITY CONTROL

.1 All equipment shall be configured and functionally tested to the Purchaser's Drawings, Contractor's Documents and manufacturers specifications.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, programming instructions, and datasheet.

3.2 INSTALLATION

.1 All communication cable installation shall comply with EIA/TIA 568B (Building Wiring), EIA/TIA 569 (Electrical Pathway) and Canadian Electrical code.

.2 Minimum bend radius shall be a minimum of four times the cable outside diameter and shall observe any additional vendor recommendations.

.3 Communication cables shall not be routed near lighting ballasts, power cables, or motors. Communication cable distances from various equipment, shall be:

.1	Transformers up to 5 kVA	1,000 mm
.2	Power Lines (110 Vac power systems)	300 mm
.3	Fluorescent Lighting Ballasts	300 mm
.4	Power Lines (600 Vac power systems)	1,000 mm
.5	Power Lines (>600 Vac power systems)	1,500 mm
.6	Electrical Motors	1,000 mm

.7	Mechanical equipment (coils, dampers, VAR boxes etc.)	300 mm
.8	Transformers >5 kVA	3,000 mm

.4 The contractor shall clearly identify and tag all communication cables with cable number markers at both ends as indicated on the Drawings.

.5 All wiring closets, patch panels, switches, devices, individual room ports, wall jacks are to be identified.

.6 All CAT 6 cables shall be terminated to T568A wiring pattern.

.7 All CAT 6 wiring shall be installed by cabling system manufacturer trained technicians (e.g., AMP TE trained).

.8 Supply and install conduits and pull boxes as required.

.9 Conduit shall be used for all surface mounted communication outlet boxes.

.10 Where conduit is used, pull boxes are to be installed between two 90° bends.

.11 No power cables are allowed in communication cable tray or conduit.

.12 Install the panels and racks as shown on the issued for construction package and supply hardware and anchors required for installations.

.13 The panels and racks shall be bonded to the facility ground grid in accordance issued for construction package.

.14 Terminate communication cables in accordance with the approved connection diagram, and supply all glands for cable entry into the panel, heat shrinks, and terminal lugs.

.15 See also Section 26 05 21 Cable and Wire Support Systems for additional copper and fibre optic cable installation requirements.

.16 25 pair Cat5E riser cable shall be installed in conduit.

.17 Category 6 UTP cables to be installed using strain relief bars or cable support bars, wire management panels and velcro tie wraps for neatness.

3.3 FIELD QUALITY CONTROL

.1 The requirements shall be in accordance with Subsection 7.13 Project Quality Management of the General Specification.

.2 All equipment and material shall be new, unused, and suitable for the intended use.

.3 All electrical equipment and material shall be CSA approved or ULC accepted for the application.

.4 Test and record the lengths of all communication cables. Verify that cable performance is within specification and that maximum cable lengths have not been exceeded. Replace all cables which do not meet specification or exceed the maximum specified cable length.

.5 Site Tests

.1 Visual and mechanical inspections (for all panels):

.1 Inspect for physical damage and defects.

.2 Check nameplate information for correctness.

.3 Check presence of foreign materials, moisture, dust, etc.

.4 Verify the correctness of panel wiring in accordance with the approved panel Drawings and schematics.

.2 Pre-Commissioning (All System):

.1 Confirm the functionality of the telephone and PA systems in accordance to the approved specifications and manufacture's recommendations.

3.4 SPARE PARTS

.1 Submit a list of recommended spare parts.

3.5 TOOLS AND TEST EQUIPMENT

.1 The Contractor shall purchase a new set of fusion splicer apparatus (electric arc) which will be used for the termination of the fibre optic network and will be left on site for maintenance.

.1 The Contractor shall be responsible for fibre optic cable testing tools.

3.6 WARRANTY

.1 The requirements shall be in accordance with Section 25 Warranty of the General Specification.

.2 Contractor warranty shall provide full system functionality, parts replacement, software and hardware upgrades necessary in to ensure full system functionality during the warranty period.

3.7 TRAINING

.1 The contractor shall provide a training session for up to three people upon the Purchaser or Purchaser's Representatives request including:

.1 The full operation of the PA system.

.2 All network management, commissioning tools, network diagnostic tools, and network analysis tools.

.3 All device configuration and programming tools.

3.8 CLEANING

.1 The requirements shall be in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion of the installation and verification of performance, remove surplus materials, excess materials, rubbish, tools, and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, materials and plant and performing all Work necessary for designing, manufacturing, transporting, storing, handling, installing and testing of the Security Access Control, Alarm and Intercom Systems throughout the Powerhouse complex and Project Site as shown on the Purchaser's Drawings, Contractor's Documents and as specified herein.

.2 The Contractor, through the use of an approved Security Integrator, shall be responsible for the following Work under these Specifications in respect of the Security Access Control, Alarm and Intercom Systems.

.1 Design, supply, manufacture, quality control, factory assembly and testing, delivery and covered heated storage at Site of:

.1 Requisite quantity and type of access card readers, access control keypads, electric and magnetic door locks, and associated computer-based control system hardware and software, as per drawings and Security Integrator's design.

.2 Requisite quantity and type of intrusion detection passive infrared (PIR) devices, door and access point switches and glass-break detectors, as per drawings and Security Integrator's design.

.3 Requisite quantity and type of intercom devices for main personnel access door, main roadway gate, Powerhouse access roadway gate and control room, as per drawings and Security Integrator's design.

.2 Provide installation instructions and drawings.

.3 Install and connect all card readers, electric and magnetic door locks, intercom system devices, intrusion detection system devices.

.4 Provide complete set of final, as-approved, design drawings and documents, including outline and assembly drawings, and wiring, interconnection, logic, and schematic diagrams.

.5 Provide Site equipment test and commissioning procedures and carry out Site equipment testing and commissioning in accordance with the Specifications.

.6 Compile and provide operation and maintenance manuals, including all factory test reports.

.7 Supply two sets of special maintenance tools and materials, if applicable.

.8 Provide a priced list of recommended spare parts.

.9 Provide the specified equipment warranty.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wire and Cable Systems.

.4 Section 26 05 34 - Cable and Wire Support Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Works shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, the Work shall be performed in accordance with:

.1 CSA C22.1 - Canadian Electrical Code, Part I.

.2 Underwriters Laboratories of Canada (ULC):

.1 CAN/ULC-S301 - Standard for Signal Receiving Centre Burglar Alarm System and Operations.

.2 CAN/ULC-S302 - Standard for Installation and Classification of Burglar Alarm Systems for Financial and Commercial Premises, Safes and Vaults.

.3 CAN/ULC-S304 - Signal Receiving Centre and Premise Burglar Alarm Control Units.

.4 ULC-S318 - Standard for Power Supplies for Burglar Alarm Systems.

.5 ULC-C634 - Guide for the Investigation of Connectors and Switches for Use with Burglar Alarm Systems.

.3 Underwriters' Laboratories (UL):

.1 UL 294 - Access Control System Units.

.2 UL 603 - Power Supplies for Use with Burglar Alarm Systems.

.3 UL 681 - Installation and Classification of Burglar and Holdup Alarm Systems.

.4 UL 827 – Central-Station Alarm Services.

.5 UL 1076 - Safety for Proprietary Burglar Alarm Units and Systems.

.4 Purchaser’s Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section shall be in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor’s Submission multiplied by the corresponding unit price for each Item as specified

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes of the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Item 28 13 00 (a) will be based on accepted design deliverables.

.2 Measurement for Items 28 13 00 (b) will be based on the Purchaser's Drawings and revisions determined by the Engineer.

.3 No separate measurement shall made for boxes, conduits, conduit fittings, cables and wires, supports and hardware.

.3 Unit Price

.1 The Estimated Cost proposed for Items 28 13 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the development of design concept with the Purchaser's Drawings.

.2 The Estimated Cost proposed for Item 28 13 00 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply, shipment to the Site, storage, Site handling, installation including mounting hardware, raceways and junction boxes as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, commissioning, touch-up painting, and turn over documentation, as specified herein and as shown on the Purchaser's Drawings.

.3 The supply and installation of boxes, conduits, conduit fittings, supports and hardware are considered incidental to the Work. Include costs for such Work in the unit prices proposed for Items to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit manufacturer's instructions, printed product literature and data sheets for access controls and equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit:

.1 Functional description of equipment.

.2 Technical data for all devices.

.3 Device location plans and cable lists.

.4 Device mounting location detail drawings.

.5 Typical device connection detail drawings.

.3 Shop Drawings

.1 Submit drawings sealed by a Professional Engineer registered or licensed in the province of Manitoba.

.2 Shop drawings to indicate equipment layouts and details.

.1 Shop drawings to indicate mounting heights and locations, wiring and interconnection diagrams.

.2 Submit zone layout drawing indicating number and location of zones and areas covered.

.3 Submit wiring diagrams.

.4 Submit complete equipment list.

.5 Drawings that describe more than one type of Item shall be marked to indicate which Item will be provided.

.4 Test and Evaluation Reports

.1 Submit certified test reports from approved independent testing laboratories indicating compliance with specifications for specified performance characteristics and physical properties.

.5 Manufacturer's Instructions

.1 Submit manufacturer's installation instructions.

.6 Closeout Submittals

.1 Submit to the Engineer four sets of approved submittals and drawings immediately after approval and no later than 15 working days prior to final inspection.

.2 Submit the following:

.1 Manufacturer's Data for all equipment supplied:

.1 Submit original for each Item and clear, legible, first-generation photocopies for remainder of specified copies.

.2 System as-built drawings.

.3 Instructions for operation of all devices and systems.

.4 Test Reports.

.5 Programming Software:

.1 Provide programming software, program setup files and documentation.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with Section 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 The security system integrator must be an authorized Genetec dealer and have been trained in Security Centre V5.0 and V5.1. The security integrator’s field technicians must be certified Genetec installation technicians.

.2 Submit documentation confirming the above requirements with the bid as well as a list of previous, large scale Genetec installations performed in industrial settings.

.3 Provide services of a manufacturer’s representative or technician, experienced in the installation and operation of the type of system being provided to supervise the installation, adjustment, preliminary testing, and final testing of the system and to provide instruction to project personnel.

.4 Spares

.1 Submit a list of recommended spare parts.

.5 Maintenance Service

.1 Include one year's warranty and maintenance from the time of system acceptance and two inspections by the manufacturer during the warranty period.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with the General Specification.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 SCOPE OF WORK

.1 The Security Access Control, Alarm and Intercom Systems throughout the Powerhouse Complex and Project Site shall include:

.1 Door position switches, access card readers, electric and/or magnetic door locking systems on all Powerhouse access doors, including the main overhead service bay access doorway.

.2 Door position switches, access card readers and electric and/or magnetic door locking systems for Powerhouse interior doors accessing areas housing control and communication equipment.

.3 A computer based system for the access card database and operating system.

.4 A powerhouse interior, zone based coverage alarm system complete with intrusion detectors, door and access point switches and glass break detectors, as required to provide complete coverage of the powerhouse interior and including an enable/disable keypad located adjacent to the main personnel access door.

.5 Gate position switches, access card readers and access control keypads on the Keeyask Site main roadway and powerhouse access roadway entrance gates.

.6 An intercom and remote door or gate release system wired between the control room, the main personnel access door to the powerhouse, the Keeyask Site main roadway entrance gate and the powerhouse access roadway entrance gate.

.7 Computer-based alarm system controller.

2.2 DESIGN

.1 The final design requirements and detailed design for the Security Access Control, Alarm, Intercom and Closed Circuit Television (CCTV) Systems are to be determined by the security integrator in coordination with Manitoba Hydro. The security integrator shall be selected by the Contractor from the following list of authorized Genetec dealers:

.1 BIL Security.

.2 Johnson Controls.

.3 Southwest Surveillance Systems.

.2 Reference Codes and Standards

.1 The access control and intrusion detection control system shall be designed, built, and tested according to the laws and regulations of the Province of Manitoba and in accordance with these Specifications and the latest revision of the standards and codes specified herein.

.3 Access Control System

.1 The Contractor, in conjunction with the Security Integrator, shall design, supply, install and commission an access control system that will include:

.1 Access card readers at all personnel access doors into the Powerhouse.

.2 Access card readers and access control keypads at the main roadway access gate to the Site and at the Powerhouse access roadway gate.

.3 Access card readers on the Powerhouse Control Room, Communications Room and UCMS server room doors.

.4 Electric strikes on all doors covered by the access control system.

.5 Computer-based access card and access keypad database and system controller, to be located in the Control Room.

.6 Access control system power sourced from the station UPS system to ensure continued operation on loss of normal AC supply.

.4 Intrusion Detection and Alarm System

.1 The Contractor, in conjunction with the Security Integrator, shall design, supply, install and commission an intrusion detection and alarm system that will include:

.1 PIR-type detection devices to provide ‘zone coverage’ within the Powerhouse.

.2 Opening sensors on all access doors and access points into the Powerhouse.

.3 Sensors on interior doors controlled by card access system.

.4 Glass-break sensors on all Powerhouse exterior windows, second floor and lower.

.5 Interface between intrusion detection system and access control system.

.6 Enable/disable keypad controller for installation adjacent to the main personnel access door.

.7 Intrusion detection system power sourced from the station UPS system to ensure continued operation on loss of normal AC supply.

.5 Intercom System

.1 The Contractor, in conjunction with the Security Integrator, shall provide, as part of the access control system, an access intercom system that will include:

.1 Intercom devices on the main access door and main roadway access gates wired to a compatible device in the Control Room.

.2 Remote door release and gate activation controls located in the Control Room for operator control of the main access door and gates.

2.3 ACCESS CONTROL SYSTEM

.1 Access cards are to be of the Proximity type.

.2 For Site access roadway gates and Powerhouse access roadway gates, combined Proximity-type card readers with incorporated keypad, manufactured by Genetec, are to be provided.

.3 System operating system is to be by Genetec.

.4 Stand alone appliances that can connect at a later date to the security network residing on the station IDN LAN: Genetec SV-PRO.

.5 Door locks are to be electric or magnetic types.

.6 Electronic locking mechanisms, whether electric strike or magnetic locks must have a minimum holding force of 1500lbs.

.7 Fire alarm integration shall allow for fail safe operation, regardless of door locking mechanism.

.8 Network switches shall be manufactured by RuggedCom.

2.4 INTRUSION DETECTION AND ALARM SYSTEM

.1 Zone intrusion detectors are to be PIR type.

.2 Door opening switches are to be mechanical balance magnetic sensor type.

Part 3 Execution

3.1 GENERAL

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.2 Contractor will supply and install an active control system that will maintain all doors in a locked position unless entrance is allowed by an authorised cardholder. Workstations at remote locations will be able to view, control and configure all video and access control systems so installed. The local system must integrate into the Purchaser’s enterprise security system, Genetec Security Centre, by means of connection to the security network terminating in the Communication room, at a later date.

3.2 INSTALLATION

.1 The Contractor shall install all components of the Security Access Control, Alarm and Intercom Systems, including network interconnections, and operators’ work stations in accordance with the approved system design drawings and the manufacturer’s recommendations.

.2 All components of the Security system shall be connected with wiring and cables in accordance with the approved design and the manufacturer’s instructions.

.3 Security system cables will be CAT6 UTP in an overall purple PVC jacket. Conductors shall be solid copper. Cables shall be installed in accordance with Section 26 05 21 Wire and Cable Systems.

.4 Security system wiring shall be installed in Rigid Galvanized Steel (RGS) conduit in all areas other than the Control Building. For the Control Building, Electrical Metallic Tubing (EMT) may be utilized. RGS and EMT conduit shall be installed in accordance with Section 26 05 29 Cable and Wire Support Systems.

.5 For remote facilities, such as the intercom and remote control on the main roadway access gate, it is anticipated that the System Integrator and Contractor's installation design will incorporate the use of fibre optic cable interconnections and copper to fibre convertors at both ends.

.6 The Contractor shall configure and program all programmable components in accordance with the system Design Requirements and provide the Engineer with all software and documentation required to maintain the system.

.7 The Contractor shall inspect and clean each completed component of the Security Access Control, Alarm and Intercom Systems installation and correct any installation deficiencies. The security system components shall be covered, if necessary, protected and kept clean pending completion of all surrounding construction work and the Contractor's equipment testing and commissioning in accordance with these Specifications.

3.3 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Perform tests in accordance with Section 26 05 00 Electrical General Requirements.

.3 Carry out a complete program of equipment inspections, checks and tests, generally in accordance with the manufacturer's recommendations, to confirm the condition of the equipment and verify the correctness of the installation work.

.4 Following successful completion of all equipment tests, the Contractor together with the Security Integrator shall perform all system functional testing in accordance with testing procedures developed by MH Corporate Security Department (Physical Security Coordinator) and the security integrator to demonstrate that the system is fully-functional, meets all stipulated requirements and is available for operation.

.5 Safety: Demonstrate with documentation that the access control system meets the safety requirements specified in UL 294.

.6 Manufacturer's Field Services:

.1 Obtain written reports from manufacturer verifying compliance of Work, in particular the handling, installing, applying, protecting and cleaning of the product and submit the Manufacturer's Field Reports as described in Part 1.

.2 Provide manufacturer's field services for periodic inspections of product installations in accordance with the manufacturer's recommendations.

.3 Schedule Site visits to review Work as directed in Part 1.

3.4 TRAINING

.1 Arrange and pay for on-Site lectures and demonstrations by the security equipment manufacturer to train operational personnel to use and maintain the security system including access control equipment and any other security devices installed by the security integrator.

3.5 CLEANING

.1 Shall be in accordance with the requirements of Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion and verification of system performance, remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall include all labour and Materials necessary to design, manufacture, transport, store, handle, install and test the powerhouse complex and Site video surveillance system as shown on the Purchaser's Drawings, Contractor's Documents as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wire and Cable Systems.

.4 Section 26 05 29 - Cable and Wire Support Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 CSA C22.1 - Canadian Electrical Code, Part I.

.2 Underwriters Laboratories of Canada (ULC):

.1 ULC-S317 - Installation and Classification of Closed Circuit Video Equipment (CCTV) Systems for Institutional and Commercial Security Systems.

.3 Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therin for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any

changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Item 28 23 00 (a) will be based on accepted design deliverables.

.2 Measurement for Item 28 23 00 (b) will be based on the issued for Purchaser's Drawings and revisions determined by the Engineer.
No separate measurement will be made for boxes, conduits, conduit fittings, cables and wires, supports and hardware.

.3 Unit Price

.1 The Estimated Cost proposed for Item 28 23 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the development of design concept with the Purchaser's input, riser diagrams, general arrangement drawing, schematics, connection diagrams and Purchaser's Drawings.

.2 The Estimated Cost proposed for Item 28 23 00 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply, shipment to the Site, storage, Site handling, installation including mounting hardware, raceways and junction boxes as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, commissioning, touch-up painting, and turn over documentation as specified herein and as shown on the Purchaser's Drawings.

.3 The supply and installation of boxes, conduits, conduit fittings, supports and hardware are considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices for Items to which such Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit manufacturer's instructions, printed product literature and data sheets for the video surveillance equipment and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit:

.1 Functional description of equipment.

.2 Technical data sheets for all devices.

.3 Device location plans and cable lists.

.4 Video camera surveillance chart.

.5 Interconnection detail drawings.

.3 Shop Drawings

.1 Submit drawings sealed by a Professional Engineer registered or licensed in the province of Manitoba.

.2 Submit shop drawings indicating camera locations, point-to-point diagrams, cable schematics, risers and mounting details.

.3 Drawings that describe more than one type of Item shall be marked to indicate which Item will be provided.

.4 Submit zone layout drawings indicating number and location of zones and areas covered.

.4 Manufacturer's Instructions

.1 Submit manufacturer's installation instructions.

.5 Closeout Submittals

.1 Submit the following:

.1 Manufacturer's data for all equipment supplied:

.1 Submit original for each Item and clear, legible, first-generation photocopies for remainder of specified copies.

.2 As-built drawings.

.3 Instructions for operation of all devices.

.4 Test Reports.

.5 Programming Software:

.1 Provide programming software, program setup files and documentation.

1.6 QUALITY MANGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 The security system integrator must be an authorized Genetec dealer and have been trained in Security Centre V5.0 and V5.1. The security integrator’s field technicians must be certified Genetec installation technicians.

.2 Submit documentation confirming the above requirements with the bid as well as a list of previous, large scale Genetec installations performed in industrial settings.

.3 Provide services of a manufacturer’s representative or technician, experienced in the installation and operation of the type of system being provided to supervise the installation, adjustment, preliminary testing, and final testing of the system and to provide instruction to project personnel.

.4 Spares

.1 Submit a list of recommended spare parts.

.5 Maintenance Service

.1 Include 1 year's warranty and maintenance from the time of system acceptance and two inspections by the manufacturer during the Warranty Period.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries and to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading

.1 Deliver, store and handle Materials in accordance with manufacturer's written instructions.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 The Video Surveillance (CCTV) Systems throughout the Powerhouse Complex and Site shall include:

.1 CCTV cameras shall be positioned to allow viewing of all powerhouse access doors, including the main overhead service bay access doorway.

.2 CCTV cameras at the Keeyask Site main roadway entrance gate.

.3 CCTV cameras at the Keeyask powerhouse access roadway entrance gate.

.4 Exterior CCTV cameras shall be positioned to allow scanning of the powerhouse exterior, parking lot, access roadways, intake, service bay, north, central and south dams, and spillway deck areas at elevation 162.5 m.

.5 CCTV camera controller and video management and recording system.

.2 The Contractor, through the use of an approved security integrator, shall be responsible for the following Work with respect to the Video Surveillance Systems.

.1 Design, supply, manufacture, quality control, factory assembly and testing, delivery and covered, heated storage at Site of:

.1 Requisite quantity and type of CCTV cameras, camera controllers and video management and recording system.

.2 Provision of installation instructions and drawings.

.3 Installation and connection of all CCTV cameras and controllers and associated components.

.4 Provision of a complete set of final, as-approved, design drawings and documents, including outline and assembly drawings, and wiring, interconnection, logic, and schematic diagrams.

.5 Provision of all Site equipment test and commissioning procedures necessary to carry out Site equipment testing and commissioning in accordance with this Section of the Technical Specification.

.6 Compilation and provision of operation and maintenance manuals including all factory test reports.

.7 Supply of two sets of special maintenance tools and materials, if applicable.

.8 Provision of a priced list of recommended spare parts.

.9 Provision of the specified equipment warranty.

2.2 DESIGN

.1 The final design requirements and detailed design for the Video Surveillance (CCTV) Systems are to be determined by the security integrator in coordination with the

Purchaser. The security integrator shall be selected by the Contractor from the following list of authorized Genetec dealers:

.1 BIL Security.

.2 Johnson Controls.

.3 Southwest Surveillance Systems.

.2 Reference Codes and Standards

.1 The video surveillance system shall be designed, built, and tested in accordance with the Laws of the Province of Manitoba, this Section of the Technical Specification, and the latest edition of the standards and codes specified herein in effect at the time this aspect of the Work is performed.

.3 CCTV System

.1 The Contractor, in conjunction with the security integrator, shall design, supply, install and commission a video surveillance system that will include:

.1 Exterior fixed cameras above all access doors.

.2 Exterior fixed cameras on intercom units.

.3 Exterior Pan, Tilt, Zoom (PTZ) cameras on powerhouse/intake, service bay, north, central and south dams and spillway deck level.

.4 Exterior PTZ cameras at the main roadway access gate, access roads and parking lot as required.

.5 Interior and exterior cameras at the service bay overhead doorway.

.6 Interior cameras at all access doors covered by the access control system.

.7 Interior cameras as required for operating areas of the powerhouse and service bay.

.8 Video management and recording facilities and interface to communications system for transmission of alarm events to remote locations to be located in the communications room.

.9 System workstation, camera controller and monitor to be located in the control Room.

.10 CCTV system power sourced from the station UPS system to ensure continued operation on loss of normal AC supply.

2.3 CCTV SYSTEM EQUIPMENT

.1 CCTV system equipment is to be by AXIS.

.2 Interior CCTV cameras are to be AXIS P3343V or latest model as of the time this aspect of the Work is performed.

.3 Exterior CCTV cameras are to be AXIS Q6034E or latest model as of the time this aspect of the Work is performed.

.4 Stand alone appliances that can connect at a later date to the security network residing on the station IDN LAN: Genetec SV-PRO.

.5 Network switches shall be manufactured by RuggedCom.

.6 Video management and recording system is to be Genetec Security Centre.

.7 Heaters shall be provided as required for exterior cameras.

2.4 CAMERA POWER SUPPLIES

.1 Provide custom designed 24 Vac power supplies located inside each camera equipment cabinet for all cameras. Power supply inputs and outputs shall be fused.

2.5 JUNCTION BOXES

.1 Metal, sized to handle all system conduit interconnections with appropriate expansion.

Part 3 Execution

3.1 GENERAL

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.2 Contractor will supply and install the specified end connected security devices in the correct manner to allow for the live viewing of video images and the playback of recorded images. Workstations at remote locations will be able to view, control and configure all video and access control systems so installed. The local system must integrate into the Purchaser’s enterprise security system, Genetec Security Centre, by means of connection to the security network terminating in the communication room, at a later date.

3.2 INSTALLATION

.1 The Contractor shall install all components of the video surveillance system, including network interconnections and operators’ workstations in accordance with the approved Contractor’s Documents and the manufacturer’s recommendations. Install components securely, properly aligned and in the locations shown on the approved shop drawings.

.2 Install video surveillance equipment and components in accordance with ULC-S317.

.3 All components of the video surveillance system shall be connected with wiring and cables in accordance with the approved design and the manufacturer’s instructions.

.4 Video Surveillance system cables will be CAT6 UTP in an overall purple PVC jacket. Conductors shall be solid copper. Cables shall be installed in accordance with Section 26 05 21 Wire and Cable Systems.

.5 Video Surveillance system wiring shall be installed in Rigid Galavanized Steel (RGS) conduit in all areas other than the control building. For the control building Electrical Metallic Tubing (EMT) may be utilized. RGS and EMT conduit shall be installed in accordance with Section 26 05 29 Cable and Wire Support Systems.

.6 Due to the distance of the runs, remote facilities, such as the spillway, dams and roadway access gate, the system integrator’s and Contractor’s installation design shall incorporate the use of fibre optic cable interconnections and copper to fibre convertors at both ends.

.7 The Contractor shall configure and program all programmable components in accordance with the system design requirements and the approved design and provide the Engineer with all software and documentation required to maintain the system.

.8 The Contractor shall inspect and clean each completed component of the video surveillance system installation and correct any installation deficiencies. The system components shall be covered, if necessary, protected and kept clean pending completion

of all surrounding construction Work and the Contractor's equipment testing and commissioning in accordance with this Section of the Technical Specification.

3.3 ADJUSTING

.1 Remove protective coverings from cameras and components.

.2 Adjust cameras for correct function.

3.4 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Site Tests

.1 Perform tests in accordance with Section 26 05 00 Electrical General Requirements.

.2 Coordinate testing with the Engineer.

.3 Visual inspection to include:

.1 Sturdiness of equipment fastening.

.2 Non-existence of installation related damages.

.3 Compliance of device locations with approved shop drawings.

.4 Compatibility of equipment installation with physical environment.

.5 Inclusion of all accessories.

.6 Device and cable identification.

.4 Technical verification to include:

.1 Measurements of tension and power.

.2 Connecting joints and equipment fastening.

.3 Measurements of signals (dB loss, lux, baud rate, etc.).

.4 Compliance with the manufacturer's specifications, product literature and installation instructions.

.5 Operational verification to include:

.1 Confirmation of fields of view.

.2 Operation of each device individually and within its environment.

.3 Operation of each device in relation to its programmable schedule and or/specific functionality.

.4 Operational control of camera pan, tilt and zoom.

.5 Switching of cameras to any monitor.

.6 Switching of system video recorder to selective monitoring.

.7 Confirmation of "mapping" ability. The facility floor plan will be programmed into Genetec Security Centre in such a manner that a floor plan will "map" out the location of each camera and related access device and any other security equipment. Operation shall be confirmed by the user clicking the link on this map, and being taken to that device.

.8 Demonstrate

.1 Sequence viewing of cameras on each monitor.

.2 Bypass capability.

.3 Display of stored images.

.9 Following successful completion of all equipment tests, perform, in conjunction with the system integrator, system functional testing in accordance with testing procedures developed by Manitoba Hydro Corporate Security Department (Physical Security Coordinator) and the security integrator to demonstrate that the system is fully-functional, meets all stipulated requirements and is available for operation.

.6 Manufacturer's Field Services

.1 Obtain written reports from manufacturer verifying compliance of Work, in particular the handling, installing, applying, protecting and cleaning of the product and submit the manufacturer's field reports as described in Part 1 of this Section of the Technical Specification.

.2 Provide manufacturer's field services for periodic inspections of product installations in accordance with the manufacturer's recommendations.

.3 Schedule Site visits to review this aspect of the Work as directed in Part 1 of this Section of the Technical Specification.

3.5 TRAINING

.1 Arrange and pay for on-Site lectures and demonstrations by the video surveillance equipment manufacturer to train operational personnel to use and maintain the video surveillance system.

3.6 CLEANING

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification

.2 Perform Site clean-up in accordance with Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.3 Upon completion and verification of system performance, remove surplus Materials, rubbish, Tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall include all labour and Materials necessary to design, manufacture, transport, store, handle, install and test the Powerhouse Complex and Project Site Fire Detection and Alarm Systems as shown on the Purchaser's Drawings, Contractor's Specification and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 21 13 00 - Fire Suppression Sprinkler System.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 26 05 21 - Wire and Cable Systems.

.5 Section 26 05 29 - Cable and Wire Support Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, the Work shall be performed in accordance with:

- .1 Manitoba Hydro
  - .1 Manitoba Hydro Fire Manual.
- .2 Province of Manitoba
  - .1 Manitoba Building Code.
  - .2 Manitoba Fire Code.
- .3 Underwriters Laboratories of Canada (ULC)
  - .1 CAN/ULC-S524 - Installation of Fire Alarm Systems.
  - .2 CAN/ULC-S525 - Audible Signal Devices for Fire Alarm Systems.
  - .3 CAN/ULC-S526 - Visual Signal Appliances for Fire Alarm Systems.
  - .4 CAN/ULC-S527 - Control Units for Fire Alarm Systems.
  - .5 CAN/ULC-S528 - Manual Pull Stations for Fire Alarm Systems.
  - .6 CAN/ULC-S529 - Smoke Detectors for Fire Alarm Systems.
  - .7 CAN/ULC-S530 - Heat Actuated Fire Detectors for Fire Alarm Systems.
  - .8 CAN/ULC-S531 – Smoke Alarms.
  - .9 CAN/ULC-S536 - Inspection and Testing of Fire Alarm Systems.
  - .10 CAN/ULC-S537 - Verification of Fire Alarm Systems.

.4 Canadian Standards Agency (CSA)

.1 CSA C22.1 - Canadian Electrical Code, Part I.

.2 C22.2 No. 208 - Fire Alarm and Signal Cable.

.5 National Fire Protection Agency

.1 NFPA 72 - National Fire Alarm and Signalling Code.

.2 NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

.6 Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurements

.1 Measurement for Item 28 31 00 (a) will be based on accepted design deliverables.

.2 Measurement for Item 28 31 00 (b) will be based on the Purchaser's Drawings and revisions determined by the Engineer.

.3 No separate measurement shall be made for boxes, conduits, conduit fittings, cables and wires, supports and hardware.

.3 Unit Price

.1 The Estimated Cost proposed for Item 28 31 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the development of design concept with the Purchaser's inputs, riser diagrams, general arrangement drawings, schematics, connection diagrams and bills of material drawings as shown on the Purchaser's Drawings.

.2 The Estimated Cost proposed for Item 28 31 00 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be used for the supply, shipment to the Site, storage, Site handling, installation including mounting hardware, raceways and junction boxes as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, commissioning, touch-up painting, and turn over documentation, as specified herein and as shown on the Purchaser's Drawings

.3 The supply and installation of boxes, conduits, conduit fittings, supports and hardware are considered incidental to the Work. Include costs for such Work in the unit prices for Items to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit manufacturer's instructions, printed product literature, specifications and datasheets in accordance with the General Specification.

.3 Shop Drawings

.1 Submit shop drawings in accordance with the General Specification.

.1 Shop drawings shall be sealed by a Professional Engineer registered or licensed in the Province of Manitoba.

.2 Include:

.1 Zone layout drawings and riser diagrams and provide locations of the equipment within each zone.

.2 Complete wiring diagrams, including schematics of modules.

.3 Data sheets mark data sheets that describe more than one type of Item to indicate which type will be provided.

.4 Bill of material drawings.

.4 Quality assurance submittals

.1 Certificates: submit certificates signed by manufacturer certifying that materials comply with specified performance characteristics and physical properties.

.2 Instructions: submit manufacturer's installation instructions.

.3 Manufacturers' Field Reports: Submit manufacturers' field reports verifying the installation of equipment and systems.

.5 Closeout Submittals

.1 Submit to Engineer four sets of reviewed submittals and drawings immediately after acceptance but no later than 15 working days to prior to final inspection.

.2 Submit the following

.1 Manufacturer's Data for all equipment supplied

.1 Submit original for each Item and clear, legible, first-generation photocopies for remainder of specified copies.

.2 Design data: Power Calculations:

.1 Submit design calculations to substantiate that battery capacity exceeds supervisory and alarm power requirements.

.2 Show comparison of detector power requirements per zone versus control panel smoke detector power output per zone in both standby and alarm modes.

.3 Show comparison of notification appliance circuit alarm power requirements with rated circuit power output.

.3 As-built drawings.

.4 Instructions for operation of all devices.

.5 Test Reports

.1 Preliminary testing.

.2 Final acceptance testing.

.3 Submit for inspections and tests specified under Field Quality Control.

.6 Programming Software

.1 Provide programming software, program setup files and documentation.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 Installer: company specializing in fire alarm system installations approved by the manufacturer.

.3 Provide services of representative or technician from manufacturer of the system, experienced in the installation and operation of type of system being provided, to supervise installation, adjustment, preliminary testing, and final testing and to provide system certification and instruction to Project personnel.

.4 Spares

.1 Submit a list of recommended spare parts.

.2 Include:

.1 20 spare glass rods for manual pull box stations.

.5 Maintenance Service

.1 Include one year's warranty and maintenance from the time of system acceptance with two inspections by the manufacturer during the Warranty Period. Inspection tests to conform to CAN/ULC-S536. Submit inspection reports to Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading

.1 Deliver, store and handle in accordance with the General Specification.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with the requirements of Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 SCOPE

.1 The Fire Detection and Alarm System shall be a supervised, multi-zone coded system that includes a network of detectors, pull stations and audible signalling devices located throughout the Powerhouse Complex. The system shall provide timely detection of fire conditions, activate and monitor protection systems where applicable, communicate with the HVAC and smoke management system controls, provide interface for relay of alarms to remote locations, sound alarms throughout the Powerhouse Complex and indicate incident location for protection of life and reduction of property damage and be capable of supporting pre-action deluge and agent release including sprinkler supervision.

.2 The fire detection and alarm system will be completely independent of the Access Control and Intrusion Detection System specified in Section 28 13 00 Access Control & Intrusion Detection of these Specifications.

.3 The fire detection systems for each generator will include deluge system activation and valve status indication. Coordination of review, for compliance with the turbine, generator and associated controls requirements, will be done during the Engineer's Review.

.4 The Contractor, through the use of an approved fire alarm system installation contractor, shall be responsible for the following work under these Specifications in respect of the Fire Detection and Alarm System.

.1 Design, supply, manufacture, quality control, factory assembly and testing, preparation for shipping, delivery and covered, heated storage at Site of:

.1 One master fire alarm control panel complete with external colour laser printer.

.2 One remote fire alarm annunciator panel.

.3 Local fire alarm control panels as required to service all generator and transformer deluge systems and any foam and pre-action systems within the powerhouse and on the Site.

.4 Requisite quantity and type of smoke and/or heat detectors to provide adequate coverage for all specified areas.

.5 Requisite quantity and type of alarm annunciation devices to provide adequate coverage for all specified areas.

.6 Requisite quantity and type of output relay and input contact monitoring devices to interface the fire alarm control panel with specified Powerhouse equipment and systems and to monitor the status of fire protection system operations.

.7 Provide installation instructions and drawings.

.8 Install and connect all equipment supplied for the fire detection and alarm system.

.9 Provide complete set of final, as-approved, design drawings and documents, including outline and assembly drawings, and wiring, interconnection, logic, and schematic diagrams.

.10 Provide Site equipment test procedures and carry out Site equipment testing in accordance with the Specifications, and CAN/ULC-S536.

.11 Provide Site commissioning procedures.

.12 Perform system verification in accordance with CAN/ULC-S537.

.13 Compile and provide operation and maintenance manuals including all factory test reports.

.14 Supply two sets of maintenance tools and materials.

.15 Provide a priced list of recommended spare parts.

.16 Provide the specified equipment warranty.

2.2 DESIGN

.1 The final design requirements and detailed design for the Fire Detection and Alarm System are to be determined by the fire alarm system supply and installation contractor selected by the Contractor. The fire alarm system integrator shall be experienced in and qualified for the implementation of a fire detection and alarm system utilizing the specified Firefinder® XLS system from Siemens.

.1 Reference Codes and Standards:

.1 The fire detection and alarm system shall be designed, built, and tested according to the laws and regulations of the Province of Manitoba and in accordance with these Specifications and the latest revision of the standards and codes specified herein.

.2 General:

.1 The Contractor, in conjunction with the Fire Alarm System supply and installation contractor, shall design and supply a fire detection and alarm system that will be connected to a network of addressable smoke and heat detectors, tamper switches, system activation sensors, and signal devices. The fire and alarm system functions shall be designed to provide control and monitoring of individually addressable fire and alarm devices, to control related fire suppression systems, to interface with the HVAC and smoke management system for smoke control and fan system override, and to provide visual and audible alarm signals.

.2 The system shall be designed to supervise all circuits and provide local and remote trouble alarms for all abnormal conditions.

.3 26 discrete detection zones are expected within the Powerhouse and Service Bay.

.3 Fire Alarm Control Panel:

.1 The Contractor, in conjunction with the fire alarm supply and installation contractor, shall provide a central Fire Alarm Control Panel to be installed in the control room that will include a microprocessor based advanced life safety system which, upon receipt of a signal from a fire detector, shall sound the audible alarms, indicate the location of the activated detector, activate respective fire protection systems where appropriate, start or stop related HVAC and smoke management systems through interfaces with the HVAC control system and provide alarm indication to a remote location.

.2 The system shall have the ability to utilize both addressable analog and conventional detection devices.

.3 The CPU shall communicate with and control intelligent detectors, addressable modules, annunciators, printers, and other associated system controlled devices.

.4 The central Fire Alarm Control Panel shall include the following functions and features.

.1 Monitoring of all detector, alarm, indication and control circuits.

.2 Monitoring of all deluge and fire suppression release panels

.3 Mapping and integration of all point-by-point alarms from all deluge and fire suppression release panels.

.4 Local and remote indication and annunciation of the location of any fire condition and/or activation of any control or fire protection device or system.

.5 Local and remote alarm indication of any system or device trouble.

.6 Operator controlled isolation or sensitivity adjustment of specific detector(s) to allow welding or other maintenance activities to proceed.

.7 Maintenance of historical data and provision of trending information and reports.

.8 Monitoring of equipment maintenance requirements.

.5 As per Section 21 13 00 Fire Suppression Sprinkler System, the central Fire Alarm Control Panel shall provide control initiation inputs for fire suppression release panels. The Fire Alarm Control Panel shall also monitor inputs from manual fire alarm pull stations, sprinkler and deluge system pressure switches, valve operation switches, water flow detector switches and fire suppression release panels.

.4 Fire Detectors:

.1 The Contractor, in conjunction with the Fire Alarm System supply and installation contractor, shall design a network of detectors which will effectively sense any fire condition in the specified areas and defined rooms of the powerhouse. The detection network shall generally provide coverage throughout the intake, spillway and service bay, and powerhouse above elevation 152.0 m.

.2 The detection network shall sense any fire condition and provide location indication for the following areas protected by wet-pipe sprinkler systems as per Section 21 13 00 Fire Suppression Sprinkler System of these Specifications.

.1 Pump Room.

.2 Diesel Fire Pump Room.

.3 Compressor Room.

.4 Governor Equipment Areas.

.5 Stores Areas.

.6 Cable Trays.

.7 Standby Diesel Generator Rooms.

.3 The detection network shall sense any fire condition, provide location indication and initiate fire protection control actions for the following areas protected by double interlock pre-action sprinkler systems as per Section 21 13 00 Fire Suppression Sprinkler System of these Specifications.

.1 Electrical equipment rooms including:

.1 Service Bay Electrical Room.

.2 Control Room.

.3 Communications and UCMS Rooms.

.4 Spillway MCC Area.

.5 Spillway Hoist Housing.

.6 Intake Hoist Housing.

.4 The detection network shall sense any fire condition, provide fire location indication and initiate protective control actions for the following areas protected by dry deluge systems as per Section 21 13 00 Fire Suppression Sprinkler System of these Specifications.

.1 Generator Enclosure, in particular, the upper and lower windings areas.

.2 Powerhouse downstream wall water curtain and Generator Step-up Transformers for Units 1 through 7.

.3 Oil Room.

.5 The Contractor shall be responsible for determining the type of detection required for each location, based on the specific fire hazards and ambient conditions expected at the installed locations, the quantity of detectors required to provide complete coverage and the detector installation locations to ensure effective sensing.

.5 Alarm Annunciators:

.1 The Contractor, in conjunction with the Fire Alarm System supply and installation contractor, shall design and supply a network of electric vibrating bells, strobes, and horns/loudspeakers initiated from the central fire alarm control panel and to be located throughout the interior and exterior of the Powerhouse Complex and Spillway, including the Powerhouse Complex roof, at strategic locations sufficient to provide warning anywhere in the vicinity of the detection of a fire condition.

.2 The Contractor shall be responsible for determining the type of alarm annunciation device required for each location, based on the ambient conditions expected at the installed location, and the quantity and locations as required to provide complete coverage.

.6 Fire Alarm Interface Panel:

.1 The Contractor, in conjunction with the Fire Alarm System supply and installation contractor, shall design and supply a Fire Alarm Interface Panel to be installed inside the Powerhouse, adjacent to the principal personnel access door to provide point by point indication of the location of any detected fire condition and/or operation of any fire suppression devices and/or systems.

.7 Fire Detection and Alarm System Design:

.1 The Contractor, in conjunction with the Fire Alarm System supply and installation contractor, shall submit the proposed Fire Detection and Alarm System design complete with proposed device model numbers, manufacturer's data, design calculations and data and layout arrangements of all components for approval by the Engineer before proceeding with supply and installation.

2.3 FIRE ALARM CONTROL PANEL

.1 The Fire Alarm Control Panel and associated deluge control panels shall be Firefinder® XLS series intelligent fire alarm control panel by Siemens.

.2 The fire alarm control panel shall be complete with minimum 12 hour capacity battery power supply and separate colour laser report printer.

2.4 DETECTORS AND INTELLIGENT DEVICES

.1 The detectors shall include both conventional and addressable thermal detectors, smoke detectors, air duct housing detectors and multi-detectors, compatible with the Firefinder® XLS system, from Siemens or Purchaser's approved equivalent.

.2 The addressable manual pull stations shall be model HMS-2S devices from Siemens or Purchaser's approved equivalent.

.3 Intelligent detectors shall be HFP-11 devices from Siemens.

.4 The output control relays shall be model CRC-6 Firefinder® XLS series devices.

.5 The input contact monitor devices shall include model SIM-16 or similar Firefinder® XLS series devices, all from Siemens or Purchaser's approved equivalent.

2.5 ALARM DEVICES

.1 The alarm annunciation devices shall be Siemens Notification Appliances - alarm motor bells, horns and strobes or Purchaser's approved equivalent.

2.6 FIRE ALARM INTERFACE PANEL

.1 The Fire Alarm Interface Panel shall include a model SSD system status display for the Firefinder® XLS system from Siemens.

2.7 POWER SUPPLY

.1 120 Vac, 60 Hz input, 24 Vdc output from rectifier to operate alarm and signal circuits with standby power from gell cell batteries, 12 hour capacity, minimum expected life of 4 years, sized in accordance with the NBC.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations and specifications including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 The Contractor shall install all components of the fire detection and alarm system in accordance with ULC CAN/ULC-S524, Installation of Fire Alarm Systems.

.2 The detectors shall be located and installed in accordance with the approved design and these specifications. Detectors shall not be mounted within 1 m of sprinkler nozzle/head or air outlets and a clear space radius of at least 600 mm shall be maintained around and below ceiling-mounted detectors. Duct-type detectors shall be mounted in straight sections of duct.

.3 The manual pull stations shall be located and installed in accordance with the approved design and these Specifications. Manual pull stations shall be provided at all points of personnel access or egress to the powerhouse and adjacent to major equipment areas or rooms within the powerhouse.

.4 The alarm annunciation devices shall be located and installed in accordance with the approved design and these Specifications throughout the Powerhouse Complex. Outdoor-rated alarm annunciation devices shall be located and installed around the exterior of the powerhouse adjacent to all points of access. Strobe-equipped alarm annunciation devices shall be located and installed in all areas of the powerhouse subject to high levels of equipment operating noise, such as adjacent to the generating units.

.5 Contact monitoring and output relay devices shall be located, installed and connected to specified equipment and systems in accordance with the approved design and these Specifications.

.6 The central Fire Alarm Control panel shall be installed in the main Control Room in accordance with the approved design and these Specifications, for ease of access by operators. The fire alarm interface panel shall be located and installed on the inside wall of the powerhouse, adjacent to the main personnel access door in accordance with the approved design and these Specifications. Deluge control panels and other suppression system release panels shall be located and installed in consultation with the Manitoba Hydro Fire Protection Engineer or delegate.

.7 All components of the fire detection and alarm system shall be connected with wiring and cables in accordance with the approved design and the manufacturer's instructions.

.8 The detectors, manual pull stations, contact monitoring and output relay devices shall be connected to the fire alarm and control panel by signalling line circuits of minimum No. 18 AWG 2-wire shielded twisted pair cables for Style 7 (Class A) or Style 4 (Class B) circuits. Alarm notification devices shall be connected to the fire alarm and control panel by notification circuits of minimum No. 14 AWG 2-wire shielded twisted pair cables for Style 7 (Class A) or Style 4 (Class B) circuits. The fire alarm interface panel shall be connected to the fire alarm and control panel by a 2-wire, shielded twisted pair Style 4 (Class B) communications circuit.

.9 Fire alarm system cables will be unshielded twisted pairs in an overall PVC jacket, consisting of two solid copper conductors. Cable fillers, where they exist, will be made of non-hygroscopic material. The cable will have a red outer PVC jacket and will have an FT-4 flame spread rating. The cables will be CSA certified to standard C22.2 No. 208 - Fire Alarm and Signal Cable - CSA FAS. Cables shall be installed in accordance with Section 26 05 21 Wire and Cable Systems.

.10 Fire alarm cable systems will be installed in Rigid Galavanized Steel (RGS) conduit in all areas other than the Control Building. For the Control Building Electrical Metallic Tubing (EMT) may be utilized. RGS and EMT conduits shall be installed in accordance with Section 26 05 29 Cable and Wire Support Systems.

.11 The Contractor shall configure all programmable components within the Fire Detection and Alarm System in accordance with the specified system Design Requirements and the approved system design and provide the Engineer with all required software and documentation.

.12 The Contractor shall inspect and clean the completed Fire Detection and Alarm System installation, correct any installation deficiencies and touch-up any minor scratches or surface damage on component panel surfaces with appropriate paint. The completed

installation shall be covered, protected and kept clean pending completion of all surrounding construction work and the start of equipment testing and commissioning.

3.3 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Site Tests

.1 Perform tests in accordance with Section 26 13 00 Fire Suppression Sprinkler System.

.2 Coordinate testing with the Engineer.

.3 Together with the Fire Detection System supply and installation contractor, carry out a complete program of equipment inspections, checks and tests, generally in accordance with the manufacturer's recommendations and NFPA-72 and CAN/ULC-S536 and CAN/ULC-S537 to confirm the condition of the system components and verify the correctness of the installation Work.

.4 Fire alarm system testing and verification shall include, but not be limited to:

.1 Test each device and alarm circuit to ensure manual stations, detectors, and sprinkler systems transmit alarms to the control panel and ensure control panel actuates alarm devices and control relays.

.2 Check annunciator panels to ensure zones are shown correctly.

.3 Simulate grounds and breaks on alarm and signalling circuits to ensure proper system operation.

.4 Class A circuits:

.1 Test each circuit conductor for capability of providing an alarm signal on each side of a single open circuit fault condition imposed near the midpoint of the circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.2 Test each circuit conductor for capability of providing alarm signal during a ground fault condition imposed near midpoint of the circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.5 Class B circuits:

.1 Test each circuit conductor for capability of providing an alarm signal on line side of a single open circuit fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.2 Test each circuit conductor for capability of providing alarm signal during a ground fault condition imposed at electrically most remote device on circuit. Reset control unit after each alarm function and correct imposed fault after completion of each test.

.5 Following successful completion of all equipment tests, perform, in conjunction with the System Integrator, system commissioning tests in accordance with NFPA-72, Manitoba Hydro's Fire Protection Engineer and the Authority having jurisdiction - typically Manitoba Hydro's Fire Marshall - to demonstrate that the

system is fully-functional, meets all stipulated requirements and is available for entry into commercial operation.

.6 Final completion of the fire detection and alarm system commissioning will be dependent on the commissioning and entry into operation of the dc station service system and the Purchaser’s communication system.

.3 Manufacturer's Field Services

.1 Obtain a written report from the manufacturer verifying compliance of Work, in particular the handling, installing, applying, protecting and cleaning of the product and submit Manufacturer's Field Reports as described in Part 1.

.2 Provide manufacturer's field services for periodic inspections of product installations in accordance with the manufacturer's recommendations.

.3 Schedule Site visits to review Work as directed in Part 1.

3.4 TRAINING

.1 Arrange and pay for on-Site lectures and demonstrations by fire alarm equipment manufacturer to train operational personnel in use and maintenance of fire alarm system.

3.5 CLEANING

.1 Shall be in accordance with the requirements of Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Perform Site clean-up in accordance with the General Specification.

.3 Upon completion and verification of system performance, remove surplus materials, rubbish, tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall include all labour and Materials necessary to design, manufacture, transport, store, handle, install and test the spillway warning system as shown on the Purchaser's Drawings, Contractor's Documents, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wire and Cable Systems.

.4 Section 26 05 29 - Cable and Wire Support Systems.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 CSA C22.1 Canadian Electrical Code Part 1.

.2 Purchaser's Drawings.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurements

.1 Measurement for Item 28 31 00 (a) will be based on accepted design deliverables.

.2 Measurement for Items 28 31 00 (b) will be based on the issued for construction drawings and revisions determined by the Engineer.

.3 No separate measurement will be made for boxes, conduits, conduit fittings, wires and cables, supports and hardware.

.3 Unit Price

.1 The Estimated Cost for Item 28 31 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the development of design concept with the Purchaser's inputs, riser diagram, general arrangement drawing schematics, connection diagrams and bills of material drawings.

.2 The Estimated Cost for Item 28 31 00 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the supply, shipment to the Site, storage, Site handling, installation including mounting hardware and raceways and junction boxes as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, commissioning, touch-up painting, and turn over documentation, as specified herein and as shown on the Purchaser's Drawings.

.3 The supply and installation of boxes, conduits, conduit fittings, supports and hardware are considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices proposed for Items to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Product Data

.1 Submit manufacturer's instructions, printed product literature and data sheets and include product characteristics, performance criteria, physical size, finish and limitations.

.2 Submit:

.1 Functional description of equipment.

.2 Technical data sheets for all devices.

.3 Device location plans and cable lists.

.3 Shop Drawings

.1 Submit drawings sealed by a Professional Engineer registered or licensed in the Province of Manitoba.

.2 Submit shop drawings to indicate project layouts, siren locations, wiring diagrams, cable schematics, and mounting details.

.3 Data sheets mark data that describes more than one type of Item to indicate which type will be provided.

.4 Manufacturer's Instructions

.1 Submit manufacturer's installation instructions.

.5 Closeout Submittals

.1 Submit the following:

.1 Manufacturer's data for all equipment supplied:

.1 Submit original for each Item and clear, legible, first-generation photocopies for remainder of specified copies.

.2 As-built drawings.

.3 Instructions for operation of all devices.

.4 All shop and field test reports.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 The Contractor shall use a company or person specializing in outdoor emergency warning system installations approved by the manufacturer.

.3 Provide services of a manufacturer’s representative, experienced in the installation and operation of the type of system being provided to supervise the installation, adjustment, preliminary testing, and final testing of the system and to provide instruction to project personnel.

.4 Spares

.1 Submit a list of recommended spare parts.

.5 Maintenance Service

.1 Include one year's warranty and maintenance from the time of system acceptance and two inspections by the manufacturer during the Warranty Period.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading:

.1 Deliver, store and handle in accordance with Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Deliver, store and handle materials in accordance with manufacturer's written instructions.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 SCOPE

.1 The spillway warning system shall be based on a system of siren warning devices mounted in critical locations, to forewarn operating personnel and the general public of the imminent opening of any of the seven spillway gates and ensuing discharge of water into the spillway channel. The system will be initiated by signals from the spillway gate

manufacturer's hoist controls and will include, as a minimum, audible sirens at the following locations.

.1 Mounted on the spillway hoist structure.

.2 Mounted on the exterior powerhouse structure at the entrance to the service bay.

.3 Pole-mounted in the proximity of the upstream boat launch.

.4 Pole-mounted in the proximity of the downstream boat launch.

.2 The Contractor shall be responsible for the following Work under this Section of the Technical Specification in respect to the spillway warning system.

.1 Design, supply, manufacture, quality control, factory assembly and testing, delivery and covered, heated storage at Site of:

.1 The required quantity of warning sirens, with accessories and mounting hardware (poles, brackets, etc.).

.2 Provision of installation instructions and drawings.

.3 Installation and connection of the siren(s).

.4 Provision of a complete set of final, as-approved, design drawings and documents, including outline and assembly drawings, and wiring, interconnection, and schematic diagrams.

.5 Verification of sound pressure levels at the spillway, powerhouse and boat launch locations.

.6 Provision of Site equipment testing and commissioning procedures and carrying out Site equipment testing and commissioning in accordance with the Technical Specification.

.7 Compilation and provision of operation and maintenance manuals, including all factory test reports.

.8 Supply of two sets of special maintenance Tools and Materials, if applicable.

.9 Provision of a priced list of recommended spare parts.

.10 Provision of the specified equipment warranty.

2.2 DESIGN

.1 The Contractor shall be responsible for the final location of the spillway warning system sirens, including determining the optimum physical locations and altitudes and rating of the sirens to provide acceptable levels of warning at the powerhouse and at all points immediately upstream and downstream of the spillway, up to and including the boat launch sites.

.2 The system will interface with the spillway gate control system, which is implemented in the spillway Programmable Logic Controller (PLC) that is located in the spillway electrical room at the north transition, to obtain the horn control signals for each of the seven gates.

.3 The warning system shall provide a sound pressure level of 70 dB at the boat launch areas. The siren shall provide a varying pitch sound.

.4 The sirens will be mounted so that the sound pressure level on the spillway road deck does not exceed 123 dB during operation.

.5 The sirens shall have a lockable isolating switch for maintenance which shall positively prevent energization of the siren.

.6 The sirens will sound when triggered by a contact closure from the raise control circuit of any one of the seven spillway gates.

.7 Where a siren relies on batteries for power, the battery enclosure shall include heating to maintain battery temperature.

2.3 EQUIPMENT

.1 The siren horns shall be Federal Signal Model 2001 with required dB output or Purchaser's approved equivalent.

2.4 POWER SUPPLIES

.1 Provide AC transformers and DC rectifiers for 120 Vac operation. Power supplies to be located inside NEMA 3R equipment cabinet and fused at each input and output.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Compliance: comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.2 INSTALLATION

.1 The Contractor shall locate, install and secure the spillway warning system sirens in accordance with the Contractor's design drawings, the manufacturer's instructions and these Specifications.

.2 The Contractor shall install and terminate LV power cable connections and control cables in accordance with Section 26 05 21 Wire and Cable Systems.

.3 The Contractor shall install and terminate grounding and bonding connections in accordance with Section 26 05 28 Surface Grounding.

.4 The Contractor shall inspect and clean the completed siren installations, correct any installation deficiencies and touch-up any minor scratches or surface enclosure damage with appropriate paint. The completed siren installations shall be covered, if necessary, protected and kept clean pending completion of all surrounding construction Work and the start of equipment testing and commissioning.

3.3 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Site Tests

.1 Perform tests in accordance with Section 26 05 00 Electrical General Requirements.

.1 Coordinate testing with the Engineer.

.2 Provide Site equipment test and commissioning procedures and carry out Site equipment testing and commissioning in accordance with the Specifications.

.3 Test to include:

.1 Verification of sound pressure level at the boat launches and spillway road deck.

3.4 CLEANING

.1 Shall be in accordance with the requirements set out in Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion and verification of system performance, remove surplus Materials, rubbish, Tools and equipment.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary for clearing, and/or grubbing, and/or stripping the Site structures and associated excavations, dykes, permanent roads, permanent surface drainage works, stockpile areas, access roads, the areas of the cofferdams which are accessible prior to fill placement, and the limits shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein.

.2 The Work shall include the clearing, grubbing, and/or stripping of only the areas defined above not already cleared, grubbed, and/or stripped by the Engineer, or others.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification set out below.

1.3 SECTION 31 23 16 - UNCLASSIFIED EXCAVATION REFERENCES

.1 All activities associated with construction will be conducted in accordance with accepted practices outlined in the following documents.

.1 Environmental Protection Plan (EPP).

1.4 MERCHANTABLE TIMBER

.1 The Engineer will be responsible for any direct negotiation with Manitoba Conservation for relevant forestry charges.

.2 Merchantable timber may be retained and used on Site by the Contractor provided that no expense in connection therewith accrues to the Engineer.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to Work and Adjustments in the General Specification.

.2 Measurement

.1 Measurement for Items 31 11 00 (a) to 31 11 00 (c) shall be in square metres made to the neat lines as calculated below.

.2 Quantities will be calculated based on the horizontal projection of the areas cleared, and/or grubbed, and/or stripped, with no separate allowance for inclination of the surfaces cleared, grubbed, and/or stripped.

.3 No grubbing and stripping will be undertaken under the north and south dykes, as this activity will be carried out as a winter program as described herein.

.4 No separate measurement shall be considered for stockpiling of stripped peat or topsoil including loading, hauling and leveling.

.3 Unit Price

.1 The unit prices proposed for Items 31 11 00 (a) to 31 11 00 (c) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for clearing , grubbing and stripping of all areas under Permanent Works, as shown in the Purchaser's Drawings and as follows:

.1 Item 31 11 00 (a) shall cover clearing the sites of the Permanent Works.

.2 Item 31 11 00 (b) shall cover grubbing the sites of the Permanent Works, excluding the areas under the North Dyke and South Dyke

.3 Item 31 11 00 (c) shall cover stripping the sites of the Permanent Works, excluding the areas under the North Dyke and South Dyke.

1.6 SUBMITTALS

.1 Shall be in accordance with the requirements set out in Section 21.7 Contractor's Documents of the General Specification.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Not applicable.

Part 3 Execution

3.1 GENERAL REQUIREMENTS

.1 Unless otherwise shown on the Purchaser's Drawings or directed by the Engineer, clearing shall be limited to a distance of 15 m beyond the limits of the structures and their associated excavations.

.2 Unless otherwise directed by the Engineer, clearing for the immediate forebay area shall be as shown on the Purchaser's Drawings.

.3 Unless otherwise shown on the Purchaser's Drawings or directed by the Engineer, grubbing shall be limited to the previously cleared areas.

.4 Stripping will be required for the permanent structures and their associated channels, permanent roads, permanent surface drainage works, stockpile areas, other excavation areas, and the areas of the foundations of the Cofferdams that are accessible prior to fill placement in these areas.

.5 For hand clearing, all timber and brush cut shall be cut to lie as close to the natural ground as possible.

3.2 PROCEDURES

.1 Clearing shall consist of cutting and disposing of all trees, shrubs, debris and all other perishable material including fallen trees and logs that may be visible on the surface of the ground and in the beds of water courses within the areas to be cleared, and overhanging the area to be cleared.

.2 Limbs and branches to be trimmed shall be neatly cut close to the base of the limb or branch. Cuts more than 40 mm in diameter shall be painted with a tree-wound paint acceptable to the Engineer.

.3 For hand clearing, trees, standing deadwood and stumps shall be cut to lie as close to the natural ground as possible. No trees are to be left in standing timber.

.4 There shall be no bulldozing of woody debris into standing timber.

.5 All vegetation and debris removed shall be piled and burned or compacted in windrows. Windrow shall be compacted to lie as close to the ground as possible (maximum height of 0.6 m) and shall be no closer than 1.0 m to the bush line.

.6 All materials for disposal shall be either burned or disposed of in a manner acceptable to the Engineer and in compliance with applicable Laws. Burn piles must be located a minimum of 15.0 m from standing timber. The Contractor will be held responsible for any damage done by fire resulting from the Work under this Section of the Technical Specification and shall at no time leave a fire unattended until it has been fully extinguished. When the burning of materials cannot be permitted for an extended period of time after the materials have been placed in piles, the Contractor shall notify the Engineer in writing, and accounting for the Work performed will be included in the monthly progress estimate on the basis of 70% for cutting and piling and 30% for burning.

.7 Grubbing shall consist of excavation and disposal of stumps, roots larger than 75 mm in diameter, matted roots, boulders and rock fragments or detached rock masses of less than 1.5 m^3 in volume, and deleterious material as determined by the Engineer, to not less than 0.3 m below existing ground surface.

.8 The Contractor shall prevent damage to trees that are to remain, natural features, benchmarks, existing buildings, utility lines, Site appurtenances, water courses which are to remain, and shall correct any damage caused as a result of construction operations.

.9 Stripping shall consist of the excavation of topsoil materials, including surface soil, organic growth, or other material designated by the Engineer. The maximum depth of stripping shall not exceed 0.2 m below existing ground surface.

.10 Topsoil materials within the areas designated for stripping shall be removed and stockpiled at a location accepted by the Engineer. Stockpiling of topsoil shall be considered incidental to topsoil stripping and shall include loading, hauling and leveling.

.11 Where clearing and grubbing is required, it shall be performed in advance of topsoil stripping.

3.3 WINTER EXCAVATION

.1 Zoned impervious core dyke will be used for most of the length of the north dyke and all of the south dyke. Construction of the dyke will begin in the winter, when the soft near surface materials are frozen and more easily accessed for excavation.

.2 Contractor will first carry out excavation of the peat and postglacial clays to the top of the underlying till surface. The excavation will then be backfilled with granular fill and rockfill material as shown on the Purchaser's Drawings to slightly above the original ground surface.

.3 As part of the winter excavation above, grubbing and stripping under the footprint of the majority of the north and south dykes will not be carried under this Section of the Technical Specification, as some of the overburden in the area are frozen and may require larger equipment to remove the stumps and roots of the trees, as well as frozen soil. For winter excavation, excavation to the desired depths as shown in the Purchaser's Drawings, and as directed by the Engineer will be treated under Section 31 23 16 Unclassified Excavation.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for supplying, manufacturing, processing, loading, transporting, unloading, preparing the ground surface under the stockpile and placing of coarse and fine aggregates, riprap, filter materials and road topping in stockpiles for future use by the Engineer, as directed by the Engineer and as specified herein.

.2 This Section covers only stockpiles of material for future use by the Engineer for operation and maintenance purposes after the end of the Project.

.3 This Section does not include provision for top-up of materials during the cofferdam construction, nor for temporary stockpiles for use by the Contractor. The costs for those temporary stockpiles and for top-up of materials are deemed to be included in the Work under those Sections of the Technical Specification.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 03 30 00 - Cast-In-Place Concrete.

.3 Section 31 11 00 - Clearing, Grubbing and Stripping.

.4 Section 31 23 01 - Weight Scales.

.5 Section 31 23 24 - Granular Fill.

.6 Section 31 23 25 - Road Topping.

.7 Section 31 23 26 - Riprap Bedding.

.8 Section 31 23 27 - Rockfill.

1.3 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified in Section 27 Clarifications and Changes to Work and Adjustments.

.2 Measurement

.1 Measurement for Items 31 14 13 (a) to 31 14 13 (h) inclusive shall be in tonnes produced in accordance with this Section of the Technical Specifications and based on the weight slip submitted for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification.

.2 No separate measurement or Target Price will be made for loading and unloading, transportation, and preparation of the stockpile areas.

.3 Unit Price

.1 The Unit Prices for Items 31 14 13 (a) to 31 14 13 (h) inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, manufacturing, processing, loading, transporting, unloading and stockpiling of materials, including foundation preparation of the stockpiled areas as specified herein and as follows:

.1 Item 31 14 13 (a) shall cover 40 mm to 20 mm coarse concrete aggregate produced for future use by the Engineer.

.2 Item 31 14 13 (b) shall cover 20 mm to 5 mm coarse concrete aggregate produced for future use by the Engineer.

.3 Item 31 14 13 (c) shall cover 10 mm to 75 µm fine concrete aggregate produced for future use by the Engineer.

.4 Item 31 14 13 (d) shall cover Class 4 filter material produced for future use by the Engineer.

.5 Item 31 14 13 (e) shall cover Class 5 riprap bedding material produced for future use by the Engineer.

.6 Item 31 14 13 (f) shall cover Class 7 riprap material produced for future use by the Engineer.

.7 Item 31 14 13 (g) shall cover Class 8 riprap material produced for future use by the Engineer.

.8 Item 31 14 13 (h) shall cover road topping material produced for future use by the Engineer.

.2 Loading, unloading and transporting materials and preparation of the stockpile areas are considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices set out for the Items to which such Work applies.

1.4 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specifications.

Part 2 Products

2.1 MATERIALS

.1 Materials shall be prepared in accordance with the following sections of the Specifications:

.1 Section 03 30 00 - Cast-In-Place Concrete.

.2 Section 31 11 00 - Clearing, Grubbing and Stripping.

.3 Section 31 23 01 - Weight Scales.

.4 Section 31 23 24 - Granular Fill.

.5 Section 31 23 25 - Road Topping.

.6 Section 31 23 26 - Riprap Bedding.

.7 Section 31 23 27 - Rockfill.

Part 3 Execution

3.1 GENERAL

.1 Coarse and fine aggregates shall conform in every respect to the concrete aggregate produced under Section 03 30 00 Cast-In-Place Concrete.

.2 Filter materials, road topping materials, rockfill, riprap and riprap bedding material shall conform in every respect to the materials produced per the Sections listed in Part 2.

.3 Stockpiles will be within 4 km of the place of processing, as located by the Engineer. Multiple stockpile areas may be designated by the Engineer.

.4 The Contractor shall prepare a layout plan describing the size, maximum height, shapes of the stockpiles and the minimum distances between stockpiles within a designated stockpile for approval by the Engineer prior to stockpiling Work.

.5 Stockpiles shall be placed on surfaces which have been cleared as specified and accounted for under Section 31 11 00 Clearing, Grubbing and Stripping. The foundations for stockpiles shall be suitably prepared to the satisfaction of the Engineer, to prevent loss of materials into the foundations or contamination of materials paid for under this Item. The prepared surface for any stockpile shall extend at least 6 m beyond the limits of the stockpile.

.6 The quantities to be supplied in stockpiles, for future use by the Purchaser, shall be as follows:

Material	Material Classification or Nominal Size Sieves (with square openings)	Weight (Tonnes)
Coarse aggregate	40 mm to 20 mm	4,500
Coarse aggregate	20 mm to 5 mm	4,500
Fine aggregate	10 mm to 75 µm	1,800
Filter material	Class 4	10,000
Riprap bedding	Class 5	4,200
Riprap	Class 7	8,250
Riprap	Class 8	3,750
Road topping	19 mm to 2mm	30,800

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of the supply, installation and maintaining of a truck weight scale.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 31 52 00 - Cofferdams.

.3 Section 31 14 13 - Stockpiling of Materials.

1.3 REFERENCES

.1 Not used.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 There shall be no separate measurement or payment for providing scales, scale buildings, heating fuel or other Items necessary or incidental thereto, all of which will be considered incidental to the Work being performed.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

1.7 CERTIFICATION

.1 The Contractor shall provide evidence that scales and calibrated weights have been certified for the current calendar year by the weights and measures services of the Government of Canada before the scales will be accepted for use.

.2 Where the scale has not been certified for the current fiscal year, the Engineer may test the scale using procedures specified by Measurement Canada - Weights and Measures Inspection Services, determining the scale useable for the Work.

1.8 CERTIFICATION

.1 The Contractor shall provide evidence that scales and calibrated weights have been certified for the current calendar year by the weights and measures services of the Government of Canada before the scales will be accepted for use.

.2 Where the scale has not been certified for the current fiscal year, the Engineer may test the scale using procedures specified by Measurement Canada - Weights and Measures Inspection Services, determining the scale useable for the Work.

Part 2 Products

2.1 SUPPLY

.1 The Contractor shall supply weigh scales and calibrated weights when material used by the Contractor at the Site requires weighing to verify quantity.

.2 Separate scales may be required when two or more different types of material measured by weight are being hauled simultaneously. At least one set of calibrated weights shall be located on Site convenient to the Work.

2.2 TYPE AND CAPACITY

.1 Each weigh scale shall be of a type with a remote indicating beam.

.2 Each scale shall be of sufficient capacity and length to weigh in one operation any truck, or truck and trailer combination, hauling material to be paid for by weight as a contract item.

.3 Scales shall be equipped with metric scale heads.

.4 Belt scales which are certifiable for trade by Measurement Canada - Weights and Measure Inspection Services are acceptable for weighing aggregate being placed into a stockpile.

2.3 SCALE HOUSE

.1 Each scale shall be equipped with one well constructed weatherproof scale house, having minimum floor dimensions of 1.8m x 2.4m. The walls shall be at least 2.13 m high. A wooden door, screen door and step shall be located either on the wall opposite to approaching trucks or on the wall farthest away from the scales.

.2 A screened window facing approaching trucks shall have an area of at least 0.46 m^2 and shall be capable of being opened. A window facing the scale shall have an area of at least 0.74 m^2. Provision shall be made in the window to allow the checker to pass the scale ticket directly to the trucker.

.3 The walls, floor and ceiling shall be insulated. There shall be a controllable approved heating unit to maintain the temperature above 18 C. A suitable table and chairs shall be provided.

.4 A fully charged fire extinguisher with a minimum size of 2.3 kg, rated ABC, shall be supplied and conveniently located on the wall.

.5 The Contractor shall provide adequate lighting on the scale, the ramps and in the scale house when hauling or receiving goods over the scale during darkness.

2.4 LOCATION

.1 Scales shall be located as outlined in the Contractor's Documents or as determined by the Engineer.

Part 3 Execution

3.1 FOUNDATION

.1 The foundation and ramp for the scale shall be adequate to support the largest load to be scaled. Retaining walls at each end of the scale shall prevent the ramp from binding against the scale platform. Each ramp shall be constructed straight and to the same elevation as the scale platform for a distance equal to at least the length of the platform.

.2 The scale platform and mechanism shall be kept clean and maintained free of gravel, mud, snow and ice.

3.2 FIELD TESTING

.1 Scales shall be field tested by the Contractor on a regular basis and as requested by the Engineer, using procedures specified by Measurement Canada - Weights and Measures Inspection Service. If subsequent testing of the scale by Measurement Canada - Weights and Measures Inspection Service is required, it shall be performed at the expense of the Contractor.

3.3 OPERATION

.1 The Contractor shall direct the operation of the scale and issue weigh tickets showing gross, tare and net weight for each load of material. The tare weight shall be established when hauling beings for the Work, and therefore as frequently as directed by the Engineer. These weights shall be recorded on the delivery slip which shall be given to the Engineer the next Working Day. As a minimum, each weight slip shall identify the truck number, the date of measurement, location of placement (ie. structure name), total weight, tare weight, net weight, and Material type.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for the final preparation of rock and earth surfaces prior to placing impervious fill, granular fill, rockfill and erosion protection fill. Foundation preparation shall be completed immediately prior to fill placement and shall be undertaken as shown on the Purchaser's Drawings, as directed by the Engineer, and as specified herein.

1.2 RELATED SECTIONS

.1 General Specification.

.2 Section 03 30 00 - Cast in Place Concrete.

.3 Section 31 23 23 - Impervious Fill.

.4 Section 31 23 24 - Granular Fill.

.5 Section 31 23 25 - Road Topping.

.6 Section 31 23 26 - Riprap Bedding.

.7 Section 31 23 27 - Rockfill.

.8 Section 31 23 33 - Trenching and Backfilling.

.9 Section 31 35 19 - Geotextiles.

.10 Section 31 82 00 - Foundation Drain Holes

1.3 REFERENCES

.1 The Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed except where specified otherwise.

.2 The Works shall conform to all regulations applicable to this type of Work in effect at the time the Work is performed.

.3 As a minimum, the Works shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D698 - "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))", ASTM International.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specifications shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's

Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to Work and Adjustments in the General Specification.

.2 Measurement

.1 Measurement for Items 31 23 13 (a)i to 31 23 13 (i)iv inclusive shall be in square metres made to the total contact area actually prepared for the foundation presented in the Drawings and as directed by the Engineer. The onsite surveying will be jointly performed by the Contractor and the Engineer of the actual total square metres of contact areas prepared for the impervious core contact, granular fill, riprap bedding, rockfill, and riprap, as described herein. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary areas for accurate measurements.

.2 Measurement for Items 31 23 13 (j)i and 31 23 13 (j)ii shall be in linear metres of sand drain holes measured from the surface of Class 2a fill working platform to the end of the hole presented in the Drawings and as directed by the Engineer.

.3 Measurement for Items 31 23 13 (j)iii and 31 23 13 (j)iv shall be in cubic metres cubic metres of Class 2a Granular Fill placed and compacted to form a working platform as presented in the Drawings and as directed by the Engineer.

.4 Measurement for Items 31.23.13 (k)i and 31 23 13 (k)ii shall be in linear metres of exploratory holes measured from the surface of Class 2a fill working platform to the end of the hole presented in the Drawings and as directed by the Engineer.

.5 Measurement for Items 31 23 13 (k)iii to 31 23 13 (k)viii shall be in kilograms made on the weight of dry volume of sand material and placed in the sand drain holes as shown in specification herein.

.6 Measurement for Item 31 23 13 (l)i to 31 23 13 (l)iii shall be in cubic metres for the total volume of excavated rock from the top of the surveyed rock to the indicated elevation as presented in the Drawings and as directed by the Engineer. The on-site surveying will be jointly performed by the Contractor and the Engineer. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary area for accurate measurement.

.7 No separate measurement or target price will be made for injection of the sand and its associated work. For the purpose of measurement, the unit weight of sand will be considered as being 1,600 kg/m^3 and as shown in specification herein.

.8 No separate measurement or target price will be made for separate allowance for local irregularities or for inclination of surfaces prepared.

.9 No separate measurement or target price will be made for foundation preparation carried out in the winter period.

.3 Unit Price

.1 The unit prices proposed for Items 31 23 13 (a)i to 31 23 13 (c)vi inclusive shall be used to set the Initial Target Price for preparing rock foundations under the various structures as shown on the Drawings, and as follows:

.1 Item 31 23 13 (a)i shall cover prepare rock foundation for placement of Impervious Fill for the North Dam.

.2 Item 31 23 13 (a)ii shall cover prepare rock foundation for placement of Impervious Fill for the Central Dam.

.3 Item 31 23 13 (a)iii shall cover prepare rock foundation for placement of Impervious Fill for the South Dam.

.4 Item 31 23 13 (a)iv shall cover prepare rock foundation for placement of Impervious Fill for the North Dyke.

.5 Item 31 23 13 (a)v shall cover prepare rock foundation for placement of Impervious Fill for the South Dyke.

.6 Item 31 23 13 (a)vi shall cover prepare rock foundation for placement of Impervious Fill for the Transmission Tower Spur.

.7 Item 31 23 13 (b)i shall cover prepare rock foundation for placement of Granular Fill for the North Dam.

.8 Item 31 23 13 (b)ii shall cover prepare rock foundation for placement of Granular Fill for the Central Dam.

.9 Item 31 23 13 (b)iii shall cover prepare rock foundation for placement of Granular Fill for the South Dam.

.10 Item 31 23 13 (b)iv shall cover prepare rock foundation for placement of Granular Fill for the North Dyke.

.11 Item 31 23 13 (b)v shall cover prepare rock foundation for placement of Granular Fill for the South Dyke.

.12 Item 31 23 13(b)vi shall cover prepare rock foundation for placement of Granular Fill for the Transmission Tower Spur.

.13 Item 31 23 13 (c)i shall cover prepare rock foundation under riprap bedding, rockfill, and riprap for the North Dam.

.14 Item 31 23 13 (c)ii shall cover prepare rock foundation under riprap bedding, rockfill, and riprap for the Central Dam.

.15 Item 31 23 13 (c)iii shall cover prepare rock foundation under riprap bedding, rockfill, and riprap for the South Dam.

.16 Item 31 23 13 (c)iv shall cover prepare rock foundation under riprap bedding, rockfill, and riprap for the North Dyke.

.17 Item 31 23 13 (c)v shall cover prepare rock foundation under riprap bedding, rockfill, and riprap for the South Dyke.

.18 Item 31 23 13 (c)vi shall cover prepare rock foundation under riprap bedding, rockfill, and riprap for the Transmission Tower Spur.

.2 The unit prices proposed for Items 31 23 13 (d)i to 31 23 13 (h)vi inclusive shall be used to set the Initial Target Price for preparing earth foundations under the various structures, as shown on the Drawings, and as follows:

.1 Item 31 23 13 (d)i shall cover prepared earth foundation under Impervious Fill areas for the North Dam.

.2 Item 31 23 13 (d)ii shall cover earth foundation under Impervious Fill areas for the Central Dam.

.3 Item 31 23 13 (d)iii shall cover earth foundation under Impervious Fill areas for the South Dam.

.4 Item 31 23 13 (d)iv shall cover prepared earth foundation under Impervious Fill areas for the North Dyke.

.5 Item 31 23 13 (d)v shall cover prepare earth foundation under Impervious Fill areas for the South Dyke.

.6 Item 31 23 1 3(d)vi shall cover prepare earth foundation under Impervious Fill areas for the Transmission Tower Spur.

.7 Item 31 23 13 (e)i shall cover prepare earth foundation under Granular Fill for the North Dam.

.8 Item 31 23 13 (e)ii shall cover earth foundation under Granular Fill for the Central Dam.

.9 Item 31 23 13 (e)iii shall cover earth foundation under Granular Fill for the South Dam.

.10 Item 31 23 13 (e)iv shall cover prepare earth foundation under Granular Fill for the North Dyke.

.11 Item 31 23 13(e)v shall cover prepare earth foundation under Granular Fill for the South Dyke.

.12 Item 31 23 13 (e)vi shall cover prepare earth foundation under Granular Fill for the Transmission Tower Spur.

.13 Item 31 23 13 (f)i shall cover prepare earth foundation under riprap bedding, rockfill, and riprap for the North Dam.

.14 Item 31 23 13 (f)ii shall cover prepare earth foundation under riprap bedding, rockfill, and riprap for the Central Dam.

.15 Item 31 23 13 (f)iii shall cover prepare earth foundation under riprap bedding, rockfill, and riprap for the South Dam.

.16 Item 31 23 13 (f)iv shall cover prepare earth foundation under riprap bedding, rockfill, and riprap for the North Dyke.

.17 Item 31 23 13(f)v shall cover prepare earth foundation under riprap bedding, rockfill, and riprap for the South Dyke.

.18 Item 31 23 13 (f)vi shall cover prepare earth foundation under riprap bedding, rockfill, and riprap for the Transmission Tower Spur.

.19 Item 31 23 13(g)i shall cover prepare the earth foundation for granular dyke under the North Dyke.

.20 Item 31 23 13(g)ii shall cover prepare the earth foundation for granular dyke under the South Dyke.

.21 Item 31 23 13 (h)i shall cover prepared earth foundation for placement of geotextile for the North Dam.

.22 Item 31 23 13 (h)ii shall cover prepare earth foundation for placement of geotextile for the Central Dam.

.23 Item 31 23 13 (h)iii shall cover prepare earth foundation for placement of geotextile for the South Dam.

.24 Item 31 23 13(h)iv shall cover prepared earth foundation for placement of geotextile for the North Dyke.

.25 Item 31 23 13 (h)v shall cover prepare earth foundation for placement of geotextile for the South Dyke.

.26 Item 31 23 13 (h)vi shall cover prepared earth foundation for placement of geotextile for the Transmission Tower Spur.

.3 The unit prices proposed for Items 31 23 13 (i)i to 31 23 13 (i)iv inclusive shall be used to set the Initial Target Price for preparing foundations under the various Concrete Structures, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 13 (i)i shall cover preparation of foundations under concrete structures for the Powerhouse Complex including Service Bay and transition structures.

.2 Item 31 23 13 (i)ii shall cover preparation of foundations under concrete structures for Spillway including transition structures.

.3 Item 31 23 13 (i)iii shall cover preparation of foundations under concrete structures for Walls E, F for Powerhouse.

.4 Item 31 23 13 (i)iv shall cover preparation of earth foundations under concrete structures for Wall A, B, C, and D for Spillway.

.4 The unit prices proposed for Items 31 23 13 (j)i to 31 23 13 (j)iv inclusive shall be used to set the Initial Target Price for installation of sand drains under the North and South Dykes, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 13 (j)i shall cover drilling of 300 mm diameter sand drains for North Dyke.

.2 Item 31 23 13 (j)ii shall cover drilling of 300 mm diameter sand drains for South Dyke.

.3 Item 31 23 13 (j)iii shall cover placement of Class 2a in sand drains for North Dyke.

.4 Item 31 23 13 (j)iv shall cover placement of Class 2a in sand drains for South Dyke.

.5 The unit prices proposed for Items 31 23 13 (k)i to 31 23 13 9 (k)viii inclusive shall be used to set the Initial Target Price for installation of exploratory holes confirm the foundation conditions under the North and South Dykes, as shown on the Drawings, and as follows:

.1 Item 31 23 13 (k)i shall cover drilling of exploratory holes for North Dyke.

.2 Item 31 23 13 (k)ii shall cover drilling of exploratory holes for South Dyke.

.3 Item 31 23 13 (k)iii shall cover bentonite in grout mix for North Dyke.

.4 Item 31 23 13 (k)iv shall cover bentonite in grout mix for South Dyke.

.5 Item 31 23 13 (k)v shall cover cement in grout mix for North Dyke.

.6 Item 31 23 13 (k)vi shall cover cement in grout mix for South Dyke.

.7 Item 31 23 13 (k)vii shall cover sand in grout mix for the North Dyke.

.8 Item 31 23 13 (k)viii shall cover sand in grout mix for the South Dyke.

.6 The unit prices proposed for Items 31 23 13 (l)i to 31 23 13 (l)iii inclusive shall be used to set the Initial Target Price for excavation of bedrock under the North Dam, Central Dam, and South Dam, as shown on the Drawings, and as follows:

.1 Item 31 23 13 (l)i shall cover bedrock excavation for North Dam.

.2 Item 31 23 13 (l)ii shall cover bedrock excavation for Central Dam.

.3 Item 31 23 13 (l)iii shall cover bedrock excavation for South Dam.

1.5 QUALITY MANAGEMENT

.1 As per General Specification Requirements.

Part 2 Products

2.1 MATERIALS

.1 Refer to RELATED SECTIONS.

Part 3 Execution

3.1 ROCK FOUNDATIONS UNDER IMPERVIOUS FILL CORE

.1 Rock foundations forming the base for an impervious core for the embankments or portions of the cofferdams constructed in the dry shall be thoroughly cleaned of all soil, rock that is weathered, loose, drummy, or shattered, ice, snow, and other deleterious materials remaining after excavation or completion of grouting. All such material shall be removed from the rock surface and from cavities, faults, potholes, and exposed open joints by barring, hand excavation, jetting with air and/or water, or other effective means, to the satisfaction of the Engineer. Joints, cavities, and faults shall be excavated and thoroughly cleaned to a depth equal to at least three times the width of feature, and shall be backfilled with mortar or lean concrete, as directed by the Engineer.

.2 Any overhanging or near vertical rock surfaces shall be trimmed to the satisfaction of the Engineer to a slope of no steeper than 0.5H:1V or filled with dental concrete, to permit thorough compaction of earth fill. All bedrock points, irregularities and promonitories, etc. shall be trimmed to the satisfaction of the Engineer, to permit thorough compaction of earth fill. Accounting for bedrock excavation for North, Central and South Dams, will be made under Items 31 23 13 (l)i, 31 23 13 (l)ii, and 31 23 13 (l)iii. Accounting for dental concrete will be made under Item 03 30 00 (d)iii, as concrete in backfill.

.3 Holes and depressions shall be filled with hand compacted impervious material or lean concrete, as directed by the Engineer. Accounting for impervious fill will be made under the appropriate pay item in the Bill of Quantities and Prices. Accounting for concrete in holes and depressions will be made under Item 03 30 00 (d)iii, as concrete in backfill. Where rock surfaces at the impervious core contact surface are fractured to an extent considered unsatisfactory to the Engineer, a slush grout mixture shall be broomed into the cracks. The slush grout shall be a sand-cement grout in such proportions as to suit conditions encountered. Care shall be exercised to prevent accumulation of slush grout on unfractured surfaces. The supply and application of slush grout is considered to be incidental to the proposed Items 31 23 13 (a)i to 31 23 13 (a)vi.

.4 The Contractor shall ensure that grouting, the treatment of joints, cavities, faults, and other defects in the rock shall not result in layers of grout, mortar, or cement, covering areas of sound rock.

.5 The Contractor shall maintain the working surface free from water, ice and snow. Immediately prior to placing fill, all water shall be removed from depressions. The surfaces shall be wet, and shall be cleaned sufficiently to ensure satisfactory bond with the impervious material. Subject to the acceptance of the Engineer, water from springs may be collected in standpipes, which shall be backfilled with concrete after the fill has been placed to a height above the water level.

.6 If any previously prepared foundation surface should become contaminated with objectionable material, the objectionable material shall be removed to the satisfaction of the Engineer.

3.2 ROCK FOUNDATIONS UNDER GRANULAR FILL

.1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated.

.2 Rock foundations forming the base of granular fill areas located on the downstream side of the impervious fill zones of the embankments and portions of the cofferdams constructed in the dry shall be thoroughly cleaned of all soil, rock that is loose, drummy, or shattered, and other deleterious materials remaining after excavation or completion of grouting. Joints, cavities, and faults shall be excavated and cleaned to a depth equal to at least three times the width of the feature. Sound material which, in the opinion of the Engineer, has properties not less than those of the fill to be placed on them may be left in place.

.3 Rock foundations forming the base of granular fill areas located on the upstream side of the impervious fill zones of the embankments and the portions of the cofferdams that are constructed in the dry, or granular fill placed for erosion protection at the toe of the unclassified excavation slopes shall be thoroughly cleaned of all soil, ice, snow, and other deleterious materials to the satisfaction of the Engineer.

.4 If any previously prepared foundation surface should become contaminated with objectionable material, the objectionable material shall be removed to the satisfaction of the Engineer.

3.3 ROCK FOUNDATIONS UNDER RIPRAP BEDDING, ROCKFILL AND RIPRAP

.1 Rock foundation forming the base of riprap bedding, rockfill, or riprap shall be thoroughly cleaned of all soil, ice, snow, and other deleterious materials to the satisfaction of the Engineer.

3.4 EARTH FOUNDATIONS UNDER IMPERVIOUS FILL

.1 Earth foundations on which impervious fill is to be placed shall be drained and cleaned of any undesirable accumulation of loose or wetted materials, pervious soils, debris, ice, snow, and other unsuitable materials to the satisfaction of the Engineer.

.2 Earth foundations for impervious fill shall be scarified and loosened by means of a plough, ripper, or other methods, to a depth of at least 0.1 m, to the satisfaction of the Engineer. All lumps of foundation material larger than 0.15 m in size shall be removed from the foundation. After removal of all unsuitable material turned up during scarifying, the moisture content of the bonding layer shall be conditioned to within 2% above and 1% below the optimum moisture content obtained in the Standard Proctor Compaction Test determined in accordance with ASTM, D698 "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))", ASTM International. The entire foundation area of the impervious zone, except as shown on the Drawings or herein provided, shall then be compacted as specified for Class 1 Impervious fill in Section 31 23 23.

.3 Immediately prior to placing the initial lift of fill, the foundation surface shall be scarified or harrowed, and moistened, if required, to create a satisfactory bond between the foundation and the fill materials.

.4 Earth foundations, which are on inclined slopes steeper than lV:4H, shall be prepared as specified herein, but need not be compacted prior to fill placement. However, the fill placed adjacent to the slope shall be compacted by additional complete coverages of the

compaction equipment as specified in Section 31 23 23, if necessary, to achieve the required compaction at the boundary between the fill and its inclined foundation.

.5 If any previously prepared foundation surface should become softened, rutted, eroded, or contaminated with objectionable material, the soft or contaminated materials shall be removed and the foundation prepared again, to the satisfaction of the Engineer.

3.5 EARTH FOUNDATIONS UNDER GRANULAR FILL AND ROCKFILL

.1 Clean up and dispose of all excess material, trash, rocks, boulders and debris as Work progresses.

.2 Earth foundations on which granular fill or rockfill is to be placed shall be drained and cleaned of any undesirable accumulation of soft, loose or wetted materials, debris, and other unsuitable materials to the Engineer's satisfaction.

.3 Earth foundations for granular fill and rockfill shall be scarified and loosened by means of a plough, ripper, or other methods, to a depth of at least 0.1 m, to the satisfaction of the Engineer. All lumps of foundation material larger than 0.15 m in size shall be removed from the foundation. After removal of all unsuitable material turned up during scarifying, the moisture content of the bonding layer shall be conditioned to within 2% above and 1% below the optimum moisture content obtained in the Standard Proctor Compaction Test determined in accordance with ASTM D698, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))", ASTM International. The entire foundation area of the granular fill or rockfill zones, except as herein provided, shall then be compacted as specified for Class 1 Impervious fill in Section 31 23 23.

.4 Immediately prior to placing the initial lift of fill, the foundation surface shall be scarified or harrowed, and moistened, if required, to create a satisfactory bond between the foundation and the fill materials.

.5 Earth foundations, which are on inclined slopes steeper than lV:4H, shall be prepared as specified herein, but need not be compacted prior to fill placement. However, the fill placed adjacent to the slope shall be compacted by additional complete coverages of the compaction equipment as specified in the applicable fill material sections of these Specifications, if necessary, so as to achieve the required compaction at the boundary between the fill and its inclined foundation.

.6 If any previously prepared foundation surface should become softened, rutted, eroded, or contaminated with objectionable material, the soft or contaminated materials shall be removed and the foundation prepared again, to the satisfaction of the Engineer.

3.6 EARTH FOUNDATIONS FOR GRANULAR DYKE

.1 In the areas of the Granular Dyke, Contractor shall install vertical sand drains beneath the footprint of the dyke as shown on the Drawings.

.2 The sand drains will consist of 300 mm diameter holes drilled to 0.6 m below the upper surface of the underlying till. The drill holes will be backfilled with Class 2a fill under Section 31 23 24 - Granular Fill.

.3 The holes which are located upstream of the dyke’s centerline will be drilled at 3 m center-to center spacing.

.4 Those which are located downstream of the dyke’s centerline will be drilled at 5 m center-to-center spacing.

3.7 EARTH FOUNDATIONS UNDER GEOTEXTILE

.1 Earth foundations under Geotextiles shall be prepared in accordance with Section 31 35 19.

3.8 FOUNDATIONS UNDER CONCRETE STRUCTURES

.1 Foundations under Concrete Structures shall be prepared in accordance with Section 03 30 00.

3.9 INSTALLATION OF SAND DRAINS UNDER THE GRANULAR DYKE

.1 Placement of Class 2a working Platform shall be prepared in accordance with Sections 31 23 24 and 31 23 33.

.2 Drilling of the sand drain holes shall be prepared in accordance with Sections 31 82 00 Foundation Drain Holes.

.3 Sand gradation for the sand drain material shall conform to the sand backfill materials in accordance with Section 31 23 33 - Trenching and Backfilling.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary for the excavation of unclassified material, as shown on the Purchaser's Drawings, as directed by the Engineer, and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification set out below.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 EMPA Drawing for location of the Excavated Material Placement Areas.

1.4 GENERAL REQUIREMENTS

.1 The term "Unclassified Excavation" shall be deemed to include the removal of all materials, whether dry, wet, or frozen, not classified as rock, and also shall include:

.1 Weathered or broken rock which can be excavated after loosening with an accepted single-tooth ripper mounted on a "Caterpillar D10" tractor or equal, except where, as determined by the Engineer, the weathered rock is overlain by bedrock which must be excavated by blasting.

.2 Boulders and detached rock masses which are smaller than 1.5 m^3 in volume, or as directed by the Engineer.

.3 Any frozen or other material not classified as rock, which is removed by blasting, excluding snow or ice.

.2 The removal of ice or snow necessary to facilitate Unclassified Excavation shall be considered incidental to the excavation Work.

.3 The classification of all excavations to distinguish between unclassified materials and rock for the purpose of accounting shall be as determined by the Engineer. The Contractor shall cooperate with the Engineer and conduct the excavation operations in a manner that will permit the classification and measurement of excavations to be made.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill

of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified in the General Specification.

.4 The Unit Prices shall include all requirements for supplying, placing, and removing sheeting, bracing, shoring, or other means of temporary support.

.2 Measurement

.1 Measurement for Items 31 23 16 (a)i to 31 23 16 (c)ii shall be in cubic metres based on the on-Site surveying information jointly gathered by the Contractor and the Engineer (or his designate) comparing the pre-construction survey (after clearing and grubbing) to the final excavated geometry. The volume shall be determined using software tools such as Autodesk Civil 3D using the composite volume method that is represented by the two Triangulated Irregular Networks, (TIN), one being the pre-construction surface and the other being the excavated surface. The composite calculation will determine the volume from the discrete difference between the elevations of each surface. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary surfaces for accurate measurements.

.2 No separate measurement will be made for the removal of ice or snow necessary to facilitate Unclassified Excavation for the winter excavation as specified herein.

.3 Unit Price

.1 The unit prices for Items 31 23 16 (a)i to 31 23 16 (b)ix inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for the excavation of unclassified materials, and transportation and disposal to the Excavated Materials Placement Areas as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 16 (a)i shall cover for all concrete structures in the Powerhouse Complex.

.2 Item 31 23 16 (a)ii shall cover for tailrace channel improvement.

.3 Item 31 23 16 (a)iii shall cover for all concrete structure in spillway area.

.4 Item 31 23 16 (b)i shall cover for north dam.

.5 Item 31 23 16 (b)ii shall cover parking lot and access ramp

.6 Item 31 23 16 (b)iii shall cover for south dam (main section).

.7 Item 31 23 16 (b)iv shall cover for south dam (south section).

.8 Item 31 23 16 (b)v shall cover south dam (tie-in).

.9 Item 31 23 16 (b)vi shall cover central dam.

Item 31 23 16 (b)vii shall cover south access road ramp.

.10 Item 31 23 16 (b)viii shall cover north access road ramp.

.11 Item 31 23 16 (b)ix shall cover transmission tower spur.

.2 The unit prices for Items 31 23 16 (c)i to 31 23 16 (c)ii inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's

Submission shall be for the winter excavation of unclassified materials, and transportation and disposal to the Excavated Materials Placement Areas as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 16 (c)i shall cover winter excavation for the north dyke.

.2 Item 31 23 16 (c)ii shall cover winter excavation for the south dyke.

.3 The removal of ice and snow necessary to facilitate Unclassified Excavation for the winter excavation is considered incidental to the Work. Include costs for such Work in the unit prices set out for the Items to which this Work applies.

1.6 SUBMITTALS

.1 Shall be in accordance with the requirements set out in Section 21.7 Contractor's Documents of the General Specification.

.1 At least one month before commencing use, the Contractor shall submit for Engineer's review in accordance with Engineer's Review (21.7.9) of the General Specification, a general plan of its proposed utilization of the Excavated Materials Placement Area.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Not Used.

Part 3 Execution

3.1 EXCAVATION

.1 Unclassified Excavation shall be performed to the neat lines and grades shown on the Purchaser's Drawings or as directed by the Engineer. Near the base of excavations, the excavation slope may be steepened locally, as directed by the Engineer, to accommodate local, minor variations in the foundation levels actually encountered.

.2 Where the excavation is made to accommodate structures, sufficient material shall be removed to allow for the proper placing and bracing of forms. All excavated areas shall be drained or pumped dry and all subsurface flows entering the excavation shall be controlled to the satisfaction of the Engineer. In general, all flows shall be directed away from the excavation.

.3 All snow and surface ice shall be removed and disposed of prior to excavation. The unit prices tendered for unclassified excavation under this Item shall include due allowance for the removal and disposal of snow and surface ice.

.4 Where springs are encountered, the exposed excavation slopes shall be blanketed with granular fill, as directed by the Engineer and as soon as possible after excavation, in order to avoid deterioration of the exposed slopes. Accounting for such fill will be made under the appropriate fill Item.

.5 Where permafrost is encountered, the exposed frozen excavation slopes shall be blanketed with granular fill, as directed by the Engineer and as soon as possible after excavation, in order to avoid deterioration of the exposed slopes. Accounting for such fill will be made under the appropriate fill Item. Any local permafrost areas with visible ground ice shall be excavated as directed by the Engineer.

3.2 WINTER EXCAVATION

.1 An impervious core dyke will be used for most of the length of the north dyke and all of the south dyke. Construction of the dyke will begin in the winter, when the soft near surface materials are frozen and more easily accessed for excavation.

.2 Contractor will first carry out excavation of the peat and postglacial clays to the top of the underlying till surface. The excavation will then be backfilled with granular and rockfill material to slightly above the original ground surface.

.3 For the entire length of the impervious core dykes, Contractor shall drill exploratory boreholes to confirm the thickness of the peat and post-glacial clays to be removed and to determine the presence of visible permafrost in the underlying till. These holes will be drilled along the centerline of the dykes and will extend to approximately 3 m below the surface of the till, as determined by the Engineer.

.4 The thickness of peat and post-glacial clays varies from 1 m to 7 m, but along the length of the dykes is typically about 1 to 2 m. Excavation of peat and clay materials beyond the 2 m depth will be assessed by the Engineer, based on the exploratory boreholes and Site conditions.

.5 During the summer, Contractor will excavate the granular material which was placed in the central portion of the dyke's winter fill zone to allow for placement of the impervious core material. Removal of the granular material will be carried out over short lengths so that the impervious core material can follow immediately.

.6 Suitable re-excavated granular material will be retained for use elsewhere in the permanent structures.

3.3 UTILIZATION OF MATERIALS

.1 Unclassified Excavation materials may be used in the construction of cofferdams, temporary roads and/or the permanent structures, subject to compliance with the requirements specified herein.

3.4 DISPOSAL

.1 Materials to be disposed of shall be placed in the Excavated Materials Placement Area, as shown on the Purchaser's Drawings or as accepted by the Engineer.

.2 The Contractor shall ensure that drainage in the Excavated Materials Placement Area is not interrupted due to the development of the area for use as a disposal site. During the course of the Work, the Contractor shall take adequate measures to provide proper drainage of surface waters and to prevent undesired ponding in the disposal area.

.3 For the purposes of this Specification, disposal shall include all water control measures and excavation of all temporary ditches, culverts, etc., required to maintain the Excavated Materials Placement Area in a dry state. Construction of permanent ditches will be accounted for under the appropriate excavation and fill pay Items.

.4 On completion of the Work, all temporary facilities shall be removed and the areas occupied thereby reinstated to as reasonable a condition as is practicable in the opinion of the Engineer. The Contractor shall also construct permanent ditches, as shown on the Purchaser's Drawings. Slopes shall be left in a safe, stable condition, and shall be neatly trimmed, contoured and dressed. Coarse materials shall be placed along the toe of all slopes to a sufficient height to ensure that erosion of the slopes does not occur due to the flow of surface water. The area shall be re-vegetated, as required by the Engineer.

.5 Rock fragments shall be covered so that they do not protrude above the surface of the disposal pile or shall be placed on the outside slope of the Excavated Materials Placement Area to serve as erosion protection, as shown on the Purchaser's Drawings and as directed by the Engineer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work required for all rock excavation necessary for the foundation and adjacent areas of the Permanent Works, all as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein. This aspect of the Work shall include transporting the excavated rock to and placing in temporary stockpiles or to disposal in locations acceptable to the Engineer, unless the excavated rock is utilized directly as fill in the cofferdams, Permanent Works , including their associated channels and permanent ditches, ancillary structures, in which case the transport and placement costs shall be included with the appropriate fill Item.

.2 If required, rock excavation in quarries for the production of concrete aggregate, riprap, filter materials, and rock fills to be used in construction of the Permanent Works and Temporary Works will be accounted for under the appropriate fill or concrete Item.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 31 23 16 - Unclassified Excavation.

.3 Section 31 33 13 - Rock Support and Protection.

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.4 Section 31 82 00 - Foundation Drain Holes.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Wright, D.G., Hopky, G.E., "Canadian Technical Report of Fisheries and Aquatic Sciences 2107 - Guidelines for Use of Explosives in or near Canadian Fisheries and Waters", 1998, with update December 6, 2000.

.2 Canadian Environmental Quality Guidelines, "Summary of existing Canadian Environmental Quality Guidelines", update 2002.

.3 Williamson, D.A., "Manitoba Water Quality Standards, Objectives and Guidelines - Manitoba Conservative Report 2002-II - Final Draft", November 22, 2002.

.4 Mines and Minerals Act (C.C.S.M. c. M162) - Quarry Minerals Regulations, 1992 - Regulation 65/92 - Sections 44(1), 44(2), 44(3).

1.4 DEFINITIONS

.1 "Rock" shall mean sound material of hardness and texture such that it cannot be readily loosened or removed by backhoe, clamshell, or hand shoveling.

.2 "Rock excavation" shall mean the removal of all rock which requires blasting, drilling, barring, wedging, or ripping for removal; and the removal of boulders, and pieces of detached rock and buried concrete each 1.5 cubic meters or more in volume.

.3 "Controlled perimeter blasting" shall mean the techniques of pre-splitting or line drilling and variations thereof as necessary to achieve the results specified herein.

.4 "Line drilling" shall mean the drilling of a row of drill holes along the excavation limit spaced on centers no more than three times the hole diameter or 175 mm on centers, whichever is greater.

.5 "Smooth blasting" shall mean a controlled blasting technique where the neat line holes are detonated after the bulk has been blasted and removed.

.6 "Pre-splitting" shall mean the formation of cracks along the final excavation faces by firing a single row of holes prior to the initiation of the rest of the holes of the blast pattern.

.7 A “round” shall mean a single cycle of drilling, loading and blasting to excavate rock, including scaling, mucking and moving equipment in and out.

.8 “Overbreak” shall mean the volume of rock removed beyond the neat lines for the excavation as shown on the Purchaser’s Drawings.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor’s Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor’s Submission for each Item as specified..

.2 Measurement

.1 Measurement for Items 31 23 17 (a)i to 31 23 17 (a)ix inclusive shall be in cubic metres made using the on-Site surveying information jointly gathered by the Contractor and the Engineer from a comparison of the surveyed geometry following the completion of Unclassified Excavations but prior to blasting, as measured and accepted by the Engineer. The measured volume shall be determined using software tools such as Autodesk Civil 3D using the composite volume method that is represented by the two Triangulated Irregular Networks, (TIN), one being the above survey information and the other being the excavation limits based on the neat lines shown on the Purchaser’s Drawings as

compared with the on-Site surveyed geometry following the completion of Unclassified Excavation but prior to blasting, as measured and accepted by the Engineer. The composite calculation will determine the volume from the discrete difference between each surface. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary surfaces for accurate measurements.

.2 Measurement for Items 31 23 17 (b)i to 31 23 17 (b)iv inclusive shall be in linear metre of presplit drilling for perimeter control blasting and for line drilling within the powerhouse and spillway areas, as shown on the Purchaser's Drawings and as described herein.

.3 No separate measurement or pricing will be made for excavation, scaling, or loose rock removal beyond the neat lines of excavation as shown on the Purchaser's Drawings or as directed by the Engineer; or for any measures employed to mitigate potential impacts on water and fish.

.3 Unit Price

.1 The unit prices for Items 31 23 17 (a)i to 31 23 17 (a)ix inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for sorting or selective excavation techniques required in the rock excavations to produce materials suitable for use as concrete aggregate, riprap, filter materials and rockfills to be used in construction of the permanent and temporary works as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 17 (a)i shall cover powerhouse intake channel.

.2 Item 31 23 17 (a)ii shall cover spillway approach channel.

.3 Item 31 23 17 (a)iii shall cover powerhouse.

.4 Item 31 23 17 (a)iv shall cover spillway discharge channel.

.5 Item 31 23 17 (a)v shall cover service bay of the powerhouse.

.6 Item 31 23 17 (a)vi shall cover spillway concrete structure.

.7 Item 31 23 17 (a)vii shall cover tailrace channel.

.8 Item 31 23 17 (a)viii shall cover channel improvement area.

.9 Item 31 23 17 (a)ix shall cover ailrace channel under powerhouse cofferdam.

.2 The unit prices proposed for Items 31 23 17 (b)i to 31 23 17 (b)iv inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for pre-split and line drilling in preparation for blasting as shown on the Purchaser's Drawings and as follows:

.1 Item 31 23 17 (b)i shall cover pre-split drilling at the powerhouse and service bay structures, intake and tailrace channels.

.2 Item 31 23 17 (b)ii shall cover pre-split drilling at the spillway structure, and the spillway approach and discharge channels.

.3 Item 31 23 17 (b)iii shall cover line drilling of the powerhouse and its associated channels.

.4 Item 31 23 17 (b)iv shall cover line drilling of the spillway and its associated channels.

.3 Excavating, scaling and loose rock removal beyond the neat lines shown on the Purchaser's Drawings or any measures employed to mitigate impacts on water and fish are considered incidental to the Work set out in this Section. Include

costs for such Work in the unit prices proposed for Items to which this Work applies.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 The Contractor shall submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, at least 1 month before commencing excavation, a Rock Excavation Plan of its proposed methods and sequence of excavating, including controlled perimeter blasting procedures as necessary, together with the pertinent data for each stage of each area.

.3 The Rock Excavation Plan shall be signed by the blasting design specialist(s) who shall be certified in accordance with Manitoba Laws. The blast design specialist shall certify that he is familiar with the Site conditions and the condition of adjacent or associated existing structures that the blast design has considered these conditions and meets the intent that adjacent existing structures and associated foundations are not damaged.

.4 At least 24 hours prior to commencement of preparatory work for each blast, the Contractor shall submit for review complete details of the blast to the Engineer. Such data shall include the location, depth and area of each blast; diameter, depth, pattern and inclination of blast holes; the type, strength, amount, column load and distribution of explosives to be used per hole, per delay and per blast; the sequence and pattern of delays and the description and purposes of any special methods to be adopted.

.5 If, in a specific area, a plan which has been previously adopted does not produce rock conditions in accordance with the requirements of this Section of the Technical Specification, the Contractor shall submit a revised plan to the Engineer before continuing excavation in adjacent areas.

.6 In addition to other records, the Contractor shall maintain accurate records of all rock excavation and blasting operations performed:

.1 As-built details of the location and elevation of blast, the drilling pattern, number, locations and sizes of drill holes and the type and amount of explosives used in each round or lift, the type, location and firing pattern of detonators and the time of each blast.

.2 Any unusual occurrence including, but not limited to, rockfalls, unstable or soft ground and inflows of water.

.3 Contractor shall make available to Engineer copies of all rock excavation and blasting records as requested.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

1.8 PRE-BLAST SURVEY

.1 Contractor shall conduct a pre-blast survey to document the pre-blast condition of structures and slopes.

.2 The pre-blast survey shall be made by qualified specialists retained for this purpose by the Contractor to observe the condition of existing structures and facilities in the vicinity of the Work. The survey shall include inspections of all structures and facilities located entirely or partially within 300 m of areas to be blasted. The pre-blast survey shall include diagrams, sketches, photographs, videos of all walls, partitions, floors and ceilings showing existing cracks, or damage and other data as applicable to locate and define the amount and extent of existing structural deficiencies. The pre-blast survey shall be signed by those who witnessed and/or took part in the inspections. All existing structural deficiencies, major or minor, shall be shown.

.3 As construction progresses, Contractor shall re-inspect as often as necessary to verify the adequacy of his construction methods for prevention of damage.

1.9 DRAINAGE AND DISPOSAL

.1 All excavated areas shall be drained to the satisfaction of the Engineer. Surface flows shall be directed away from the Work by means of ditches or other acceptable means. All surface and subsurface flows entering the excavation shall be satisfactorily controlled by methods acceptable to the Engineer.

.2 Water pumped into the river shall meet with the Canadian Environmental Quality Guidelines for freshwater containing aquatic life and Manitoba water quality standards. For details, please see the references set out in Subsection 1.3.3 of this Section of the Technical Specification.

.3 The removal of snow and ice, when necessary to ensure the safe and effective performance of this aspect of the Work, shall be performed by the Contractor.

Part 2 Products

2.1 GENERAL

.1 Contractor shall furnish all products necessary for the completion of the Work set out in this Section of the Technical Specification.

.2 The Federal Fisheries Act prohibits the deposit of toxic by-products (ammonia) from ammonium nitrate-fuel oil (ANFO) mixtures into waters frequented by fish. ANFO shall not be permitted for excavations in or near water.

Part 3 Execution

3.1 SITE PREPARATION AND PROTECTION

.1 The Contractor shall be responsible for the safety of all excavations performed until final acceptance of the Work and shall perform all remedial work required in excavations throughout the duration of the Contract to ensure that all excavated rock surfaces are maintained in a stable and safe condition.

.2 Immediately following blasting, and at any time during the Contract, all excavated faces which, in the opinion of the Engineer and/or the Contractor, are unsafe or appear to

endanger persons, Work, or property, shall be scaled and the loose rock shall be removed from the excavations. The fact that such scaling and removal may enlarge the excavation beyond the required excavation lines shall not relieve the Contractor from the necessity of doing such scaling and removal.

.3 After scaling and prior to excavation of the next lower bench, the Contractor shall install drain holes, rock bolts, and wire mesh, as shown on the Purchaser's Drawings, or as directed by the Engineer, and in accordance with Section 31 82 00 Foundation Drain Holes, and Section 31 33 13 Rock Support and Protection.

.4 As this aspect of the Work proceeds, the Contractor shall cooperate with the Engineer to allow for geological mapping of exposed rock faces and surfaces. All surfaces against which concrete and impervious fill are to be placed, as well as selected areas outside these limits, will be mapped by the Engineer prior to placement of concrete or fill. Should the Engineer require strips or localized areas to be cleaned to facilitate geological mapping in advance of the Contractor's normal final cleanup operations, such cleanup will be as specified in Section 31 23 13 Foundation Preparation.

.5 All excavation shall be performed in accordance with the best modern practice, using methods and techniques that will reduce overbreak to a minimum beyond the neat lines and grades shown on the Purchaser's Drawings or as directed by the Engineer, and which will preserve, in the soundest possible condition, the rock beyond these lines and grades. Particular care shall be exercised in the excavations where vertical or near vertical rock faces are required. Shattering or splitting of rock, or the opening up of seams in rock not required to be excavated, shall be prevented, and any shattered material and drummy rock beyond such lines caused by excavation operations, shall be removed at no additional expense to the Purchaser.

.6 The surfaces of all excavations which are to remain permanently exposed shall be finished to prescribed lines and slopes in a careful and workmanlike manner.

.7 Except for the limitations specified herein, blasting shall be performed in such a manner as to yield as much material as possible which is suitable for use as rockfill and riprap in the temporary and permanent structures, and for the production of aggregate for concrete.

3.2 EXCAVATION METHODS

.1 Special blasting procedures, including controlled perimeter blasting, shall be used to obtain sound excavation faces.

.2 All blasting operations shall be performed in a manner satisfactory to the Engineer and as required to achieve the tolerances and results as specified herein. Care shall be taken to avoid disturbing completed Work and the Contractor shall be prepared to limit blasting operations in accordance with Subsection 3.6 of this Section in the vicinity of concrete, and earthfill in place, completed structures, grouted areas and grouting operations, and cofferdams.

.3 The Contractor shall develop controlled blasting techniques by trial, which will satisfy the excavation requirements specified herein. For that purpose, the Contractor's initial blasts in each area shall be performed as trials, and the burden, drill hole pattern, hole depth, explosive type and quantity, blasting sequence and/or delay pattern shall be modified to achieve the requirements specified herein.

.4 Benching operations in any area shall be limited to a maximum of 9 m in height, unless the Contractor can demonstrate to the Engineer that the Contractor can meet the requirements set out in this Section of the Technical Specification while excavating

higher benches. The bench height may then be increased upon written acceptance by the Engineer.

3.3 CONTROLLED PERIMETER BLASTING

.1 Clean up and dispose of all excess material, trash, rocks, boulders and debris as Work progresses. Controlled perimeter blasting techniques shall be used on all faces steeper than 1.0 vertical to 1.0 horizontal against which concrete or earthfill is to be placed. Outside the limits of the concrete structures, controlled perimeter blasting techniques shall be used to excavate selected faces as directed by the Engineer.

.2 Drill holes for controlled perimeter blasting shall be not less than 63 mm in diameter and shall be a single row of holes spaced at no more than 0.5 m drilled down the required rock face. The maximum acceptable hole deviation shall be 0.15 m from the proposed alignment of the drill hole. On the basis of results obtained and subject to the acceptance by the Engineer, the spacing of the perimeter holes may be modified.

.3 All blast holes within a distance of 6 m horizontally and 2 m vertically to the final excavated face shall be less than 77 mm in diameter and shall be loaded in a manner and detonated in a sequence to ensure that a minimum of damage will result to the face when the main charge is fired.

.4 Only standard explosives manufactured especially for controlled blasting shall be used in controlled perimeter blasting holes, unless otherwise accepted by the Engineer. Bulk ammonium nitrate and fuel oil (ANFO) shall not be allowed to be loaded in the controlled perimeter blasting holes.

3.4 ROCK EXCAVATION TOLERANCES

.1 Excavated rock surfaces, against which concrete is to be placed, may remain up to 0.10 m inside the neat lines shown on the Purchaser's Drawings. In the channels outside the limits of the structures and where concrete will not be placed, rock may remain up to 0.15 m inside the neat lines, provided that the average excavation surface, as measured over any single rectangle area of 10 m^2, is not more than 0.10 m inside the neat lines.

.2 The Contractor's techniques of controlled perimeter blasting will be considered acceptable and in accordance with this Section of the Technical Specification for controlling the completed rock surface when at least 50% of the drill hole traces are visible and are distributed generally uniformly over the rock surface after scaling of all loose and shattered rock. In addition, not less than 80% of the surface area in any single rectangular area of 50 m^2 shall lie within a zone of 0.15 m outside and 0.10 m inside the neat lines of excavation shown on the Purchaser's Drawings, except where, in the opinion of the Engineer, the achievement of such results is not reasonably possible because of adverse rock conditions.

.3 Overbroken zones in rock faces against which concrete is to be placed shall be backfilled with concrete to the neat lines. Overbroken zones in rock faces against which concrete is not to be placed may be required to be backfilled with fill concrete if overbreak exceeds 600 mm in depth. Grouted dowels may be required to secure the concrete to rock on steep faces. Backfill concrete shall be placed to within 600 mm of the neat line. Engineer shall determine the need for fill concrete based on the stability requirements of the rock face and/or the effect of the overbreak on hydraulic flow.

3.5 MONITORING OF BLASTING

.1 The Engineer will monitor part or all of the Contractor's blasting operations utilizing seismographic or other equipment. The Contractor shall cooperate with the Engineer during the placing, operating, and recording with the Engineer's monitoring equipment. In general, trial blasts, initial blasting, initial blasts in new areas, and blasts adjacent to completed concrete, grout, cofferdams, and dams will be monitored.

3.6 PROTECTION OF CONCRETE, GROUT, EARTHFILL AND COMPLETED STRUCTURES

.1 In the vicinity of concrete or grout in place more than four hours and less than 60 hours, the peak particle velocity as determined by seismographic measurement shall not exceed 12 mm/s.

.2 In the vicinity of concrete or grout in place less than four hours, or greater than 60 hours but less than 28 days, the peak particle velocity shall not exceed 50 mm/s.

.3 In the vicinity of concrete or grout in place more than 28 days, the peak particle velocity shall not exceed 75 mm/s.

.4 For completed or partly completed portions of the main dams, dykes, or cofferdams, the peak particle velocity shall not exceed 75 mm/s, as measured at the nearest point to the blast on the toe of the fill or slope.

.5 On the basis of the observations made of the structures after each blast, the limits specified herein may be revised by the Engineer.

.6 The Contractor shall prevent damage to the transmission towers and overhead conductors at the Site during its blasting operation. The Contractor shall be responsible for any damage resulting from its blasting operations.

3.7 PROTECTION OF AQUATIC AND OTHER WILDLIFE

.1 To meet with the Environmental Impact Assessment of the Project, the Contractor shall carry out all blasting in conformance with the “Canadian Technical Report of Fisheries and Aquatic Sciences 2107 - Guidelines for Use of Explosives in or near Canadian Fisheries and Waters”, 1998, with update December 6, 2000. Tables 1 and 2 of that document present recommended setback distances from the centre of a confined explosive to fish spawning habitat to achieve 13 mm/sec guideline criteria.

.2 The Quarry Minerals Regulation prohibits blasting between 4 p.m. and 9 a.m. at any time on a Saturday, Sunday or Public Holiday, unless otherwise accepted by the director under the Mines and Minerals Act (see Subsection 1.3.4 References). To limit disturbance to wildlife, excavation activities shall not be continuous within a 24 hour period.

3.8 UTILIZATION AND DISPOSAL

.1 Rock excavated under this Section may be used in the construction of the cofferdams, the permanent structures, temporary and permanent roads, in the preparation of concrete aggregate, or placed in stockpiles for future use, or disposed of in designated areas.

.2 Temporary stockpiles shall be formed in such a manner that wastage and segregation of rock shall be kept to a minimum.

.3 Surfaces of temporary stockpiles shall be trimmed to safe slopes and to regular lines and grades satisfactory to the Engineer. Stockpiling of materials shall be such that it will not interfere with natural drainage.

.4 The utilization of all excavated rock shall be subject to the authorization of the Engineer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all Labour, Materials and Plant, and performing all Work required for all rock excavation in-the-wet under the upstream leg of the Spillway Stage 1 Cofferdam and under the rock groin placed on the upstream side of the cofferdam, all as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein. This aspect of the Work shall include transporting the excavated rock to and placing in temporary stockpiles or to disposal in locations acceptable to the Engineer, unless the excavated rock is utilized directly as fill in the cofferdams, Permanent Works, including their associated channels and permanent ditches, ancillary structures, in which case the transport and placement costs shall be included with the appropriate fill Item.

.2 Work to be performed under this Section shall include:

.1 Construction and maintenance of the Rock Groin upstream off the Spillway Stage I Cofferdam. This Rock Groin shall be constructed of Class C2 rockfill, or rockfill material approved by the Engineer.

.2 Construction and maintenance of a working pad consisting of fill material placed on top of the Spillway Stage I Cofferdam to facilitate drilling on a flat platform.

.3 Drilling through rock groin, working pad and Spillway Stage I Cofferdam to facilitate blasting.

.4 Removal of the Rock Groin and Rock Pad placed to facilitate the drilling and blasting of the bedrock beneath and outside of the Spillway Stage I Cofferdam.

.5 Controlling suspended sediment as per Section 31 25 00 which results from fill placement or excavation activities adjacent to or in the natural water courses to within the parameters indicated in the Considerations of Methods to Manage Sediment During Construction, a copy of which is included with these documents.

.6 The Contractor and the Engineer with jointly prepare as-built models of all Cofferdams. These models will be used to measure and determine the total Cofferdam removal quantities.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 31 23 16 - Unclassified Excavation.

.3 Section 31 23 17 – Rock Excavation.

.4 Section 31 23 01 – Weight Scales

.5 Section 31 25 00 – Erosion and Sedimentation Control.

.6 Section 31 52 00 - Cofferdams

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Wright, D.G., Hopky, G.E., “Canadian Technical Report of Fisheries and Aquatic Sciences 2107 - Guidelines for Use of Explosives in or near Canadian Fisheries and Waters”, 1998, with update December 6, 2000.

.2 Canadian Environmental Quality Guidelines, “Summary of existing Canadian Environmental Quality Guidelines”, update 2002.

.3 Williamson, D.A., “Manitoba Water Quality Standards, Objectives and Guidelines - Manitoba Conservative Report 2002-II - Final Draft”, November 22, 2002.

.4 Mines and Minerals Act (C.C.S.M. c. M162) - Quarry Minerals Regulations, 1992 - Regulation 65/92 - Sections 44(1), 44(2), 44(3).

.5 “Canadian Technical Report of Fisheries and Aquatic Sciences 2107 – Guidelines for Use of Explosives in or near Canadian Fisheries and Waters”, 1998, with update December 6, 2000.

.6 Manitoba Quarry Minerals Regulation.

1.4 DEFINITIONS

.1 "Rock" shall mean sound material of hardness and texture such that it cannot be readily loosened or removed by backhoe, clamshell, or hand shoveling.

.2 "Rock excavation in-the-wet" shall mean the removal of all rock which requires blasting, drilling, through a constructed cofferdam, rock groin and working pad, and adjacent to body of water; and the removal of boulders, and pieces of detached rock and buried concrete each 1.5 cubic meters or more in volume.

.3 "Controlled perimeter blasting" shall mean the techniques of pre-splitting or line drilling and variations thereof as necessary to achieve the results specified herein.

.4 "Line drilling" shall mean the drilling of a row of drill holes along the excavation limit spaced on centers no more than three times the hole diameter or 175 mm on centers, whichever is greater.

.5 "Smooth blasting" shall mean a controlled blasting technique where the neat line holes are detonated after the bulk has been blasted and removed.

.6 "Pre-splitting" shall mean the formation of cracks along the final excavation faces by firing a single row of holes prior to the initiation of the rest of the holes of the blast pattern.

.7 A “round” shall mean a single cycle of drilling, loading and blasting to excavate rock, including scaling, mucking and moving equipment in and out.

.8 “Overbreak” shall mean the volume of rock removed beyond the neat lines for the excavation as shown on the Purchaser’s Drawings.

.9 “sinking cut/shot” shall mean a blast where there is no free vertical or slope face available. In this type of blast, a portion of the blasted material will be expelled upward to create space for the expanding material from subsequent detonation charges.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified.

.2 Measurement

.1 Measurement for Items 31 23 18 (a)i shall be the dry weight of materials placed for the construction of the Rock Groin and Working Pad in tonnes, as presented in the drawings and as directed by the Engineer. Tonnage tickets will be collected following each day for each truck delivered, unloaded and placed.

.2 Measurement for Items 31 23 18 (a)ii shall be in cubic metres of excavated bedrock made using the on-Site surveying information jointly gathered by the Contractor and the Engineer from a comparison of the surveyed geometrybefore the placement of the Rock Groin , as measured and accepted by the Engineer. The measured volume shall be determined using software tools such as Autodesk Civil 3D using the composite volume method that is represented by the two Triangulated Irregular Networks, (TIN), one being the above survey information and the other being the excavation limits based on the neat lines shown on the Purchaser's Drawings. The composite calculation will determine the volume from the discrete difference between each surface. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary surfaces for accurate measurements.

.3 No separate measurement or pricing will be made for excavation, scaling, or loose rock removal beyond the neat lines of excavation as shown on the Purchaser's Drawings or as directed by the Engineer; or for any measures employed to mitigate potential impacts on water and fish.

.4 No separate measurement or pricing will be made for the removal of the Rock Groin or Working Pad.

.5 No separate measurement or pricing will be made for drilling and blasting to loosen or break the rock.

.3 Unit Price

.1 The unit prices for Items 31 23 18 (a)i to 31 23 18 (a)ii inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for sorting or selective excavation techniques required in the rock excavations and removal , and as follows:

.1 Item 31 23 18 (a)i shall cover the supply, transport and place class C2 material for the Rock Groin, and for rockfill, or granular fill as approved by the Engineer for the Working Pad.

.2 Item 31 23 18 (a)ii shall cover the rock excavation in-the-wet under the upstream leg of the Spillway Stage 1 Cofferdam and under the rock groin place on the upstream side of the cofferdam as shown in the drawing.

.2 Excavating, scaling and loose rock removal beyond the neat lines shown on the Purchaser's Drawings or any measures employed to mitigate impacts on water and fish are considered incidental to the Work set out in this Section. Include costs for such Work in the unit prices proposed for Items to which this Work applies.

.3 Drilling and blasting for rock excavation is considered incidental in the Work set out in this Section. Include costs for such Work in the unit prices proposed for Items to which this Work applies.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 The Contractor shall submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, at least 1 month before commencing excavation, a Rock Excavation Plan as defined in Section 31 23 17 Section 1.6. The Rock Excavation Plan shall include the Contractor's proposed methods and sequence of excavating rock in-the-wet, including controlled perimeter blasting , pre-split or sinking cut procedures as necessary, together with the pertinent data for each stage of each area.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

1.8 PRE-BLAST SURVEY

.1 Contractor shall conduct a pre-blast survey as outlined in Section 31 23 17 Rock Excavation Section 1.8 to document the pre-blast condition of structures and slopes.

1.9 DRAINAGE AND DISPOSAL

.1 Surface flows shall be directed away from the Work by means of ditches or other acceptable means.

.2 Water pumped into the river shall meet with the Canadian Environmental Quality Guidelines for freshwater containing aquatic life and Manitoba water quality standards. For details, please see the references set out in Subsection 1.3.3 of this Section of the Technical Specification.

.3 The removal of snow and ice, when necessary to ensure the safe and effective performance of this aspect of the Work, shall be performed by the Contractor.

Part 2 Products

2.1 GENERAL

.1 Contractor shall furnish all products necessary for the completion of the Work set out in this Section of the Technical Specification.

.2 The Federal Fisheries Act prohibits the deposit of toxic by-products (ammonia) from ammonium nitrate-fuel oil (ANFO) mixtures into waters frequented by fish. ANFO shall not be permitted for excavations in or near water. Only standard explosives manufactured especially for blasting in-the-wet shall be, unless otherwise accepted by the Engineer.

Bulk ammonium nitrate and fuel oil (ANFO) shall not be allowed to be loaded in the blasting holes.

.3

Part 3 Execution

3.1 GENERAL

.1 The Contractor shall be responsible for the safety of all excavations performed until final acceptance of the Work and shall perform all remedial work required in excavations throughout the duration of the Contract to ensure that all excavated rock surfaces are maintained in a stable and safe condition.

.2 All excavation shall be performed in accordance with the best modern practice, using methods and techniques that will reduce overbreak to a minimum beyond the neat lines and grades shown on the Purchaser's Drawings or as directed by the Engineer, and which will preserve, in the soundest possible condition, the rock beyond these lines and grades. Particular care shall be exercised in the excavations where vertical or near vertical rock faces are required. Shattering or splitting of rock, or the opening up of seams in rock not required to be excavated, shall be prevented, and any shattered material and drummy rock beyond such lines caused by excavation operations, shall be removed at no additional expense to the Purchaser.

.3 Drilling in-the-wet will be extended through the rock fill with specialized casing from top of the rock groin or rock fill pad to solid rock (depth is variable) as approved by the Engineer. Each hole will then be extended (drilled) thru the bedrock to the required design depth.

.4 During drilling, all measures necessary to maintain the hole shall be taken by the Contractor as required.

.5 To maintain the integrity of the Spillway Stage 1 Cofferdam and avoidunanticipated under seepage, the contractor shall perform the excavation in-the-wet immediately prior to removal of the Spillway Stage 1 Cofferdam. .

3.2 EXCAVATION METHODS

.1 Special blasting procedures, including controlled perimeter blasting, shall be used to obtain sound excavation faces.

.2 All blasting operations shall be performed in a manner satisfactory to the Engineer and as required to achieve the tolerances and results as specified herein. Care shall be taken to avoid disturbing completed Work and the Contractor shall be prepared to limit blasting operations in accordance with Subsection 3.6 of this Section in the vicinity of concrete, and earthfill in place, completed structures, grouted areas and grouting operations, and cofferdams.

.3 The Contractor shall develop controlled blasting techniques by trial on land, which will satisfy the excavation requirements specified herein. For that purpose, the Contractor's initial blasts in each area shall be performed as trials, and the burden, drill hole pattern, hole depth, explosive type and quantity, blasting sequence and/or delay pattern shall be modified to achieve the requirements specified herein.

3.3 MONITORING OF BLASTING

.1 The Engineer will monitor part or all of the Contractor's blasting operations utilizing seismographic or other equipment. The Contractor shall cooperate with the Engineer during the placing, operating, and recording with the Engineer's monitoring equipment. In general, trial blasts, initial blasting, initial blasts in new areas, and blasts adjacent to completed concrete, grout, cofferdams, and dams will be monitored.

3.4 PROTECTION OF CONCRETE, GROUT, EARTHFILL AND COMPLETED STRUCTURES

.1 In the vicinity of concrete or grout in place more than four hours and less than 60 hours, the peak particle velocity as determined by seismographic measurement shall not exceed 12 mm/s.

.2 In the vicinity of concrete or grout in place less than four hours, or greater than 60 hours but less than 28 days, the peak particle velocity shall not exceed 50 mm/s.

.3 In the vicinity of concrete or grout in place more than 28 days, the peak particle velocity shall not exceed 75 mm/s.

.4 For completed or partly completed portions of the main dams, dykes, or cofferdams, the peak particle velocity shall not exceed 75 mm/s, as measured at the nearest point to the blast on the toe of the fill or slope.

.5 On the basis of the observations made of the structures after each blast, the limits specified herein may be revised by the Engineer.

3.5 PROTECTION OF AQUATIC AND OTHER WILDLIFE

.1 To meet with the Environmental Impact Assessment of the Project, the Contractor shall carry out all blasting in conformance with the “Canadian Technical Report of Fisheries and Aquatic Sciences 2107 - Guidelines for Use of Explosives in or near Canadian Fisheries and Waters”, 1998, with update December 6, 2000. Tables 1 and 2 of that document present recommended setback distances from the centre of a confined explosive to fish spawning habitat to achieve 13 mm/sec guideline criteria.

.2 By-products from the detonation of explosives may include ammonia or similar compounds and may be toxic to fish and other aquatic biota. The deposit of deleterious substances in to waters frequented by fish is prohibited under Section 36(3) of the Fisheries Act, unless otherwise permitted by regulation.

.3 Contractor should contact Department of Fisheries and Oceans (DFO) before irrevocable commitments (such as contracts for equipments/services) are made, in order to avoid any unnecessary delays in the application process.

.4 The Quarry Minerals Regulation prohibits blasting between 4 p.m. and 9 a.m. at any time on a Saturday, Sunday or Public Holiday, unless otherwise accepted by the director under the Mines and Minerals Act (see Subsection 1.3.4 References). To limit disturbance to wildlife, excavation activities shall not be continuous within a 24 hour period.

3.6 UTILIZATION AND DISPOSAL

.1 Rock excavated under this Section may be used in the construction of the cofferdams, the permanent structures, temporary and permanent roads, in the preparation of concrete aggregate, or placed in stockpiles for future use, or disposed of in designated areas.

.2 Temporary stockpiles shall be formed in such a manner that wastage and segregation of rock shall be kept to a minimum.

.3 Surfaces of temporary stockpiles shall be trimmed to safe slopes and to regular lines and grades satisfactory to the Engineer. Stockpiling of materials shall be such that it will not interfere with natural drainage.

.4 The utilization of all excavated rock shall be subject to the authorization of the Engineer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Mmaterials and Pplant, and performing all Work necessary for the design, fabrication, installation, maintenance and removal of temporary dewatering facilities required to remove surface water, natural surface runoff or groundwater seepage from the Site.

.2 The Work performed by the Contractor pursuant to this Section of the Technical Specification shall be in accordance with any and all Erosion and Sediment Control Plans accepted by the Purchaser.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Data for Proponents.

.3 Section 31 52 00 - Cofferdams.

.4 Section 31 25 00 - Erosion and Sedimentation Control.

1.3 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 There shall be no separate measurement or payment for control of water and associated Work and it shall be considered incidental to the related Items of Work to which the Work of this Section applies.

1.4 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 Contractor shall submit, at least 30 days prior to the start of construction, a complete plan for diversion of flowing water and dewatering the Site. The plan shall include a description of the methods and procedures, a sequence of operations with corresponding schedule, details of temporary structures and a description which includes the capacity of the proposed equipment for use in the diversion Work. The plan shall include design calculations, installation details, Materials, sequencing of Work on Contractor's Documents, and any other information required to fully describe the Contractor's plans. The design shall be carried out by a qualified professional Engineer and shall carry the signature of the Engineer responsible for the design.

.3 Contractor's 'Control of Water Plan' shall include the detailed means and methods for controlling water into the Work areas and shall also include an 'Emergency Action Plan'. The Emergency Action Plan shall describe in detail the action to be taken with respect to the evacuation of workers and equipment from Work areas whenever overtopping or failure of any control of water system is imminent. The Emergency Action Plan must also provide measures to ensure public and property safety, not related to this Contract, if applicable.

1.5 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 GENERAL

.1 Contractor shall furnish all Materials, equipment, labor, and appurtenances required for furnishing, installing, and removing water control facilities and shall also supply sufficient standby pumping and auxiliary equipment to preclude any interruption of pumping operations during periods of breakdown, off shift hours, holidays and maintenance.

Part 3 Execution

3.1 DESIGN

.1 The Contractor shall provide surface runoff drainage management to handle a storm with a return period of 25 years and duration of 24 hours. The surface runoff drainage system shall discharge into appropriate watercourses in accordance with applicable Laws.

.2 The Contractor shall design, construct and maintain facilities with sufficient capacity to handle precipitation and surface run-off during construction for at least the 25 year recurrence interval flood event without damage to the constructed Work or delay to the completion of the Project.

.3 The Contractor shall design, construct and maintain facilities with sufficient capacity to handle all temporary pumping required to maintain the powerhouse drainage sump within the control range specified by the Engineer and to keep the intake and dewatering gallery in a water free state until the permanent pumps are operational. This Work shall be undertaken without damage to the constructed Work or delay to the completion of the Project.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures as per Section 31 25 00 Erosion and Sedimentation Control to prevent soil erosion and discharge of soil-bearing water runoff.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established, as per Section 31 25 00 Erosion and Sedimentation Control.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal, as per Section 31 25 00 Erosion and Sedimentation Control.

3.3 CONSTRUCTION

.1 The Contractor shall construct drainage, drainage ditches, sumps, pits and settlement ponds with oil separators.

.2 The Contractor shall operate and maintain the dewatering equipment and relocate as required for the performance of other Work pursuant to the Contract.

.3 The Contractor shall furnish, construct and maintain all auxiliary Work required for safe and continuous dewatering of the Site.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for supplying, transporting and placing Class 1 impervious fill as shown on the Purchaser's Drawings, Contractor's Documents, as determined by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 General Specification.

.2 Section 31 14 13 - Stockpiling of Materials.

.3 Section 31 52 00 - Cofferdams.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, the Works shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D422 - "Standard Test Method for Particle-Size Analysis of Soils.

.2 ASTM D698 - "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m^3))", ASTM International.

.3 ASTM D2216 - "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock and Soil–Aggregate Mixtures.

.4 ASTM D2922 - "Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.4 SUBMITTALS

.1 The requirements shall be in accordance to the Subsection 21.7 Contractor's Documents of the General Specification.

.2 Contractor shall submit plan for winter protection of impervious fill material for the Engineer's review in accordance with Subsection 21.7.9 Engineer's Review.

.3 Winter protection plan shall be submitted at least 30 days prior to commencing protection Work.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be in accordance with the General Specification, the Terms and Conditions of Payments and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate as set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for items of Work of this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price for each Item as specified and incorporating any changes as identified in Section 27 Clarifications and Changes to the Work and Adjustments in the General Specification.

.2 Measurement

.1 Measurement for Items 31 23 23 (a)i to 31 23 23 (a)viii inclusive shall be in cubic metres made in place in the structures, between the surface of the prepared foundations and the neat lines and grades presented in the Purchaser's Drawings, as described in the following and as determined by the Engineer. The onsite surveying information will be jointly gathered by the Contractor and the Engineer from a comparison of the pre-construction survey after the foundation preparation but prior to the fill placement. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary surfaces for accurate measurements. The volume will be measured from the neat lines shown on the Purchaser's Drawings as compared with the onsite surveyed geometry following the foundation preparation but prior to the fill placement (where appropriate), as measured and authorized by the Engineer. The measured volume for shall be determined using software tools such as Autodesk Civil 3D using the composite volume method that is represented by two Triangulated Irregular Networks, (TIN). The composite calculation will determine the volume from the discrete difference between each surface.

.2 No separate measurement or adjustments to the Target Price will be made for winter protection measures, for moisture content control testing, and for test sections of fill placement located outside the designated earth structures identified under Paragraph 1.5.3

.3 Unit Price

.1 The unit prices proposed for Items 31 23 23 (a)i to 31 23 23 (a)viii inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, transporting and placing Class 1 impervious fill as specified herein, as shown on the Purchaser's Drawings and in the 3D Project Model and as follows:

.1 Item 31 23 23 (a)i shall cover supply, transport, and place Class 1 Impervious Fill for North Dam.

.2 Item 31 23 2 (a)ii shall cover supply, transport, and place Class 1 Impervious Fill for South Dam.

.3 Item 31 23 23 (a)iii shall cover supply, transport, and place Class 1 Impervious Fill for South Dam- Saddle Dams.

.4 Item 31 23 23 (a)iv shall cover supply, transport, and place Class 1 Impervious Fill for Central Dam.

.5 Item 31 23 23 (a)v shall cover supply, transport, and place Class 1 Impervious Fill for North Dyke.

.6 Item 31 23 23 (a)vi shall cover supply, transport, and place Class 1 Impervious Fill for South Dyke.

.7 Item 31 23 23 (a)vii shall cover supply, transport, and place Class 1 Impervious Fill for South Access Road Ramp.

.8 Item 31 23 23 (a)viii shall cover supply, transport, and place Class 1 Impervious Fill for North Access Road Ramp.

.4 Water protection measures, moisture content control testing, and fill placement for test sections are considered incidental to the Work. Include costs for such Work in the unit prices for Items to which this Work applies.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Class 1 Impervious Fill

.1 Class 1 Impervious Fill, in place in the embankments, shall be silty clay material, free of organic matter, snow, ice, frozen or other deleterious material, and well-graded within the gradation limits given below:

Sieve Size	Percent Passing by Weight
	Class 1
150 mm	100
76 mm	98-100
38 mm	95-100
19 mm	90-100
No. 4 (4.75 mm)	80-100
No.10 (2.00 mm)	70-100
No.40 (425 µm)	50-92
No.100 (150µm)	38-80
No.200 (75 µm)	30-70
0.01 mm	10-40
0.002 mm	0-20

.2 Class 1 impervious material may be obtained from borrow areas shown on the Purchaser's Drawings where investigations have indicated the presence of suitable materials.

.3 Alternatively, Class 1 impervious material may be obtained from the required unclassified excavations or other sources authorized by the Engineer.

2.2 EQUIPMENT

.1 Equipment for the compaction of silty clay materials shall consist of Discing equipment, Towed-Tamping (Sheepsfoot) Rollers, Self-propelled Tamping (Sheepsfoot) Rollers, and/or Rubber Tired Rollers and light compaction equipment for restricted areas, as specified below.

.2 Discing Equipment.

.3 Towed - Tamping (Sheepsfoot) Rollers

.1 Towed - Tamping (Sheepsfoot) Rollers shall consist of two or more non-vibratory roller drums mounted side-by-side in a suitable frame and towed by either a crawler-type or rubber tired tractor having sufficient power to pull the roller satisfactorily when the drums are fully ballasted. Each drum shall be free to pivot about an axis parallel to the direction of travel. Rollers operated in tandem sets shall be controlled in a manner such that the prints produced by the tamping feet of the tandem units are staggered.

.2 Each drum of a roller shall have an outside diameter of not less than 1,500 mm and shall be not less than 1,500 mm in length. The space between two adjacent drums, when on a level surface, shall not be less than 300 mm nor more than 375 mm.

.3 At least one tamping foot shall be provided for each 186,000 mm^2 of drum surface. The length of each tamping foot from the outside surface of the drum shall be not more than 275 mm and shall be maintained at not less than 225 mm. The bearing surface of each tamping foot shall be flat with a surface area not less than 4,500 mm^2 nor more than 6,500 mm^2. During the operation of rolling, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tampering rollers. The weight of a roller when fully loaded shall be not less than 58,400 N/m of drum length, and the weight of a roller empty shall be not more than 36,500 N/m of drum length.

.4 The bearing surface, tamping foot size, the drum loading, and the operation of the rollers shall be as required to obtain the desired compaction. If more than one roller is used on any one layer of fill, all rollers so used shall be of the same type and essentially of the same dimensions. Rollers shall be drawn by crawler-type or rubber-tired tractors at a speed not to exceed 5 km/h. The use of rubber-tired towing equipment shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller, and the substitution of crawler-type towing equipment may be determined by the Engineer.

.4 Self-Propelled Tamping (Sheepsfoot) Rollers

.1 The use of self-propelled non-vibratory tamping (Sheepsfoot) rollers conforming with the following specification will be permitted, and their design and operation shall be subject to authorization by the Engineer, and subject to the right, at any time during the execution of the work, to direct such modifications to the tamping feet or variations in roller drum weight where applicable, as may be found necessary to secure optimum compaction of the earth fill materials. If use

of self-propelled tamping rollers causes shearing of the fill, laminations in the fill, or results in inadequate compaction, the Engineer may direct that such rollers be removed from the fill and that appropriate towed tamping rollers be used.

.2 Two or three-drum side-by-side units that are either in drive position or drawn by separate power equipment shall have a clearance between adjacent drums not less than 300 mm nor more than 375 mm. Two-drum or four-drum equipment separated by cab and differential and arranged in tandem must have its static weight equally distributed to all compaction drums and must have the tandem drums positioned such that the prints of the tamping feet produced by the tandem drums are staggered.

.3 The surface on which the tamping feet are mounted shall have a minimum outside diameter of 1,200 mm and at least one tamping foot for each 186,000 mm^2 of drum surface. The distance between the centers of any two adjacent tamping feet shall be not less than 225 mm. The length of each tamping foot from the outside mounting surface of the drum shall be not more than 275 mm and shall be maintained at not less than 225 mm. The bearing surface of each tamping foot shall be flat and have a surface area not less than 4,500 mm^2 nor more than 9,000 mm^2. Cupped recesses within the bearing surface of each tamping foot will be permitted but shall not exceed 13 mm in depth. During rolling operations, the spaces between the tamping feet shall be maintained clear of materials which would impair the effectiveness of the tamping roller.

.4 The weight of all roller drums during compaction of fill materials shall be maintained uniform and with the weight per metre of drum length not less than 62,800 N.

.5 For self-propelled rollers in which steering is accomplished through the use of rubber-tired wheels, the tire pressure shall not exceed 275 kPa. The use of the compactor shall be discontinued if the tires leave ruts that prevent uniform compaction by the tamping roller and the substitution of appropriate towed tamping rollers may be directed. When a self-propelled roller is provided with a dozer blade, coverages made with the blade in operation shall not be counted as compaction coverages. Self-propelled rollers shall be operated at a speed not to exceed 5 km/h.

.5 Rubber Tired Rollers

.1 Rubber-tired rollers shall have a minimum of four wheels equipped with pneumatic tires. The tires shall be of such size and ply as can be maintained at tire pressures between 550 and 700 kPa for a 110 kN wheel load during rolling operations. The roller wheels shall be located abreast and be so designed that each wheel will carry approximately equal load in traversing uneven ground. The spacing of the wheels will be such that the distance between the nearest edges of adjacent tires will be greater than 50% of the tire width of a single tire at the operating pressure for a 110 kN wheel load. The roller shall be provided with a body suitable for ballast loading such that the load per wheel may be varied, from 80 to 110 kN. The roller shall be towed at speeds not to exceed 5 km/h. The character and efficiency of this equipment shall be subject to authorization by the Engineer.

.6 Light equipment for restricted areas

.1 Power tampers for compaction in restricted areas and adjacent to concrete structures in accordance with Paragraph 3.3.7 shall be subject to the authorization of the Engineer.

Part 3 Execution

3.1 PLACEMENT

.1 The placing of Class 1 impervious fill shall be subject to the authorization by the Engineer and shall be directed at obtaining a stable and homogeneous fill, which is free of horizontal stratifications and of lenses or pockets of pervious materials and from lumps of material which do not satisfy the requirements of these Specifications. To achieve a homogeneous fill, methods such as discing, ploughing, or other suitable operations may be required as determined by the Engineer.

.2 Impervious fill shall be placed to lines and grades as shown on the Purchaser's Drawings. No impervious shall be placed on any part of the foundation until the foundation has been inspected and authorized by the Engineer.

.3 Placement of Class 1 fill shall commence at the area having the lowest foundation elevation.

.4 Special attention shall be given to the boundary between the Class 1 impervious fill and adjacent granular fill zones to ensure adequate compaction at these boundaries.

.5 The Class 1 impervious fill shall be raised in such a way that the top surface of any section under construction shall remain approximately level and crowned. The Class 1 impervious fill shall also be maintained at approximately the same level as adjacent pervious fill zones of the embankment and in no case shall the difference in levels exceed one lift thickness.

.6 If fill placement activities are to be discontinued for an extended period of time or when rain is anticipated, the surface of the Class 1 impervious fill shall be raised above the adjacent granular zones and crowned and sealed.

.7 During placing and compacting operations, equipment shall be turned carefully to maintain uniform compaction. Compaction units shall travel at speeds not exceeding 5 km/h and shall travel in a direction parallel to the axis of the impervious core. Units which are not self-propelled shall only be pulled, not pushed. The lifts within a zone shall be compacted in strips with compaction coverage overlapping not less than 0.6 m.

.8 The Contractor shall maintain and protect the embankment in a satisfactory condition at all times. If in the opinion of the Engineer the hauling equipment causes horizontal shears or slickensides, rutting, quaking, heaving, cracking, or excessive deformation of the embankment, the Contractor shall limit the type, load, or travel speed of the hauling equipment on the embankment.

.9 After dumping, the Class 1 material shall be spread in a direction parallel to the embankment axis in continuous and approximately horizontal layers not exceeding 0.20 m in thickness. During spreading and compaction, a crown shall be maintained on the fill surface providing a transverse grade not less than 2% nor more than 5% so that water from precipitation will drain freely into the adjacent zones.

.10 All openings through embankments for construction purposes shall be subject to the authorization of the Engineer. The slope of openings left through embankments and the end of any unfinished section, shall not be steeper than four horizontal to one vertical. Prior to placement of fill to close the openings, all loosened, dried or altered fill shall be removed, as determined by the Engineer. Additional scarification and compaction shall be applied to the contact between the existing and additional fill as determined by the Engineer.

.11 Materials which contain any roots, sod or top-soil shall be removed from the embankment and disposed of in an authorized area as determined by the Engineer. All stones and rock fragments having maximum dimensions greater than 0.15 m shall be removed from the Class 1 fill prior to compaction.

.12 Care shall be taken to prevent the Class 1 impervious fill from being contaminated by mixing with adjacent granular materials.

.13 Fill shall not be placed in a frozen condition and shall not be placed on a surface which is frozen or covered with snow or ice. Placing of fill in freezing weather shall only be permitted if authorized by the Engineer and when proper measures are taken to prevent freezing of the material.

.14 Any portion of the impervious fill or random fill which has suffered a reduction in density due to the action of frost, rain, or due to any other reason, shall be scarified and re-compacted or removed.

3.2 MOISTURE CONTENT CONTROL

.1 The moisture content shall be as uniform as practicable throughout any one layer of impervious material. The moisture content shall be such as to provide for proper compaction of the material, and shall be determined by the Contractor to suit the plasticity of the material being placed. The impervious materials shall be compacted with a moisture content between 1% below and 3% above the optimum moisture content as determined by ASTM D698ael, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))", ASTM International.

.2 Notwithstanding the limits specified above, the moisture content shall not exceed that at which rutting begins to occur during the placing operations.

.3 Material that is too wet for proper compaction shall be removed from the fill and wasted or spread and permitted to dry, assisted if necessary by discing or harrowing or other suitable methods, until the moisture content is reduced to within the specified limits.

.4 When the moisture content of the material is below the specified lower limit, the Contractor shall add water to the material at the borrow area or stockpile area, or alternatively, the Contractor shall increase the moisture content of the material when it is deposited on the embankment. If the latter method is adopted, the Contractor shall sprinkle each layer of the fill and work the water into the uncompacted layer by means of discing, harrowing, or other acceptable methods until a uniform and satisfactory moisture distribution is obtained. The amount of water added to the fill shall be carefully controlled so that no free water will appear on the surface during rolling. Should too much water be added to any layer, no additional fill shall be placed until the moisture content has been reduced to an amount within the specified limits.

3.3 COMPACTION REQUIREMENTS

.1 After a layer has been spread and conditioned to have the required moisture content, it shall be graded with a motor patrol and then compacted with compaction equipment that has been authorized by the Engineer. Each layer shall be compacted to the density specified below.

.2 Following compaction and prior to the placement of a new lift of fill, the surface shall be loosened by discing, harrowing or other authorized methods.

.3 If the impervious fill is too dry to bond properly with the lift of material to be placed thereon, it shall be moistened and scarified to a sufficient depth to provide a satisfactory bonding surface before the succeeding lift of material is placed.

.4 If the impervious fill is too moist for proper compaction of the lift of material to be placed thereon, it shall be removed, allowed to dry, and/or be scarified to reduce the moisture content to the specified limits. It shall then be compacted to the specified requirements before the succeeding lift of impervious fill is placed.

.5 Class 1 impervious fill materials placed immediately over and adjacent to the bedrock and concrete structures shall be conditioned such that the moisture content of the fill is between optimum and 3% above Standard Proctor Optimum moisture content. To achieve the best possible contact between the fill and the abutment foundation or concrete structure, the lifts shall be sloped up against the contacts at a slope of approximately 1V:6H for a distance of 3 to 4 m. Heavy pneumatic equipment may be used to compact the impervious fill and may travel in a direction parallel to the face.

.6 The density of the impervious material in place, for an average of any 10 consecutive field test samples, shall not be less than 98% of the maximum Standard Proctor Density as determined in accordance with ASTM D698-00ae1, "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))", ASTM International. The density of the impervious material, as indicated by any single test, shall not be less than 95% of the maximum Standard Proctor Density.

.7 Portions of the fill which, in the opinion of the Engineer, cannot be compacted adequately with rollers, due to inaccessibility, and fill that is within 1 m of concrete structures, shall be placed in layers not exceeding 0.10 m in thickness, and compacted to the specified density by means of power tampers. The type of tamper and its method of operation shall be subject to authorization by the Engineer. Rubber-tired hauling equipment, as authorized by the Engineer, may be used to compact the initial layers above rock or concrete.

.8 Inspection pits and trenches, not to exceed 10 in number, which may be required for Quality Assurance, shall be excavated by the Contractor as determined by the Engineer. On completion of the tests, the inspection pits or trenches shall be backfilled with the excavated materials there from to a density equal to or greater than that of the adjacent part of the embankment as specified herein. The methods of placing and compaction may be varied according to the results obtained from the tests. While these tests will be the responsibility of the Engineer, the Contractor shall cooperate in every way to ensure that tests can be performed at all locations and times, as determined by the Engineer. Payment for excavation and backfill of inspection pits and trenches will be made on a time and materials basis as described in Subsection 27.3 Changes to the Work of the General Specification.

3.4 WINTER PROTECTION

.1 Contractor shall prepare and submit a plan for winter protection of placed and compacted impervious fill material to ensure such material is not damaged by frost or moisture penetration during the winter season.

.2 Protection measures may include the use of tarpaulins, blankets, granular fill cover, sacrificial layers, or a combination of these and other measures, as authorized by the Engineer.

.3 All impervious fill material left in place over a winter season must comply with Paragraph 3.3.6 prior to proceeding with new material placement.

.4 All winter protection measures including labour, equipment and materials, etc. shall be considered incidental to impervious fill placement, and will not be measured separately for payment.

3.5 TEST SECTIONS

.1 As soon as is practicable after the first impervious borrow material becomes available from the required excavations, the Contractor shall construct test sections to confirm the required compactive effort and moisture conditioning to be used in the compaction of the impervious fill. Test sections shall be located in the stockpile area or any other area authorized by the Engineer. The materials may be excavated at a later date for use in the work on the authorization of the Engineer.

.2 For these sections, the lift thickness, moisture content, and number of passes shall be varied as required by the Engineer. The Contractor shall have available for these test sections at least one compaction unit of each type, which is proposed for use in the compaction of impervious fill. The Contractor shall cooperate with the Engineer at all times in the conducting of these tests.

.3 Based on the results of these test sections, the lift thickness, type of compaction unit, moisture conditioning, and the number of passes required may be revised.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary for supplying, transporting and placing Classes 2a, 2b, 3 and 4 Granular Fill materials as shown on the Purchaser's Drawings, Contractor's Documents, as determined by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D422 - "Standard Test Method for Particle-Size Analysis of Soils".

.2 ASTM D698 - "Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3)", ASTM International.

.3 ASTM D4253 - "Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table", ASTM International.

.4 ASTM D2216 - "Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.

.5 ASTM D2922- "Standard Test Method of Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 23 24 (a)i to 31 23 24 (d)vi inclusive shall be in cubic metres of Granular Fill placed and compacted as presented in the Purchaser's Drawings and as determined by the Engineer. The onsite surveying information will be jointly gathered by the Contractor and the Engineer from a comparison of the pre-construction survey after the foundation preparation but prior to the fill placement. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary surfaces for accurate measurements. The volume will be measured from the neat lines shown on the Purchaser's Drawings as compared with the onsite surveyed geometry following the foundation preparation but prior to the fill placement (where appropriate), as measured and authorized by the Engineer. The measured volume shall be determined using software tools such as Autodesk Civil 3D using the composite volume method that is represented by two Triangulated Irregular Networks, (TIN). The composite calculation will determine the volume from the discrete difference between each surface.

.2 No separate measurement or target price will be made for testing of materials and compaction tests for excavating, trenching, backfilling, and associated Work.

.3 Unit Price

.1 The unit prices proposed for Items 31 23 24 (a)i to 31 23 24 (a)x inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be supplying, transporting, and placing of Class 2a (Pervious Granular) fill as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 24 (a)i shall cover supply, transport, and place Class 2a fill for North Dam.

.2 Item 31 23 24 (a)ii shall cover supply, transport, and place Class 2a fill for parking lot and access ramp.

.3 Item 31 23 24 (a)iii shall cover supply, transport, and place Class 2a fill for South Dam.

.4 Item 31 23 24 (a)iv shall cover supply, transport, and place Class 2a fill for South Dam - Saddle Dams.

.5 Item 31 23 24 (a)v shall cover supply, transport, and place Class 2a fill for Central Dam.

.6 Item 31 23 24 (a)vi shall cover supply, transport, and place Class 2a fill for North Dyke.

.7 Item 31 23 24 (a)vii shall cover supply, transport, and place Class 2a fill for South Dyke.

.8 Item 31 23 24 (a)viii shall cover supply, transport, and place Class 2a fill for south access road ramp.

.9 Item 31 23 24 (a)ix shall cover supply, transport, and place Class 2a fill for north access road ramp.

.10 Item 31 23 24 (a)x shall cover supply, transport, and place Class 2a fill for transmission Tower Spur.

.11 Item 31 23 24 (a)xi shall cover supply, transport, and place Class 2a fill for Winter placement for North Dyke.

.12 Item 31 23 24 (a)xii shall cover supply, transport, and place Class 2a fill for Winter placement for South Dyke.

.2 The unit prices proposed for Items 31 23 24 (b)i to 31 23 24 (b)vi inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, transporting, and placing of Class 2b (Semi-Pervious Granular) fill as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 24 (b)i shall cover supply, transport, and place Class 2b fill for North Dam.

.2 Item 31 23 24 (b)ii shall cover supply, transport, and place Class 2b fill for South Dam.

.3 Item 31 23 24 (b)iii shall cover supply, transport, and place Class 2b fill for South Dam Saddle Dams.

.4 Item 31 23 24 (b)iv shall cover supply, transport, and place Class 2b fill for Central Dam.

.5 Item 31 23 24 (b)v shall cover supply, transport, and place Class 2b fill for North Dyke.

.6 Item 31 23 24 (b)vi shall cover supply, transport, and place Class 2b fill for South Dyke.

.7 Item 31 23 24 (b)vii shall cover supply, transport, and place Class 2b fill for south access road ramp.

.8 Item 31 23 24 (b)viii shall cover supply, transport, and place Class 2b fill for north access road ramp.

.9 Item 31 23 24 (b)ix shall cover supply, transport, and place Class 2b fill for transmission Tower Spur.

.3 The unit prices proposed for Items 31 23 24 (c)i to 31 23 24 (c)vii inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, transporting, and placing of Class 3 (Fine Filter) fill as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 24 (c)i shall cover supply, transport, and place Class 3 fill for North Dam.

.2 Item 31 23 24 (c)ii shall cover supply, transport, and place Class 3 fill for South Dam.

.3 Item 31 23 24 (c)iii shall cover supply, transport, and place Class 3 fill for Central Dam.

.4 Item 31 23 24 (c)iv shall cover supply, transport, and place Class 3 fill for North Dyke.

.5 Item 31 23 24 (c)v shall cover supply, transport, and place Class 3 fill for South Dyke.

.6 Item 31 23 24 (c)vi shall cover supply, transport, and place Class 3 fill for south access road ramp.

.7 Item 31 23 24(c)vii shall cover supply, transport, and place Class 3 fill for north access road ramp.

.4 The unit prices proposed for Items 31 23 24 (d)i to 31 23 24 (d)vi inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, transporting, and placing of Class 4 (Coarse Filter) fill as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 24 (d)i shall cover supply, transport, and place Class 4 fill for North Dam.

.2 Item 31 23 24 (d)ii shall cover supply, transport, and place Class 4 fill for South Dam.

.3 Item 31 23 24 (d)iii shall cover supply, transport, and place Class 4 fill for Central Dam.

.4 Item 31 23 24 (d)iv shall cover supply, transport, and place Class 4 fill for North Dyke.

.5 Item 31 23 24 (d)v shall cover supply, transport, and place Class 4 fill for South Dyke.

.6 Item 31 23 24 (d)vi shall cover supply, transport, and place Class 4 fill for transmission Tower Spur.

.5 Material and compact testing is considered incidental to the Work. Include the costs for such Work in the unit prices proposed for the Items to which this work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Provide for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review the manufacturer's data giving all dimensions, weight and complete technical data for vibratory rollers.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Class 2a (Pervious Granular Fill)

.1 Class 2a fill shall be a uniform to well graded pit run gravelly sand with less than 5% (by weight) passing 0.075 mm. free of organic matter, snow, ice or other deleterious material with the gradation limits specified below.

Sieve Size	Percent Passing by Weight
75.0 mm	100
19.0 mm	90-100
No.4 (4.75 mm)	70-100
No.10 (2.00 mm)	55-100
No.40 (425 µm)	10-55
No.200 (75 µm)	0-5

.2 Class 2b (Semi-Pervious Granular Fill)

.1 Class 2b fill will be a semi-pervious sand containing between 4% and 10% fines, free of organic matter, snow, ice or other deleterious material.

.2 Class 2b material shall have the gradation specified below.

Sieve Size	Percent Passing by Weight
75.0 mm	100
19.0 mm	90-100
No.4 (4.75 mm)	60-100
No.10 (2.00 mm)	25-100
No.40 (425 µm)	10-80
No.200 (75 µm)	4-10

.3 Class 3 (Fine Filter)

.1 Class 3 fill shall be a well graded, free draining gravelly sand, with less than 5% fines (by weight) than 0.075 mm, having a coefficient of uniformity greater than 3, and a maximum particle size of 75 mm. Limited processing and/or selective exploitation to remove oversize materials may be required.

.2 Class 3 material shall be composed of tough, durable particles, reasonably free from thin, flat and elongated pieces, free of organic matter, snow, ice, frozen or other deleterious material, and well-graded with the gradation limits specified below.

Sieve Size	Percent Passing by Weight
75.0 mm	100
19.0 mm	90 - 100
4.75 mm	75 - 100
2.36 mm	60 - 100
1.18 mm	40 - 90
600 µm	25 - 70
300 µm	10 - 50
150 µm	0 - 25

75 µm	0 - 5

.3 Not more than 5% of the material used for Class 3 shall be finer the 75 µm and these fines, if any, shall be cohesionless (i.e., plasticity index = 0).

.4 The coefficient of uniformity shall be at least 3.0 for Class 3 material, where the coefficient of uniformity is the ratio of the 60% finer particle diameter to the 10% finer particle diameter, as determined from the grain size curve.

.5 Class 3 materials may be obtained from borrow areas shown on the Purchaser's Drawings where investigations have indicated the presence of suitable material. Alternatively, Class 3 materials may be obtained from other sources authorized by the Engineer.

.4 Class 4 (Coarse Filter)

.1 Class 4 material shall be 100% crushed material, composed of tough, durable particles, free from cracks and seams, not subject to freeze-thaw deterioration, free from thin, flat and elongated pieces, free of organic matter, snow, ice, frozen or other deleterious material, and well-graded with the gradation limits specified below.

Sieve Size	Percent Passing by Weight
75.0 mm	100
19.0 mm	90 - 100
9.5 mm	60-100
No.4 (4.75 mm)	40-85
No.10 (2.00 mm)	15-60
No.20 (850 µm)	0-35
No.40 (425 µm)	0-15
No.100 (150 µm)	0-7

.2 Where Class 4 materials are to remain permanently exposed, the Contractor may be required to blend or otherwise mix or select the materials to be placed so as to achieve a uniform appearance.

.3 The source of Class 4 material may come from quarries or the required rock excavations.

2.2 EQUIPMENT

.1 Compaction shall be undertaken with a vibrating roller approximately 1.5 m in diameter and between 2.0 and 2.5 m in width. The total static weight of each unit shall be a minimum of 11 tonnes, with a minimum centrifugal force of 18 tonnes at a frequency between 1,100 and 1,500 vibrations per minute. Prior to shipping vibratory rollers to Site, the Contractor shall submit to the Engineer the manufacturer's data giving all dimensions, weight and complete technical data.

.2 The speed of the roller during operation shall be less than 6 km/h. The power of the engine driving the vibratory roller shall be sufficient to maintain the specified frequency and centrifugal force under the most adverse conditions, which may be encountered during compaction of the fill.

Part 3 Execution

3.1 PLACEMENT

.1 The placing of Classes 2, 3 and 4 granular fills shall be subject to the authorization of the Engineer and shall be directed at obtaining a stable and homogeneous fill which is free of horizontal stratifications and of lenses or pockets of materials which do not satisfy the requirements of these Specifications. In general, within a zone of an embankment, the materials approaching the finer gradation limit shall be placed in the interior of the embankment, and materials approaching the coarse gradation limit shall be placed in the outer portion of the zone.

.2 Granular fill shall be placed to lines and grades shown on the Purchaser's Drawings and as determined by the Engineer. No granular fill shall be placed on any part of the foundation until the foundation is inspected and authorized by the Engineer.

.3 Fill shall be raised in such a manner that the top surface of any section of the dams under construction shall remain approximately level. The top elevation of the granular fill, adjacent to impervious core shall be maintained within 0.3 m of the elevation of the impervious fill. Elsewhere within the limits of the granular Classes 2, 3 and 4 fills, the maximum differential in height between adjacent zones shall be one lift thickness. In general, the level of the impervious core shall be higher than the granular fills except during periods of inclement weather when impervious fills cannot be placed. A maximum of a one lift difference between zones shall be maintained.

.4 All openings through embankments for construction purposes shall be subject to the authorization of the Engineer. The slope of openings left in the embankments and the end of any unfinished section, shall not be steeper than four horizontal to one vertical. Prior to placement of fill to close the openings, all loosened, dried and altered fill shall be removed as determined by the Engineer. Additional scarification and compaction shall be applied to the contact between existing and additional fill as determined by the Engineer.

.5 Material which contains any roots, sod or topsoil shall be removed from the fill placement area and disposed of, as determined by the Engineer. Care shall be taken to prevent granular fill from being contaminated by mixing with adjacent impervious materials, or from being contaminated by concentrated hauling traffic or over-compaction which could produce particle breakdown.

.6 If, on completion of each layer of the Classes 2, 3 and 4 materials, the surface of the layer is such that in the opinion of the Engineer it will obstruct the free drainage of water through the zone, the Contractor shall scarify, or otherwise prepare the surface of the layer, or remove such material and replace it with suitable material which will permit free drainage.

.7 For Classes 2, 3 and 4 fills in the earthfill embankments, the materials shall be spread parallel to the axis in continuous and approximately horizontal layers after dumping. The material shall be spread in such a manner as to prevent segregation of particles or the formation of voids.

.8 Prior to and during the compaction operation, the material in each layer of Classes 2, 3 and 4 materials shall be wetted thoroughly, and the material mixed, if required, to ensure the moisture content is uniform throughout the layer. Water shall be applied as required by spraying.

.9 During placing and compacting operations, equipment shall be turned carefully to ensure uniform compaction and prevent rutting.

.10 Granular fill shall not be placed on a surface which is frozen or covered with snow or ice. Placement of granular fill in freezing weather shall only be permitted when proper measures are taken to prevent freezing of the fill prior to compaction, as authorized by the Engineer.

3.2 COMPACTION REQUIREMENTS

.1 Classes 2a and 2b fills shall be placed in layers not exceeding 0.15 m in thickness and compacted by not less than two complete coverages of the 11 tonne (static) vibrating steel drum roller, operating at the vibrating frequency specified in Article 2.2, such that the density, as measured in place for an average of any 10 consecutive tests, is not less than 96% of maximum density as determined using ASTM D698 "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3) (600 kN-m/m^3)", ASTM International. The in place density, as measured by any single test, shall not be less than 93% of the maximum vibrated density. Elsewhere in the Work, or where authorized by the Engineer, compaction may be achieved by not less than three complete coverages of a track of a crawler tractor weighing not less than 21 tonnes.

.2 Classes 3 and 4 fill shall be placed in layers not exceeding 0.30 m in thickness and compacted by not less than two complete coverages of the 11 tonne (static) vibrating steel drum roller, operating at the vibrating frequency specified in Artoc;e 2.2, such that the density, as measured in place for an average of any 10 consecutive tests, is not less than 96% of maximum vibrated density as determined using ASTM D4253 "Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table", ASTM International. The in place density, as measured by any single test, shall not be less than 93% of the maximum vibrated density. Elsewhere in the Work, or where authorized by the Engineer, compaction may be achieved by not less than three complete coverages of a track of a crawler tractor weighing not less than 21 tonnes.

.3 Restricted areas of fill, which, in the opinion of the Engineer, cannot be compacted adequately with rollers, due to inaccessibility, shall be placed in layers not thicker than 0.10 m and compacted to the specified density by means of power tampers. The type of tamper and its method of operation shall be subject to the authorization of the Engineer.

.4 The layers within the zones and at the junction between adjacent zones shall be compacted in strips, with adjacent strips overlapping by not less than 600 mm.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for supplying, transporting and placing Class RT road topping materials as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 31 23 24 - Granular Fill.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.2 ASTM C127 - "Standard Test Methods for Density, Relative Density, and Absorption of Coarse Aggregate.

.3 ASTM C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.

.4 ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.5 ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding

unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 23 25 (a)i to 31 23 25 (a)x inclusive shall be in cubic metres made to the neat lines and grades presented in the Purchaser's Drawings and as directed by the Engineer.

.3 Unit Price

.1 The unit prices proposed for Items 31 23 25 (a)i to 31 23 25 (a)x inclusive in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, transporting and placing of Class RT (Road Topping) materials as shown on the Purchaser's Drawings and as follows:

.1 Item 31 23 25 (a)i shall cover supply, transport, and place road topping Materials for north dam.

.2 Item 31 23 25 (a)ii shall cover supply, transport, and place road topping Materials for parking lot and access ramp.

.3 Item 31 23 25 (a)iii shall cover supply, transport, and place road topping Materials for south dam.

.4 Item 31 23 25 (a)iv shall cover supply, transport, and place road topping Materials for south dam - saddle dams.

.5 Item 31 23 25 (a)v shall cover supply, transport, and place road topping Materials for central dam.

.6 Item 31 23 25 (a)vi shall cover supply, transport, and place road topping Materials for north dyke.

.7 Item 31 23 25(a)vii shall cover supply, transport, and place road topping Materials for south dyke.

.8 Item 31 23 25 (a)viii shall cover supply, transport, and place road topping Materials for south access road ramp.

.9 Item 31 23 25 (a)ix shall cover supply, transport, and place road topping Materials for north access road ramp.

.10 Item 31 23 25 (a)x shall cover supply, transport, and place road topping Materials for transmission tower spur.

1.5 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subseection 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Class RT (Road Topping Material)

.1 Road Topping Material shall be sand and gravel sized Material, composed of tough, durable particles, free from cracks and seams, not subject to freeze-thaw

deterioration, free from thin, flat and elongated pieces, free of organic matter, snow, ice, frozen or other deleterious material, and well-graded with the gradation limits specified below.

Sieve Size	Percent Passing by Weight
25.0 mm	100
19.0 mm	85-100
12.5 mm	70-100
No.4 (4.75 mm)	35-60
No.10 (2.0 mm)	25-45
No.40 (425 μm)	10-25
No.200 (75 μm)	4-10

.2 Where Road Topping Materials are to remain permanently exposed, the Contractor may be required to blend or otherwise mix or select the Materials to be placed so as to achieve a uniform appearance.

.3 Road Topping may be obtained from borrow areas, quarries, stockpiles, or the required rock excavations.

.4 Physical properties of the Road Topping Materials shall be as follows:

Lab Test	Standard/Designation	Value
Los Angeles Abrasion Test (LAA)	ASTM C131	Less than 50% weight loss
Bulk Specific Gravity	ASTM C127	Greater than 2.6
Magnesium Soundness Test	ASTM C88 at five cycles	Weight loss less than or equal 8%
Plasticity Index	ASTM D4318	Non plastic
Water Absorption	ASTM C127	Less than or equal 1.5%

.5 Unless indicated otherwise on the Purchaser's Drawings or specified herein, Road Topping Materials shall conform to Manitoba Infrastructure and Transportation requirements.

Part 3 Execution

3.1 PLACEMENT

.1 Road Topping Material shall be placed in layers not exceeding 0.15 m in thickness and each layer shall compacted to 98% to 100% SPMDD, or to the satisfaction of the Engineer.

.2 Sufficient water to obtain proper compaction shall be added during the rolling operation.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for supplying, transporting and placing Class 5 Riprap Bedding material as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 31 23 24 - Granular Fill.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.2 ASTM C127 - Standard Test Method for Density, Relative Density, and Absorption of Coarse Aggregate.

.3 ASTM C88 - Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate.

.4 ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.5 ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.6 ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit

Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 23 26 (a)i to 31 23 26 (a)viii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be the cubic metres placed Class 5 materials (riprap bedding) set out in the Purchaser's Drawings and as directed by the Engineer. Where appropriate, onsite surveying information will be jointly gathered by the Contractor and the Engineer from a comparison of the pre-construction survey after the foundation preparation but prior to the fill placement, or of the survey immediately following the placement of the underlying fill zone. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary surfaces for accurate measurements. The volume will be measured from the neat lines shown on the Purchaser’s Drawings as compared with the on-site surveyed geometry following the foundation preparation or underlying fill zones but prior to the fill placement (where appropriate), as measured and accepted by the Engineer. The measured volume for shall be determined using software tools such as Autodesk Civil 3D using the composite volume method that is represented by two Triangulated Irregular Networks, (TIN). The composite calculation will determine the volume from the discrete difference between each surface.

.3 Unit Price

.1 The unit prices for Items 31 23 26 (a)i to 31 23 26 (a)viii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying, transporting and placing Class 5 material as specified herein, as shown on the Purchaser's Drawings and in the 3D Project Model and as follows:

.1 Item 31 23 26 (a)i shall cover supply, transport and place Class 5 fill for North Dam.

.2 Item 31 23 26 (a)ii shall cover supply, transport and place Class 5 fill for parking lot and access ramp.

.3 Item 31 23 26 (a)iii shall cover supply, transport and place Class 5 fill for South Dam.

.4 Item 31 23 26 (a)iv shall cover supply, transport and place Class 5 fill for Central Dam.

.5 Item 31 23 26 (a)v shall cover supply, transport and place Class 5 fill for North Dyke.

.6 Item 31 23 26 (a)vi shall cover supply, transport and place Class 5 fill for South Dyke.

.7 Item 31 23 26 (a)vii shall cover supply, transport and place Class 5 fill for south access road ramp.

.8 Item 31 23 26 (a)viii shall cover supply, transport and place Class 5 fill for transmission tower spur.

1.5 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Managment of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Class 5 (Riprap Bedding)

.1 Class 5 material shall be clean broken, crushed or blasted rock material, composed of tough, durable particles, free from cracks and seams, not subject to freeze-thaw deterioration, generally cubical in shape, free from thin, flat and elongated pieces, free of organic matter, snow, ice, frozen or other deleterious material, and well-graded with the gradation limits specified below.

.2 The nominal cube size of a rock fragment is the cube root of the product of the three principal dimensions. The grading requirements given below are indicated as a number of individual particles finer than a given size.

Sieve Size	Percent Smaller by Weight
	Class 5
500 mm	100
300 mm	70-100
200 mm	60-80
19.0 mm	10-35
12.5 mm	0-27
4.75 mm	0-10

.3 Materials shall be obtained from required excavations, or from quarries authorized by the Engineer.

.4 Physical properties of the materials shall be as follows:

Lab Test	Standard/Designation	Value
Los Angeles Abrasion Test (LAA)	ASTM C131	Less than 50% weight loss
Bulk Specific Gravity	ASTM C127	Greater than 2.6
Magnesium Soundness Test	ASTM C88 at five cycles	Weight loss less than or equal 8%
Plasticity Index	ASTM D4318	Non plastic
Water Absorption	ASTM C127	Less than or equal 1.5%

Part 3 Execution

3.1 PLACEMENT

.1 In general, within Class 5 zones, the materials approaching the finer gradation limit shall be placed toward the interior of the embankment or erosion/filter layer, and the materials approaching the coarse gradation limit shall be placed in the outer portion of the zone.

.2 Where Class 5 material is placed against dumped rockfill or riprap, special precautions shall be taken to ensure that there will be no large voids at the interface. Where Class 5 is placed against Class 4, special precautions shall be taken to ensure gouging of the Class 4 does not occur.

.3 Where Road Topping (RT) is placed in direct contact with Class 5 fill, the surface of the Class 5 shall be run over by additional passes of compaction or other equipment in order to increase the fine material content and decrease the voids in the surface layer, as directed by the Engineer. The cost of such additional passes of equipment over the surface of Class 5 fill shall be deemed to be included in the unit prices for the appropriate fill Item.

.4 Class 5 fill in the permanent earth structures shall be placed in layers not exceeding 0.50 m in thickness and compacted by not less than two complete coverages of the 11 tonne (static) vibrating steel drum roller, operating at the vibrating frequency specified in Section 31 23 24 Granular Fill of the Technical Specification, Subsection 2.2. Elsewhere in the Work, or as determined by the Engineer, compaction may be achieved by not less than three complete coverages of a track of a crawler tractor weighing not less than 21 tonnes.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for supplying, transporting and placing Class 6 Rockfill as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 31 23 24 - Granular Fill.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

.2 ASTM C127 - Standard Test Method for Density, Relative Density, and Absorption of Coarse Aggregate.

.3 ASTM C88 - Standard Test Method for Soundness of Aggregates by use of Sodium Sulfate or Magnesium Sulfate.

.4 ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.5 ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.6 ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission

multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 23 27 (a)i to 31 23 27 (a)x in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in cubic metres of Class 6 materials (rockfill) placed as set out in the Purchaser's Drawings, as directed by the Engineer, and described as follows. The onsite surveying will be jointly performed by the Contractor and the Engineer from a comparison of the pre-construction survey after the foundation preparation but prior to the fill placement, or of the survey immediately following the placement of the underlying fill zone. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary surfaces for accurate measurements. The volume will be measured from the neat lines shown on the Purchaser’s Drawings as compared with the onsite surveyed geometry following the foundation preparation or underlying fill zones but prior to the fill placement (where appropriate), as measured and determined by the Engineer. The measured volume shall be determined using software tools such as Autodesk Civil 3D using the composite volume method that is represented by two Triangulated Irregular Networks, (TIN). The composite calculation will determine the volume from the discrete difference between the elevations of each surface.

.3 Unit Price

.1 The unit prices for Items 31 23 27 (a)i to 31 23 27 (a)x in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying, transporting, and placing Class 6 fill as specified herein, as shown on the Purchaser's Drawings and in the 3D Project Model and as follows:

.1 Item 31 23 27 (a)i shall cover supply, transport and place Class 6 fill for North Dam.

.2 Item 31 23 27 (a)ii shall cover supply, transport and place Class 6 fill for parking lot and access ramp.

.3 Item 31 23 27 (a)iii shall cover supply, transport and place Class 6 fill for South Dam.

.4 Item 31 23 27 (a)iv shall cover supply, transport and place Class 6 fill for South Dam - Saddle Dams.

.5 Item 31 23 27 (a)v shall cover supply, transport and place Class 6 fill for Central Dam.

.6 Item 31 23 27 (a)vi shall cover supply, transport and place Class 6 fill for North Dyke.

.7 Item 31 23 27 (a)vii shall cover supply, transport and place Class 6 fill for South Dyke.

.8 Item 31 23 27 (a)viii shall cover supply, transport and place Class 6 fill for south access road ramp.

.9 Item 31 23 27 (a)ix shall cover supply, transport and place Class 6 fill for north access road ramp.

.10 Item 31 23 27 (a)x shall cover supply, transport and place Class 6 fill for Transmission Tower Spur.

1.5 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

1.6 MATERIALS

.1 Class 6 (Rockfill)

.1 Class 6 rockfill shall be sound quarry run, blasted Precambrian rock free of organic matter snow, ice, frozen or other deleterious material, and well-graded between the grading limits specified herein.

Sieve Size	Percent Finer By Weight
500 mm	100
300 mm	50-100
200 mm	30-100
100 mm	0-80
19 mm	0-35
4.75 mm	0-10

.2 The particles shall be strong, hard, dense, durable, free from cracks and seams, resistant to abrasion, and not subject to freeze-thaw deterioration. The rock fragments shall be generally cubical in shape, which interlock when placed and compacted. Long flat particles shall not be used.

.3 Rockfill may be obtained by selective excavation methods from required excavations, from stockpiles, or from the quarries shown on the Purchaser's Drawings, or from other sources as determined by the Engineer. The Purchaser has stockpiled quarry-run rock obtained from the excavation work undertaken prior to the commencement of this Contract. This rock will be made available free of charge to the Contractor. The Purchaser neither warrants the gradation or the quality of the stockpiled material. The Contractor should anticipate the need for processing these materials to meet the required gradations for Class 6.

.4 Physical properties of the materials shall be as follows:

Lab Test	Standard/Designation	Value
Los Angeles Abrasion Test (LAA)	ASTM C131, C535	Less than 50% weight loss
Bulk Specific Gravity	ASTM C127	Greater than 2.6
Magnesium Soundness Test	ASTM C88 at five cycles	Weight loss less than or equal 8%
Plasticity Index	ASTM D4318	Non plastic
Water Absorption	ASTM C127	Less than or equal 1.5%

Part 2 Execution

2.1 PLACEMENT AND COMPACTION

.1 The placing of rockfill shall be directed at obtaining a stable and homogeneous fill, which is free of horizontal stratification and lenses or pockets which do not satisfy the requirements of this Section of the Technical Specification, or as determined by the Engineer. In general, within the rockfill zones the materials approaching the finer

gradation limit shall be placed in the interior of the embankment and the materials approaching the coarse gradation limit shall be placed in the outer portion of the zone.

.2 Rockfill shall not be placed in a frozen condition and shall not be placed on a surface which is frozen or covered with snow or ice.

.3 Class 6 rockfill shall be dumped and spread parallel with the axis of the structures. Class 6 rockfill shall be dumped and spread in horizontal lifts not exceeding 0.7 m in thickness and shall be compacted by two complete coverages of a track of a crawler tractor weighing not less than 21 tonnes, or as determined by the Engineer.

.4 Where Road Topping (RT) is placed in direct contact with Class 6 fill, the surface of the Class 6 shall be run over by additional passes of compaction or other equipment in order to increase the fine material content and decrease the voids in the surface layer, as determined by the Engineer. The cost of such additional passes of equipment over the surfaces of the Class 6 fill shall be deemed to be included in the unit prices for the appropriate fill Item.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for trenching, and backfilling including excavation of all materials to facilitate the installation of culverts, pipes, electrical conduits and cables, stockpiling and disposal of excess material, removal of unsuitable material, backfilling trenches, restoration of surfaces and associated works.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 21 00 - Reinforcing Steel.

.3 Section 03 30 00 - Cast in Place Concrete.

.4 Section 26 05 43 - Installation of Cables in Trenches and Ducts.

.5 Section 31 23 17 - Rock Excavation.

.6 Section 31 23 19 - Control of Water.

.7 Section 31 23 23 - Impervious Fill.

.8 Section 31 23 24 - Granular Fill.

.9 Section 31 23 27 - Rockfill.

.10 Section 31 35 19 - Geotextiles.

.11 Section 31 37 00 - Riprap.

.12 Section 33 42 00 - Corrugated Steel Pipe Culverts.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D422, Standard Test Method for Particle-Sized Analysis of Soils.

.2 ASTM D698 - "Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))", ASTM International.

.4 Manitoba Workplace Safety and Health Branch, "Guideline for Excavation Work".

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 Measurement

.1 There shall be no separate measurement or payment for trenching, backfilling and associated work and it shall be considered incidental to the pipe, culvert, pre-cast vaults, utility or conduits and cables being installed and placement of various fill materials as set out in other Sections of the Technical Specification.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Provide for Engineer's review details of proposed dewatering procedures, if required.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

1.7 REGULATORY REQUIREMENTS

.1 The Contractor shall comply with all Laws of Manitoba Conservation and Water Stewardship and Government of Canada Department of Fisheries and Oceans with respect to public health, public water supplies and sewage systems.

.2 The Contractor shall comply with all Laws of the Province of Manitoba and the municipality in which the Work is located and abide by applicable Laws with respect to stream crossings and public safety.

.3 All excavation Work shall be in accordance with Manitoba's Workplace Safety and Health Division - Guideline for Excavation Work, unless otherwise authorized by the Engineer.

Part 2 Products

2.1 MATERIALS

.1 Pipe Bedding and Cover Materials

.1 Granular bedding and cover materials shall be in accordance with Section 31 23 24 Granular Fill of the Technical Specification and as indicated on the Purchaser's Drawings.

.2 General Backfill

.1 Impervious fill shall be in accordance with Section 31 23 23 Impervious Fill and Random Fill of the Technical Specification.

.3 Geotextile

.1 Geotextile shall be in accordance with Section 31 35 19 Geotextiles of the Technical Specification.

.4 Sand Backfill for Electrical Trenches and Excavations

.1 Sand shall be as follows:

Sieve Size (mm)	% Finer
9.5	100
4.75	80-100
2.36	60-100
1.18	40-95
0.3	10-84
0.075	0-5

.5 Concrete Backfill for Electrical Trenches and Utilities

.1 Concrete shall be Type GU and have a minimum compressive strength at 28 days of 20 MPa, maximum aggregate size 20 mm, exposure class F-1. Concrete shall be in accordance with the requirements of Section 03 30 00 Cast-In-Place Concrete of the Technical Specification.

.2 Concrete reinforcement shall be in accordance with the requirements of Section 03 21 00 Reinforcing Steel of the Technical Specification.

Part 3 Execution

3.1 SITE PREPARATION AND PROTECTION

.1 Remove obstructions, ice and snow, from surfaces to be excavated within limits indicated in the Technical Specifications and Purchaser's Drawings.

.2 Dispose of such material as determined by the Engineer.

.3 Keep excavations clean, free of standing water, and loose soil.

3.2 CONTROL OF WATER

.1 Provide temporary dewatering facilities and sediment and erosion control in accordance with Section 31 23 19 Control of Water of the Technical Specification.

3.3 TRENCH EXCAVATION

.1 Trenches shall be excavated to the lines, grades and dimensions specified on the Purchaser's Drawings. The width of the trench at the bottom shall not exceed the width at the top.

.2 Trenching for pipe culverts shall include the excavation for frost tapers and end sections.

.3 No more that 15 m of trench shall be open in advance of the completed work.

.4 The Engineer shall be notified immediately if the bottom of the trench appears to give an unsuitable foundation.

.5 If the trench depth is excavated beyond the limits of the required excavation without the Engineer's authorization, suitable material shall be placed and compacted in the trench to

reinstate the required trench limits prior to backfilling the trench as specified. Alternatively, another structurally accepted design shall be provided by adjusting the limits of the excavation before backfilling.

.6 Rock excavation for trenches, if required, shall be in accordance with Section 31 23 17 Rock Excavation of the Technical Specification.

.7 Pipe design is dependent upon the type of bedding specified and the class of backfilling in the pipe zone, as well as the width of the trench. If the Contractor uses trenching equipment or trenching methods that result in a wider trench than specified under the installation of pipe, corrective work shall be performed as required by the Engineer. The corrective work may take the form of either or both of the following:

.1 Supply and installation of a higher class of bedding and backfilling in the pipe zone.

.2 Supply and installation of a stronger class pipe.

.8 Excavation must not interfere with bearing capacity of adjacent foundations, and shall not be in the 45 degrees splay of the adjacent foundations unless authorized by the Engineer.

.9 Keep excavated and stockpiled materials safe distance away from edge of trench as to ensure safe working conditions. Typical minimum safe distance would be the height of the excavated trench.

.10 Restrict vehicle operations directly adjacent to open trenches.

.11 Do not obstruct flow of surface drainage or natural watercourses.

.12 Remove unsuitable material, including frozen material, from excavation bottom including those that extend below required elevations to extent and depth as determined by Engineer.

3.4 BACKFILLING AND COMPACTION - GENERAL

.1 Where a trench passes through, across or adjacent to rockfill as described in Section 31 23 27 Rockfill of the Technical Specification or riprap as described in Section 31 37 00 Riprap of the Technical Specification the trench shall be lined with a non-woven geotextile fabric prior to backfilling to prevent migration of backfill material into the rockfill. The geotextile shall extend a minimum of 100 mm beyond the contact of the trench backfill with the rockfill or riprap.

.2 Where indicated on the Purchaser's Drawings, trench backfill above the specified bedding and/or cover material shall be impervious fill as provided for in Section 31 23 23 Impervious Fill and Random Fill of the Technical Specification, unless the trenches have been excavated in areas of defined fill classes (Classes 2a, 2b, Class 3, Class 4, Class 5, Classes 6-8). In these cases, the backfill shall consist of the same defined fill zones, placed and compacted in accordance with the requirements for those classes.

3.5 BACKFILLING AND COMPACTION - CULVERTS AND PIPES

.1 Pipe bedding shall be of the class specified in the Technical Specification and Purchaser’s Drawings.

.2 The pipe bed shall be shaped to the specified dimensions set out in the Technical Specification and Purchaser’s Drawings. When bell and spigot pipe is to be laid, recesses shall be shaped to receive the bells.

.3 Bedding material placed in the haunches must be compacted prior to continued placement of cover material.

.4 Bedding requiring compaction shall be placed in layers not exceeding 200 mm in thickness, loose measurement, and compacted to 95% of the standard maximum dry density (Reference - Sub-paragraph 1.3.3.1.2 of this Section of the Technical Specification) before a subsequent layer is placed.

.5 Bedding on each side of the pipe shall be completed simultaneously. At no time shall the levels on each side differ by more than the 200 mm uncompacted layer.

.6 Cover material shall be placed so that damage to, or movement of the pipe is avoided.

.7 Cover material requiring compaction shall be placed in layers not exceeding 200 mm in thickness, loose measurement, and compacted to 95% of the maximum dry density before a subsequent layer is placed.

.8 Impervious fill material shall be placed in uniform layers not exceeding 300 mm in thickness for the full width of the trench and each layer shall be compacted to 95% of the standard maximum dry density before a subsequent layer is placed.

.9 Backfill shall be placed to a minimum depth of 900 mm above the crown of the pipe before power operated tractors or rolling equipment shall be used for compaction.

3.6 BACKFILLING AND COMPACTION - ELECTRICAL CABLES AND UTILITIES

.1 Place concrete around conduits or utilities as indicated on the Purchaser's Drawings. Concrete reinforcement shall be in accordance with Section 03 21 00 Reinforcing Steel of the Technical Specification. Conduits shall have a minimum of 75 mm concrete encasement and a minimum burial depth to top of conduit of 300 mm. Do not place other backfill material over or around concrete within 24 hours of concrete placement.

.2 Place sand bedding/cover/backfill around cables and utilities as indicated on the Purchaser's Drawings. Unless indicated otherwise on the Purchaser's Drawings, direct buried cables shall have a minimum of 75 mm thickness of sand cover below and 150 mm above. Cable separation shall be in accordance with Section 26 05 43 Installation of Cables in Trenches and Ducts of the Technical Specification. The minimum distance from the invert of a ditch to the top of a cable or conduit shall be not less than 1,000 mm.

.3 Sand backfill requiring compaction shall be placed in layers not exceeding 200 mm loose thickness and compacted to 95% standard maximum dry density (Reference - Sub-paragraph 1.3.3.1.2 of this Section of the Technical Specification) using hand-operated power tampers.

.4 Impervious fill material shall be placed in uniform layers not exceeding 300 mm in thickness for the full width of the trench and each layer shall be compacted to 95% of the standard maximum dry density before a subsequent layer is placed.

.5 Impervious fill for cable trench backfill placed within 300 mm of the top of the cable cover sand shall not contain any particles larger than 50 mm.

3.7 CLEANING

.1 Shall be in accordance with the requirements of Subsection 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Clean up and dispose of all excess material, trash, rocks, boulders and debris as this Work progresses.

.3 All ditches shall be cleaned and restored to designed condition.

.4 Restore all public and private roads, temporary access roads, stockpile and storage sites to a condition equal to that in which they were found, or to designed condition as indicated on the Purchaser's Drawings or determined by the Engineer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of the supply of all labour, Materials and Plant and all Work necessary for the design, fabrication, installation, maintenance and removal of temporary measures to control erosion and sedimentation from water runoff, drainage ditches, and construction, storage, maintenance and other incidental contractor site areas to provide and construct perimeter drainage ditch along the North and South Dykes.

.2 The Contractor shall submit to the Engineer for review in accordance with Subsection 21.7 Engineer's Review of the General Specification, details of all access roads, ramps, temporary roads and other features necessary for the Contractor's operations throughout the entire Site area. Drawings showing details of locations of other pertinent information shall be submitted to the Engineer at least 30 days prior to construction of said features.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 31 23 19 – Control of Water.

.3 Section 31 25 00 – Erosion and Sedimentation Control.

1.3 REFERENCES

.1 All activities associated with construction will be conducted in accordance with accepted practices outlined in the following documents to be obtained by the Contractor:

.1 Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat (DFO and Manitoba DNR, 1996).

.2 Manual of Erosion and Sedimentation Control During Highway Construction (Manitoba Transportation and Government Services [MTGS] n.d.a).

.3 Manual for the Design and Implementation of Erosion and Sediment Control: Quick Reference Manual (MTGS n.d.b).

.4 Sediment and Erosion Control (Manitoba Heavy Construction Association 2001).

.5 National Guide to Erosion and Sediment Control on Roadway Projects (May 2005).

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate for each Item as specified and any changes identified through Section 27 Clarifications and Changes to the Work Adjustments in the General Specification.

.2 Measurement

.1 Measurement for Items 31 23 34 (a)i to 31 23 34 (a)iv in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in linear meters of the perimeter ditches constructed along the North Dyke and South Dyke as projected on the neat lines as set out in the Purchaser's Drawings, as specified herein and as directed by the Engineer.

.2 Measurement for Items 31 23 34 (b)i to 31 23 34 (d)ii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be the number of sediment ponds, rock ditch checks, and ditch turn-outs constructed as set out in the Purchaser's Drawings, as specified herein, and as directed by the Engineer.

.3 No separate measurement or payment will be made for laying out the ditch location, supplying the equipment and related items for operation of such equipment, temporary pumping and sumping or supplying temporary and permanent erosion protection as shown in the Purchaser's Drawings, as specified herein and as directed by the Engineer.

.4 No separate measurement or payment will be made for transportation, placement of excavated materials to the spoil areas, the designated excavated material placement areas, or temporary storage sites for further use as directed by the Engineer.

.5 No separate measurement or payment will be made for placement of erosion blanket along the slope and bottom of ditches, grass seeding, geotextiles, sediment ditch traps, and other measures.

.3 Unit Price

.1 The unit prices for Item 31 23 34 (a)i to 31 23 34 (a)iv in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for construction of perimeter drainage ditches, as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 34 (a)i to 31 23 34 (a)ii shall cover the construction of deep perimeter ditches for the North Dyke and South Dyke.

.2 Item 31 23 34 (a)iii to 31 23 34 (a)iv shall cover the construction of shallow perimeter ditches for the North Dyke and South Dyke.

.2 The unit prices for Item 31 23 34 (b)i to 31 23 34 (d)ii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for construction of sediment ponds, rock ditch checks, and ditch turn-outs, as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 23 34 (b)i to 31 23 34 (b)ii shall cover sediment pond construction for the ditches along North Dyke and South Dyke.

.2 Item 31 23 34 (c)i to 31 23 34 (c)ii shall cover rock ditch checks construction for the ditches along North Dyke and South Dyke.

.3 Item 31 23 34 (d)i to 31 23 34 (d)ii shall cover turn-outs construction for the ditches along North Dyke and South Dyke.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 The Contractor shall submit, at least 30 days prior to the start of the Work, complete plans of site access roads, drainage ditches, construction, storage, maintenance and other incidental contractor site work. The plan shall include a description of the methods and procedures, a sequence of operations with corresponding schedule, details of temporary structures and a description which includes the capacity of the proposed equipment for use in the work. The plan shall include design calculations, installation details, materials, sequencing of Work on Purchaser's Drawings and Contractor's Documents, and any other information required to fully describe the Contractor's plans. The design shall be carried out by a qualified professional engineer and shall carry the signature of the engineer's responsible for the design.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 21.7 Project Quality Management of the General Specification.

Part 2 Products

2.1 GENERAL

.1 The Contractor shall furnish all materials, equipment, labour, and appurtenances required for construction of the perimeter ditches along the North and South Dykes, water control facilities for sumping and pumping and shall also supply sufficient standby pumping and auxiliary equipment to preclude any interruption of the Work.

Part 3 Execution

3.1 DESIGN

.1 The dyke alignments were selected along higher ground and as such the ponding of water against the downstream toe of the dykes is not anticipated to occur. Any seepage and surface runoff (snowmelt/rainfall events) will be intercepted with a perimeter surface drainage ditch, located at the downstream toe of the dyke, as shown in the Purchaser's Drawings and as directed by the Engineer.

.2 The drainage ditches will be set parallel to the centerline of the dyke line and will have off-take ditches, at near perpendicular to the dyke's axis, which will transport water into low-lying areas such as marshes, natural streams and sedimentation ponds.

.3 The drainage ditches may outfall into some of the potential low-lying areas. For the cases where a low-lying area is not near the drainage outfall, a "Ditch Turnout" will be installed. A Ditch Turnout is defined as an outfall of a drainage ditch set into a naturally vegetated area to provide dispersion and filtration of the discharged water. Undisturbed natural terrain has a high resistance to erosion and is very effective in removing sediment loads.

.4 Rockfill ditch checks complete with an underlying non-woven geotextile filter fabric will be used at the outlet of the Ditch Turnout to diffuse the water into the undisturbed terrain.

3.2 EQUIPMENT

.1 The Contractor shall supply proper equipment for ditching excavation.

3.3 CONSTRUCTION

.1 Ditches shall be excavated to the lines, grades and dimensions as specified in the Purchaser's Drawings.

.2 Dimensions for both the deep and shallow ditches are specified in the Purchaser's Drawings. The Contractor may modify the ditches with prior approval from the Engineer to suit field conditions. The Contractor shall establish procedures to minimize the disturbance to existing vegetation.

.3 Control of water during this Work shall be carried out in accordance with Section 31 23 19 Control of Water of the Technical Specification.

.4 Grade tolerance for ditch grades shall be within $\pm$50 mm from the lines and grades shown on the Purchaser's Drawings, provided positive drainage is achieved.

.5 Minor grading of the same lateral drains discharging into the existing swamps shall be performed to the grades and dimensions shown on the Purchaser's Drawings or as directed by the Engineer.

.6 If the ditch's depth is excavated beyond the limits of the required excavation without the Engineer's authorization, suitable material shall be placed and compacted in the ditch to reinstate the required ditch limits. Alternatively, another structurally accepted design shall be provided by adjusting the limits of the ditch excavation.

.7 Placement of seeding, erosion control measures, temporary ditch checks and all other sediment and erosion control works shall be placed in all drainage ditches immediately after excavation is completed to minimize the potential for erosion. Where unstable soils are present (i.e., very fine sands and silts), seeding etc. will be placed on the banks as soon as possible. Some cases may require lining sections of the ditches with stone with an underlying geotextile or placement of erosion control blankets.

.8 Install sediment traps as indicated on the Purchaser's Drawings or as directed by the Engineer, and review the need for installing temporary weirs to impound water in the traps. If the drainage area of the ditch is larger than 2 ha, a more sophisticated version of a sediment trap known as a sediment control pond will be used.

.9 The Contractor shall ensure that the outlet of the sediment traps and sediment ponds are protected from erosion.

.10 Make modifications to the outlets of low-lying areas (where required), to keep water flowing.

3.4 TEMPORARY WORK – MAINTENANCE AND MANAGEMENT

.1 The Contractor shall provide surface runoff drainage to handle a storm with a return period of 25 years and duration of 24 hours. The surface runoff drainage system shall discharge into appropriate watercourses in accordance with good industry practices and applicable Laws.

.2 The Contractor shall design, construct and maintain facilities with sufficient capacity to handle precipitation and surface run-off during construction for at least the 25 year recurrence interval flood event without damage or loss to the constructed Work or delay to the completion of the Project.

.3 Should the Engineer determine that the Contractor has not maintained the temporary ditch checks properly or has damaged the devices from construction activities resulting in sediment releases beyond the work areas; the Contractor shall retrieve all sediment that has left the construction area, to the fullest extent possible and shall not be entitled to any adjustment under Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification. At a minimum, the Contractor shall remove all deltas and sediment deposited in drainage ways and re-grade and/or reseed the areas where sediment removal results in exposed soil. The removal and restoration shall take place within 5 working days of discovery unless precluded by legal, regulatory, or physical access restraints. If precluded, removal and restoration must take place within 5 working days of obtaining access. The Contractor is responsible for contacting all local, regional, provincial, and federal authorities before working in surface waters and for obtaining applicable permits. The Contractor's restoration work to restore property outside of the designated work area shall not be entitled to any adjustment under Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

3.5 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Erosion and sediment control measures will be inspected regularly by the Contractor during construction and afterwards to ensure that they are functioning properly and are maintained and/or upgraded as required until vegetation has been re-established on the disturbed area.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

.4 Other erosion and sedimentation control requirements as specified in Section 31 25 00 Erosion and Sediment Control of the Technical Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for the design, fabrication, installation, maintenance and removal of temporary measures to control erosion and sedimentation from water runoff from all site access roads ramps, drainage ditches, and construction, storage, maintenance and other incidental contractor site areas as necessary to protect impact upon fish habitat, property and the environment.

.2 The Contractor shall submit to the Engineer for review, details of all access roads, ramps, temporary roads and other features necessary for the Contractor's operations throughout the entire Site area. Drawings showing details of locations, grades, material types and other pertinent information shall be submitted to the Engineer at least 30 days prior to construction of said features.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 31 52 00 - Cofferdams.

.3 Section 33 42 00 - Corrugated Steel Pipe Culverts.

1.3 REFERENCES

.1 All activities associated with construction of this Work will be conducted in accordance with accepted practices outlined in the following documents to be obtained by the Contractor:

.1 Manitoba Stream Crossing Guidelines for the Protection of Fish and Fish Habitat (DFO and Manitoba DNR, 1996).

.2 Manual of Erosion and Sedimentation Control During Highway Construction (Manitoba Transportation and Government Services [MTGS] n.d.a).

.3 Manual for the Design and Implementation of Erosion and Sediment Control: Quick Reference Manual (MTGS n.d.b).

.4 Sediment and Erosion Control (Manitoba Heavy Construction Association 2001).

.5 National Guide to Erosion and Sediment Control on Roadway Projects (May 2005).

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 There shall be no separate measurement or payment for erosion and sedimentation control work and it shall be considered incidental to the related items of Work described in other Sections of the Technical Specification.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Contractor shall submit, at least 30 days prior to the start of construction on the Work, complete plans of site access roads, drainage ditches, construction, storage, maintenance and other incidental contractor site work. The plan shall include a description of the methods and procedures, a sequence of operations with corresponding schedule, details of temporary structures and a description which includes the capacity of the proposed equipment for use in the diversion works. The plan shall include design calculations, installation details, materials, sequencing of Work on the Purchaser's Drawings and Contractor's Documents, and any other information required to fully describe the Contractor's plans. The design shall be carried out by a qualified professional engineer and shall include the signature of the engineer(s) responsible for the design.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 GENERAL

.1 The Contractor shall furnish all materials, equipment, labour, and appurtenances required for furnishing, installing, and removing water control facilities and shall also supply sufficient standby pumping and auxiliary equipment to preclude any interruption of pumping operations during periods of breakdown, off shift hours, holidays and maintenance.

Part 3 Execution

3.1 DESIGN

.1 The Contractor shall provide surface runoff drainage to handle a storm with a return period of 25 years and duration of 24 hours. The surface runoff drainage system shall discharge into appropriate watercourses in accordance with good industry practices and applicable Laws.

.2 The Contractor shall design, construct and maintain facilities and measures with sufficient capacity to handle precipitation and surface run-off during construction for at least the 25 year recurrence interval flood event without damage or loss to the constructed Work or delay to the completion of the Project.

.3 Should the Engineer determine that the Contractor has not maintained the temporary ditch checks properly or has damaged the devices from construction activities resulting in sediment releases beyond the work areas; the Contractor shall retrieve all sediment that has left the construction area, to the fullest extent possible and shall not be entitled to any adjustment under Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification. At a minimum, the Contractor shall remove all deltas and sediment deposited in drainage ways and re-grade and/or reseed the areas where sediment removal results in exposed soil. The removal and restoration shall take place within 5

working days of discovery unless precluded by legal, regulatory, or physical access restraints. If precluded, removal and restoration must take place within 5 working days of obtaining access. The Contractor is responsible for contacting all local, regional, provincial, and federal authorities before working in surface waters and for obtaining applicable permits. The Contractor's restoration work to restore property outside of the designated work area shall not be entitled to any adjustment under Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Erosion and sediment control measures shall be inspected regularly by the Contractor and witnessed by the Engineer during construction and afterwards to ensure that they are functioning properly and are maintained and/or upgraded as required until vegetation has been re-established on the disturbed area.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, accessories and Plant, and performing all handling and Work necessary for the installation of rock bolts, rock dowels, rock slope drains, rockfall netting and netting anchors, and the performance of tests of rock bolts, rock bolt checking and the calibration of testing equipment, as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein.

.2 This Work will also include the preparation and submission of Structural Geological Analysis Reports prepared by a Professional Geologist Registered in the Province of Manitoba. One report will be prepared for the Powerhouse Area and a second report will be prepared for the Spillway Area.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 31 23 17 - Rock Excavation.

1.3 GENERAL REQUIREMENTS

.1 Rock bolts shall be installed in portions of the Work where, in the opinion of the Engineer, the stability of excavated rock slopes will not be maintained naturally. The rock bolts shall be installed as soon as practical after their requirement has been defined.

.2 Rock bolts and wire mesh shall also be installed where protection for the safety of persons or equipment is required.

.3 Drain holes will be installed to provide drainage to rock faces.

.4 Rock dowels anchored by cement grout will be utilized along the edge of the excavations for additional support and in conjunction with the rock netting as required.

.5 As the excavation proceeds, the Contractor shall give the Engineer written notice outlining the extents of an excavated area that is ready to allow for geological survey and mapping of the rock excavations. Within 7 days of providing such notification the geological survey and mapping and data management will be complete and submitted to the Engineer for review.

.6 In general, as the excavation proceeds, the final rock bolt locations will be determined by the Engineer to suit the field conditions. The Engineer will provide the final rock bolt location within 10 days of receiving the Contractor's notice outlined in Paragraph 1.3.5 above.

.7 Notwithstanding such rock support as the Engineer may instruct the Contractor to install, the safety and integrity of the excavation shall remain the sole responsibility of the Contractor. The Contractor shall regularly inspect all excavated faces and shall inform the Engineer of any areas which require additional support or scaling.

.8 Rockfall netting, and netting anchors and plates shall be used as temporary rock reinforcement to ensure the safety of persons and equipment during construction.

.9 Rock bolts shall be installed, grouted and tensioned, all in accordance with the procedures recommended by the manufacturer or as directed by the Engineer. Holes

shall be drilled using standard drilling equipment of either the rotary or percussion type and shall be of a diameter recommended by the manufacturer and determined by the Engineer to suit the size of rock bolt to be installed.

.10 The procedures and equipment used for drilling holes in rock and for installing and tensioning the rock bolts shall be in accordance with this Section of the Technical Specification and the manufacturer's recommendations.

.11 The installation of rock bolts shall be performed by personnel experienced in this type of Work and special care shall be taken to ensure thorough and complete grouting of the full length of the embedded portion.

.12 Should the Contractor require the placement of heavy plant and equipment within 10 m of the edge of any excavated rock slope, the Contractor shall submit a proposal showing details of such a requirement to the Engineer for review at least 10 days prior to implementation. Such details shall include loadings and any additional rock support or other measures required to ensure the stability of the excavated rock slope. Any such work shall not be entitled to any adjustment under Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)), ASTM International.

.2 ASTM A615M - Standard Specification for Deformed and Plain Billet - Steel Bars for Concrete Reinforcement.

.3 ASTM A975 - Standard Specification for Double-Twisted Hexagonal Mesh Gabions and Revet Mattresses (Metallic-Coated Steel Wire or Metallic-Coated Steel Wire With Poly (Vinyl Chloride) (PVC) Coating).

.4 ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.

.5 ASTM A 370 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

.6 ASTM A90 - Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.

.2 CAN/CSA:

.1 CAN/CSA G30.18 - Billet-Steel Bars for Concrete Reinforcement.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 At least 30 days prior to commencing rock support installation, the Contractor shall submit the name(s) of the proposed rock bolt suppliers to the Engineer for approval.

.3 The Contractor shall provide copies of impact and torque wrench calibration certificates to the Engineer as provided for in Paragraph 2.1.6 of this Section below.

.4 The Contractor shall submit results of all Quality Assurance Tests carried out in accordance with Subsection 1.7 below of this Section of the Technical Specification for the Engineer's review.

.5 The Contractor shall prepare and submit a Structural Geological Analysis Report in accordance with this Section of the Technical Specification and submit same to the Engineer.

1.6 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 33 13 (a)i to 31 33 13 (c)ii in the Bill of Quantities, Unit Prices and Target Price Estimate will be based on the number of linear metres as shown in the Purchaser's Drawings and as directed by the Engineer.

.2 Measurement for Items 31 33 13 (d) i to 31 33 13 (d) ii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in square meters based on the neat lines shown in the Purchaser's Drawings and as directed by the Engineer.

.3 Measurement for Items 31 33 13 (e) to 31 33 13 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be based on the number of Items as shown in the Purchaser's Drawings, as described herein and as directed by the Engineer.

.3 Unit Price

.1 The unit prices for Item 31 33 13 (a)i to 31 33 13 (c)ii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying, drilling for, transporting, unloading, handling, assembling, installing, stressing, re-stressing as necessary, testing and checking 25 mm minimum diameter rock bolt dowels, including the supply and installation of resin, cementitious grout and rock bolt couplings and as follows:

.1 Item 31 33 13 (a) shall cover supply and install 25 mm diameter mechanical rock bolts.

.2 Item 31 33 13 (b) shall cover supply and install 25 mm diameter resin rock bolts.

.3 Item 31 33 13 (c) shall cover supply and install 25 mm rock dowels.

.2 The unit pricesfor Item 31 33 13 (d)i to 31 33 13 (d)ii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying and installing rockfall netting as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 33 13 (d)i shall cover supply and install rock netting for the Powerhouse area.

.2 Item 31 33 13 (d)ii shall cover supply and install rock netting for the Spillway area.

.3 The unit price for Item 31 33 13 (e) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying, unloading, handling, assembling and installing domed rock bolt bearing plates including hardened steel flat washers, heavy duty hex nuts and spherical washers as specified herein.

.4 The unit price for Item 31 33 13 (f) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for the drilling, flushing and maintenance of 6 metre rock drain holes as specified herein.

.5 The unit price for Item 31 33 13 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for the supply and installation of corrosion protection compound and accessories as specified herein.

.6 The unit price for Item 31 33 13 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying, unloading, handling, assembling and installing rockfall netting plates and jam nuts as specified herein.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 21.7 Project Quality Managment of the General Specification.

.2 Performance Testing of Rock Bolts:

.1 Prior to the commencement of rock bolting, the Contractor shall conduct performance testing of at least three rock bolts of each type of anchorage and each length of rock bolt shown on the Purchaser's Drawings to verify that the procedures and materials used will satisfy the requirements of this Section of the Technical Specification.

.2 The Contractor shall provide all equipment required for performance testing of rock bolts. This shall include a suitable hydraulic jack having a center bore in the ram for installation of the jack concentrically over the end of the bolt, a hydraulic pump with a calibrated load gauge, spare hydraulic hoses and load gauge and all other required accessories. Equipment shall meet the rock bolt manufacturer’s requirements and shall be authorized by the Engineer.

.3 Performance testing of rock bolts shall be carried out in accordance with the International Society for Rock Mechanics suggested methods for rock bolt testing. A load equivalent to 0.8 P (where P is equivalent to the guaranteed yield strength of the bar) shall be applied to the bar in increments equivalent to 0.1 P, or as directed by the Engineer. Measurements shall be taken of the bar deformation during loading and unloading of the bar. The maximum load shall be held for a period of 20 minutes. Measurements of extension versus time shall be taken to check creep and anchor slippage.

.3 Rock Bolt Checking:

.1 Rock bolt checking shall be randomly performed by the Contractor on a minimum of 20% of the rock bolts installed. The Contractor shall check any specific rock bolt when requested by the Engineer. The Contractor shall provide all labour and equipment required for rock bolt checking and shall furnish the results of such testing to the Engineer for review. The Contractor shall have the results of the testing sealed by a Professional Engineer licensed to practice in Manitoba. Equipment shall be the same as that described herein.

.2 Immediately after the tensioning of rock bolts, and prior to grouting, a load equivalent to the normal working load of the bar shall be applied using the center hole jack to check anchorage and the applied tension on selected bolts. The load shall be applied in three equal increments and measurements of bar extension shall be taken at each increment. Any bolt which fails (i.e., yields at or below the normal working load) shall be replaced by the Contractor, but shall not be entitled to any adjustment under Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification. Any decrease observed on the centre hole jack gauge shall be considered an indication of yield. If any bolt fails, all rock bolts installed during the previous 24 hours and within 10 m of the failed bolt shall be rechecked.

Part 2 Products

2.1 MATERIALS

.1 Rock Bolts

.1 Rock bolts may be resin anchored or mechanically anchored. Mechanical rock bolts shall be used for permanent installation and resin bolts may be used for temporary installations. All rock bolts shall conform to the requirements of ASTM A615M. Resin anchored rock bolts shall be of the solid-bar type and shall be provided with an anchorage of the resin cartridge satisfactory to the Engineer. Mechanically anchored rock bolts shall be groutable Williams Hollow Core “Spinlock Rockbolt” or Purchaser's approved equivalent. Rock bolts shall have a rolled thread of at least 300 mm in length at the exposed end. The maximum length of rock bolt will be 12 m.

.2 Rock bolts shall be 25 mm diameter bars with a minimum working load of 130 kN and have a guaranteed minimum yield strength of 160 kN. The Contractor shall provide a certificate from the manufacturer warranting the strength of the rock bolts. Rock bolts shall be provided with a spherical washer, hardened-steel flat washer, a heavy duty hex nut and a galvanized domed bearing plate, which shall have minimum dimensions of 200 mm by 200 mm by 13 mm thick.

.3 The entire bar shall be column grouted with a sufficient number of fast set resin cartridges to provide satisfactory anchorage and a cementitious grout to completely fill the remaining length of the hole. Fast-setting resin cartridges shall be Fasloc T as manufactured by Williams Form Hardware or Purchaser's approved equivalent. The setting time of the fast-setting resin cartridges shall be between 2 to 4 minutes. Cementitious grout shall consist of manufacturer’s recommended non-shrink cement grout, or Purchaser's approved equivalent, proportioned with admixtures as authorized by the Engineer.

.4 Mechanically anchored rock bolts shall be installed, tensioned and grouted in place. Grouting of mechanically anchored rock bolts shall be done using manufacturer's recommended non-shrink cement grout or Purchaser's approved equivalent, proportioned with admixtures as authorized by the Engineer. The grouting procedures, including special provisions for insulation during freezing conditions, shall be subject to the authorization of the Engineer.

.5 All rock bolts shall be a proprietary system with a well proven record of use under similar long-term conditions. The Contractor shall submit the proposed name(s) of rock bolt and rock anchor suppliers to the Engineer for review.

.6 The Contractor shall provide standard torque wrenches for tensioning of the rock bolts. The standard torque wrenches shall not be used for any other purpose. All impact and torque wrenches shall be calibrated once every month and copies of the calibration certificates shall be provided to the Engineer. The Contractor shall supply a torque wrench calibration device for this purpose. All torque wrenches utilized shall be set back to the lowest setting, at the end of each working day, by the Contractor.

.7 The Contractor shall provide all the equipment required to tension rock bolts. Equipment shall consist of a suitable calibrated impact wrench capable of delivering a minimum of 450 ft-lb torque and suitable standard torque wrenches. The impact wrench shall be equipped with an adjustable torque setting. During operation of the impact wrench an in-line lubricator shall be used. Equipment shall meet bolt manufacturer's requirements and shall be authorized by the Engineer.

.8 The bearing plates which are permanently exposed shall be galvanized. All rock bolts that are permanently exposed shall be protected from corrosion by the use of a fibre reinforced nylon cap packed with corrosion inhibiting grease. The cap and grease shall be suited to the Site conditions and authorized by the Engineer.

.2 Rock Slope Netting

.1 The standard type rockfall netting shall be flexible zinc coated rockfall netting. The mesh shall be a hexagonal woven mesh with double twisted joints formed by twisting each pair of wires through three half turns. The wire mesh shall be uniform hexagonal pattern, Mesh Type 8 x 10, with a nominal mesh opening of 83 mm.

.2 All wire shall comply with ASTM A975, style1 coating and galvanized. Wire used for the manufacture of rockfall netting and the lacing wire, shall have a maximum tensile strength of 515 MPa as per ASTM A641/A641M, soft temper steel.

.3 The mesh and wire characteristics shall be in accordance with ASTM A975 Table 1, Mesh Type 8x10.

.4 The minimum mesh properties for strength and flexibility shall be as follows:

.1 Mesh tensile strength shall be 51.5 kN/m when tested in accordance with ASTM A975, Section 13.1.1.

.2 Punch test resistance shall be a minimum of 26.7 kN when tested in accordance with ASTM A975, Section 13.1.4.

.5 The zinc coating of all wire used in the fabrication of the rockfall netting and in the wiring operations during construction shall be in accordance with the requirements of ASTM A 641, Standard Specification for Zinc-Coated

(Galvanized) Carbon Steel Wire, for galvanized wire, Class 3, soft temper, as measured before fabrication of the netting.

.6 Elongation wire tests shall be conducted on the wire before fabrication of the rockfall netting on a sample 305 mm long. Elongation shall not be less than 12%, in accordance with the requirements of ASTM A 370, Standard Test Methods and Definitions for Mechanical Testing of Steel Products.

.7 The wire diameters and minimum weights of the zinc coating shall be according to the figures shown in the table below when tested in accordance with ASTM A 90.

Wire Specifications			
	Lacing Wire	**Mesh Wire**	**Selvedge Wire**
Wire Diameter	2.20	3.00	3.90
Wire Diameter Tolerance	+/- 0.10 mm	+/- 0.10 mm	+/- 0.10 mm
Minimum Quantity of Zinc	213 g/m^2	260 g/m^2	274 g/m^2

.8 The adhesion of the zinc coating to the wire should be such that, when wrapped around a mandrel in accordance with ASTM A 641, the zinc coating will not crack or flake to such an extent that any zinc can be removed by rubbing with the bare fingers.

.9 The rockfall netting shall incorporate diaphragms to form cells having a length not greater than one and half times the width of the mesh.

.10 All edges of the standard rockfall netting including end-panels and the diaphragms, if any, shall be mechanically selvedged in such a way as to prevent unraveling of the mesh and to develop the full strength of the mesh.

.11 Sufficient lacing and connecting wire shall be supplied with the rockfall netting for all wiring operations carried out in the construction of the mesh work.

.12 Rockfall netting anchors shall be 20 M reinforcing steel with a minimum length of 600 mm, bent to form a standard 180 hook and set in a rapid-hardening resin or cement grout, as shown on the Purchaser's Drawings. The reinforcing steel anchors shall be in accordance with Section 03 21 00 Reinforcing Steel of the Technical Specification. Rapid hardening resin shall be in accordance with rock bolt installation in this Section of the Technical Specification. Cement grout shall be non-shrink cement grout, Target 1118 or Purchaser's approve equivalent, mixed in accordance with manufacturer’s recommendations.

.3 Rock Slope Netting Anchor Plates

.1 Rockfall netting anchor plates shall be used where rock bolts are used to support the rockfall netting. The rockfall netting anchor plates shall be 100 mm square galvanized steel plates, 6 mm thick, with a hole of suitable diameter so that the anchor plate slips onto the rock bolt bar, and shall be secured to the anchor bolt bar by a galvanized jam nut. The anchor plate shall be installed after the rock bolt has been tensioned to its required load and the rockfall netting has been positioned over the rock bolt.

.4 Rock Dowels

.1 Rock dowels shall be 20M, 1.5 m long, Grade 400, deformed reinforcing steel, in accordance with Section 03 21 00 Reinforcing Steel of the Technical Specification.

.2 Grout shall be a non-shrink cement grout, Target 1118 or Purchaser's approved equivalent. The grout shall develop a compressive strength of not less than 48 MPa after 28 days when mixed and cured in accordance with manufacturer directions.

Part 3 Execution

3.1 ROCK BOLT INSTALLATION REQUIREMENTS

.1 Holes for rock bolts shall be drilled to depths extending 0.15 m beyond the anchorage, at locations and inclinations shown on the Purchaser's Drawings, or as required by the Engineer.

.2 The required locations of the collars of all rock bolt holes will be marked on the excavated rock face by the Engineer. The Contractor shall provide access to the face for this purpose as soon as possible after the completion of the excavation and scaling in the adjacent area, at each bench level.

.3 Holes which are drilled out of place or alignment such that, in the opinion of the Engineer, they do not serve the intended purpose shall be grouted solid, where directed by the Engineer.

.4 The diameter of the holes shall be in accordance with the manufacturer's recommendations and shall be such that the ultimate strength of the steel can be developed without failure of the resin or mechanical anchor.

.5 In order to provide a reasonable bearing surface, the Engineer may require that the rock surface around the drilled holes be chipped smooth or be covered with a smooth quick-set mortar pad prior to installation of the rock bolt.

.6 Immediately prior to the installation of the rock bolt, the hole shall be flushed with air until the hole is cleaned of all cuttings, debris, ice and water.

.7 Where rock bolts are required on the excavation faces, as shown on the Purchaser's Drawings or as directed by the Engineer, they shall be installed and tensioned immediately after excavation of that bench in rock, and, in any case, the maximum difference between the elevation of the lowest row of installed bolts and the surface of the excavation shall not exceed 9 m.

3.2 INSTALLATION AND TENSIONING OF ROCK BOLTS

.1 Installation and tensioning of rock bolts shall be performed by personnel experienced in this type of Work.

.2 In order to provide a reasonable bearing surface, the rock surface around the drilled holes shall be chipped smooth or be covered with a smooth quick-set cement pad prior to installation of the rock bolt.

.3 Immediately prior to installation of a rock bolt, the hole shall be flushed and cleaned of all drill cuttings, debris, ice and water, by inserting the drill steel to the end of the hole and blowing compressed air through the rod as it is slowly withdrawn.

.4 Resin anchored rock bolts shall be installed in accordance with the manufacturer's recommendations, generally using the following procedures.

.1 After the hole is cleaned, a sufficient number fast-setting resin cartridges to achieve the required anchorage, such as a Fasloc T as manufactured by Williams Form Hardware or Purchaser's approved equivalent, shall be inserted in the hole and tamped to the bottom of the hole.

.2 The resin cartridges shall be stored at temperatures not below 10°C or above 50°C. Rock bolts shall be warmed, as required, to a minimum of 10°C, before installation.

.3 The bolt shall be then pushed and spun through the cartridges at a minimum speed of 100 r/min for a minimum of 1 minute.

.4 Bolts shall be tensioned when the fast-setting resin cartridges have set and before grouting of the remaining portion of the hole.

.5 The Contractor may be required to modify the installation procedures through the use of a resin accelerator such as Celtite 21-50 accelerator or Purchaser's approved equivalent in periods of extreme cold.

.5 Mechanically anchored rock bolts shall be installed, grouted and tensioned, all in accordance with the procedures recommended by the manufacturer or as directed by the Engineer. All rock bolts shall be installed in accordance with the following procedures.

.1 Rock bolts shall be installed in accordance with the system manufacturer's directions and then:

.1 The dished bearing plate shall then be placed over the projecting end of the bolt. A spherical nut shall be used to provide a uniform bearing at right angles to the longitudinal axis of the bolt. All threads on the bolt and the spherical nut shall be free of rust and burrs. A hardened steel flat washer shall be placed between the nut and the spherical washer.

.2 The rock bolt shall be tensioned to the required working load using the appropriate torque load with the impact wrench. The applied torque on all bolts shall be checked using a calibrated torque wrench immediately following completion of torquing with the impact wrench.

.3 After the bolt has been tensioned, the tension shall not be relaxed for any purpose.

.2 Rock bolts shall be re-tensioned immediately prior to grouting. Said re-tensioning and subsequent grouting of rock bolts shall be performed immediately prior to placement of concrete adjacent to the rock bolt. Where a rock bolt is to remain permanently exposed, re-tensioning and subsequent grouting shall be performed at the latest opportunity, as directed by the Engineer.

.3 If at any time prior to grouting the rock bolt, the Engineer or the Contractor finds that any installation has become loose or has lost its tension, the Contractor shall promptly re-tension the rock bolt. If it is found that any bolt will not take the required tension without anchorage slip, another bolt shall be installed in a new hole drilled in the immediate vicinity of the unsatisfactory bolt.

.4 A grease or wax mastic authorized by the Engineer shall be used between the spherical nut and the bearing plate and on the bolt threads.

.5 Once all rock bolts within a specified area, as determined by the Engineer in the field, have been installed and tensioned the Contractor shall use a calibrated torque wrench to verify that the applied load on all rock bolts is as required. If it

is found that any bolt has lost tension, the Contractor shall re-tension the bolt to the required working load, as specified herein.

.6 Bearing plates which will be permanently exposed shall be coated before installation with an accepted protective coating compound. Any defects in the coating shall be adequately coated after installation. The outer ends of the rock bolts, nuts and washers shall also be coated after installation and tensioning. The remaining portions of all rock bolts shall be clean and free of all deleterious materials, including dirt, paint and grease.

3.3 ROCK DOWELS

.1 Cement-grouted rock dowels shall be installed as indicated on the Purchaser's Drawings and as follows:

.1 After the hole for a rock dowel has been drilled and washed clean, place or inject sufficient grout into the hole such that, when the dowel is fully inserted into the hole, it will displace the grout, leaving the annulus completely filled with grout.

.2 The dowel shall be protected against disturbance for 48 hours after installation.

3.4 ROCK FACE DRAIN HOLES

.1 As rock excavation progresses, install all rock face drain holes as required, as shown on the Purchaser's Drawings or as directed by the Engineer. Drain holes shall be installed on a bench by bench basis in conjunction with other rock support measures.

.2 Unless otherwise indicated on the Purchaser's Drawings or directed by the Engineer, rock face drain holes shall be 6 m long, 50 mm diameter drill holes inclined at 6° to the horizontal and dipping out of the rock face. Holes shall be installed on a 6 m x 6 m pattern and flushed with clean water immediately after drilling to remove drill cuttings, mud and debris.

.3 All water emanating from the drain holes shall be directed to sumps, pipe headers, flumes, monitoring weirs, or other collector systems and the water subsequently removed from the excavation area.

.4 Contractor shall continuously protect and maintain the drain holes in working order. Holes which become inoperative due to improper installation or from being plugged with debris shall be re-drilled and washed or replaced.

3.5 ROCK SLOPE NETTING AND NETTING ANCHORS

.1 Rockfall netting shall be securely fastened to the rock face by the rockfall netting plates positioned over the rock bolts, installed as specified herein.

.2 Rockfall netting shall be anchored by means of rockfall netting anchors in areas where it cannot be attached to rock bolts. Rockfall netting anchors shall be used to secure the edges of netting tight to the rock surface to provide anchorage at overlaps and to provide intermediate support between rock bolts.

.3 The rockfall netting lacing wire procedure shall consist of cutting a length of lacing wire approximately 1-1/2 times the distance to be laced, but not exceeding 1,500 mm, securing one end of the wire at the corner by looping and twisting, alternately lacing with single and double loops every other mesh opening at intervals of not more than 150 mm and securing the other end of the wire to selvedges by looping and twisting.

.4 Rings can be used in lieu of lacing wire for assembly and installation operations of the mesh. Rings shall be supplied with the same zinc coating as the mesh and the wire diameter of the rings shall be the same as the mesh. The spacing of the rings shall be in accordance with ASTM A 975, Table 2, Panel to Panel Connection, Pull-Apart Resistance. In any case, the spacing of the fasteners shall not exceed 150 mm.

.5 The wire used for the rings shall be as supplied by MACCAFERRI GABIONS, (Reference No. 11G40), or Purchaser's approved equivalent, and shall be coated in accordance with ASTM A 641. Coating weight per ASTM A 90, also ASTM A 764, Class II, Type III. Tensile strength to be determined as per ASTM E 8.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary for the supply and installation of geotextile filter fabric, including loading, transporting, unloading, handling and undertaking the required surface preparation, in advance of installation, as shown on the Purchaser's Drawings, Contractor's Documents, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D4632 - "Standard Test Method for Grab Breaking Load and Elongation of Geotextiles".

.2 ASTM D4833 - "Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products".

.3 ASTM D4355 - "Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon-Arc Type Apparatus".

.4 ASTM D4751 - "Standard Test Method for Determining Apparent Opening Size of Geotextile".

.5 ASTM D4533 - "Standard Test Method for Trapezoidal Tearing Strength of Geotextiles".

.6 ASTM D4491, Rev A - "Standard Test Methods for Water Permeability of Geotextiles by Permittivity".

.7 ASTM D3786/D3786M - "Standard Test Method for Bursting Strength of Textile Fabrics - Diaphragm Bursting Strength Test Method".

1.4 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.2 The Contractor shall provide manufacturer's certificates evidencing compliance with this Section of the Technical Specification. The certificates shall identify the geosynthetic material and proposed use of each, quantity, batch number and date of manufacture. Notwithstanding Section 25 WARRANTY of the General Specification, the warranty period for all Work set out in this Section of the Technical Specification shall be 25

years, and otherwise warranted on the same terms and conditions as set out in Section 25 WARRANTY of the General Specification.

.3 The Contractor shall submit samples of the proposed geosynthetic materials to the Engineer with manufacturer's literature including minimum average roll values and expected average roll values of the physical properties of the geotextiles, for information. Two copies of the mill test data shall also be submitted at least 4 weeks prior to start of this Work.

1.5 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

1.6 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments the General Specification.

.2 Measurement

.1 Measurement for Item 31 35 19 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in square metres made on the basis of the actual area of ground surface on which geotextile has been installed as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein. Measurement will be based on the horizontal projection of the areas where geotextile has been installed, with no separate allowance for inclinations of the prepared surfaces, overlaps or seams.

.3 Unit Price

.1 The unit prices for Item 31 35 19 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying all labour, Materials and Plant, and performing all Work necessary for installation of geotextile filter fabric, including loading, transporting, unloading, handling, and surface preparation, securing pins and associated materials as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 35 19 (a) shall cover supply and installation of geotextile filter fabric.

Part 2 Products

2.1 MATERIALS

.1 Unless otherwise shown and described in the Purchaser's Drawings, or directed by the Engineer, the geotextile shall be a non-woven pervious sheet of plastic yarn as defined by ASTM D 123. The geotextile shall equal or exceed the following minimum average roll values:

Non-Woven Properties [a]			
	ASTM Test Method	**Units**	**Minimum Average Roll Values**
Physical			
Grab Tensile Strength	D-4632	N	800
Grab Tensile Elongation	D-4632	%	50
Mullen Burst	D-3786	kPa	2400
Puncture	D-4833	N	485
Trapezoidal Tear	D-4533	N	355
UV Resistance	D-4355	%@hr[b]	70/500
Hydraulic			
Apparent Opening Size	D-4751	mm	0.150
Permittivity	D-4491	s^{-1}	1.4
Flow Rate	D-4491	$L/s/m^2$	54

[a] Strength values indicated in the table are for the weaker principal direction.
[b] Percent grab tensile strength retained per hours of UV exposure following conditioning in accordance with ASTM-D4355.

.2 During delivery and storage, the Contractor shall protect the geotextiles from direct sunlight, ultraviolet rays, excessive heat, mud, dirt, dust, debris and rodents.

.3 Fibers used in the manufacturing of the geotextile shall consist of a long-chain synthetic polymer composed of at least 85% by weight of polyolefins, polyesters, or polamides. Stabilizers and/or inhibitors shall be added to the base polymer if necessary to make the filaments resistant to deterioration caused by ultraviolet light and heat exposure. Reclaimed or recycled fibers or polymer shall not be added to the formulation.

.4 Geotextile shall be formed into a network such that the filaments or yarns retain dimensional stability relative to each other, including the edges. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

.5 The geotextile shall be free of defects or flaws which significantly affect its physical and/or filtering properties.

Part 3 Execution

3.1 PROCEDURES

.1 The surface on which the geotextile will be placed shall be prepared to a relatively smooth surface condition, as determined by the Engineer, and shall be free from obstruction, debris, depressions, erosion features, or vegetation. Any irregularities will be removed so as to ensure continuous, intimate contact of the geotextile with all the surface. Any loose material, soft or low density pockets of material, snow, ice, will be

removed; erosion features such as rills, gullies etc. must be graded out of the surface before geotextile placement.

.2 The geotextile shall be placed in the manner and at the locations shown on the Purchaser's Drawings, and as determined by the Engineer. At the time of installation, the geotextile shall be rejected if it has defects, rips, holes, flaws, deterioration or damage incurred during manufacture, transportation or storage.

.3 The geotextile shall be installed as per the manufacturer's recommendations; laid smooth and free of tension, stress, folds, wrinkles, or creases, with some measure of anchorage provided prior to placement of the fill materials, all as determined by the Engineer.

.4 The strips shall be placed to provide a minimum width of 500 mm of overlap for each joint unless noted otherwise on the Purchaser's Drawings or as directed by the Engineer. Overlaps shall be constructed with the upslope sheet placed over the downslope sheet.

.5 Temporary pinning of the geotextile to help hold it in place until the pervious fill bedding layer is placed shall be allowed. The temporary pins shall be removed as the bedding material is placed to relieve high tensile stress which may occur during placement of material on the geotextile.

.6 Trimming shall be performed in such a manner that the geotextile shall not be damaged in any way.

.7 Care shall be taken during construction to avoid damaging the geotextile. Damaged geotextile shall be removed or repaired as directed by the Engineer. A geotextile patch may be placed over damaged areas if determined by the Engineer. The patch shall extend 1 m beyond the perimeter of the damaged area.

.8 The installed geotextile material shall be protected from displacement, damage or deterioration before, during and after placement of material layers.

.9 The geotextile shall be covered with fill, as shown on the Purchaser's Drawings, placed by end dumping adjacent to the geotextile or over previously placed fill. End dumping or tail gate dumping of fill on the geotextile will not be permitted.

.10 Damaged or deteriorated geotextile shall be replaced to the satisfaction of the Engineer.

.11 No vehicles shall be permitted directly on the geotextile prior to cover placement.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, and performing all Work necessary for supplying, transporting and placing Class 7 and Class 8 riprap as shown on the Purchaser's Drawings, Contractor's Documents, as directed by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D5519 - Standard Test Methods for Particle-Size Analysis of Natural and man-Made Riprap Materials.

1.2 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate multiplied by the corresponding unit price for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 37 00 (a)i to 31 37 00 (b)vii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in cubic metres of Class 7 and 8 materials (riprap) placed and measured in accordance with the neat lines and grades set out in the Purchaser's Drawings and as directed by the Engineer.

Where appropriate, on-Site surveying information will be jointly gathered by the Contractor and the Engineer from a comparison of the pre-construction survey after the foundation preparation but prior to the fill placement, or of the survey immediately following the placement of the underlying fill zone. The Contractor shall cooperate with the Engineer to allow for a joint survey of the necessary surfaces for accurate measurements. The volume will be measured from the neat lines shown on the Purchaser's Drawings as compared with the on-Site surveyed geometry following the foundation preparation or underlying fill zones but prior to the fill placement (where appropriate), as measured and determined by the Engineer. The measured volume for shall be determined using software tools such as Autodesk Civil 3D using the composite volume method that is represented by two Triangulated Irregular Networks, (TIN). The composite calculation will determine the volume from the discrete difference between each surface.

.3 Unit Price

.1 The unit prices for Items 31 37 00 (a)i to 31 37 00 (b)vii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying, transporting and placing Class 7 and 8 riprap as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 37 00 (a)i shall cover supply, transport and place Class 7 riprap for North Dam.

.2 Item 31 37 00 (a)ii shall cover supply, transport and place Class 7 riprap for parking lot and access ramp.

.3 Item 31 37 00 (a)iii shall cover supply, transport and place Class 7 riprap for South Dam.

.4 Item 31 37 00 (a)iv shall cover supply, transport and place Class 7 riprap for Central Dam.

.5 Item 31 37 00 (a)v shall cover supply, transport and place Class 7 riprap for North Dyke.

.6 Item 31 37 00 (a)vi shall cover supply, transport and place Class 7 riprap for South Dyke.

.7 Item 31 37 00 (a)vii shall cover supply, transport and place Class 7 riprap for Transmission Tower Spur.

.8 Item 31 37 00 (b)i shall cover supply, transport and place Class 8 riprap for North Dam.

.9 Item 31 37 00 (b)ii shall cover supply, transport and place Class 8 riprap for parking lot and access ramp.

.10 Item 31 37 00 (b)iii shall cover supply, transport and place Class 8 riprap for South Dam.

.11 Item 31 37 00 (b)iv shall cover supply, transport and place Class 8 riprap for Central Dam.

.12 Item 31 37 00 (b)v shall cover supply, transport and place Class 8 riprap for North Dyke.

.13 Item 31 37 00 (b)vi shall cover supply, transport and place Class 8 riprap for South Dyke.

.14 Item 31 37 00 (b)vii shall cover supply, transport and place Class 8 riprap for Transmission Tower Spur.

1.3 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Riprap (Classes 7 and 8)

.1 Riprap shall consist of unweathered Precambrian rock, and shall be strong, hard, dense, durable, free from cracks and seams, resistant to abrasion, not subject to freeze-thaw deterioration, free of organic matter, snow, ice, frozen or other deleterious material, and shall be clean and well graded within the gradation limits specified below.

.2 The rock fragments shall be generally cubical in shape. The largest dimension of individual pieces shall not be greater than twice the shortest dimensions; long, flat stones shall not be used.

Size	Percent Finer by Weight	
	Class 8	Class 7
1100 mm	100	
1000 mm	50-100	
900 mm	30-50	100
800 mm	0-20	70-100
760 mm	0	
700 mm		50-70
600 mm		20-40
500 mm		0

Part 3 Execution

3.1 PLACEMENT

.1 Riprap shall be obtained from required excavations or from the quarries shown on the Purchaser's Drawings or from other sources as determined by the Engineer. The Engineer will accept sources of riprap material that, in his opinion, provide the most suitable usage of available material.

.2 Riprap shall be so placed that segregation of sizes does not occur. Riprap shall be dumped and leveled in such a manner as to ensure that the completed riprap is stable and interlocked with no tendency for individual particles to roll or slide, and that there will be no voids through which bedding material is visible. The dumping of the riprap at the top of slopes and pushing to place down the slope for slope distances in excess of 5 m will not be permitted.

.3 Riprap shall be generally placed in the dry in locations shown on the Purchaser's Drawings and shall be placed on an underlying blanket of Class 5 or 6 material as shown on the Purchaser's Drawings and/or as directed by the Engineer. No gouging of the bedding material shall occur during placement of the riprap.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, except as herein provided, and performing all Work necessary for supplying, transporting and placing materials, as well as operation of equipment, required for:

.1 Construction and maintenance of the cofferdams.

.2 Initial dewatering and continued pumping as required to maintain the cofferdammed areas and excavations in a dewatered state.

.3 All temporary and long term pumping required to maintain the powerhouse drainage sump within the control range specified by the Engineer until the Engineer has relieved the Contractor of this pumping requirement.

.4 Construction of erosion protection measures (if required, and as determined by the Engineer) on the south abutment prior to river closure.

.5 Removal of those sections of the cofferdams which must be excavated to effectively divert the river during construction, as well as those sections which must be removed to ensure unimpeded operation of the completed structures.

.6 Flooding, by controlled methods, any areas necessary to permit removal of the cofferdams.

.7 Controlling suspended sediment in accordance with Section 31 25 00 Erosion and Sediment Control of the Technical Specification which results from fill placement or excavation activities adjacent to or in the natural water courses to within the parameters indicated in the Environmental Protection Plan.

.8 The Contractor and the Engineer will jointly prepare as-built models of all cofferdams. These models will be used to measure and determine the total cofferdam removal quantities.

.2 All as shown on the Purchaser's Drawings, as determined by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 31 23 01 - Weight Scales.

.3 Section 31 23 13 - Foundation Preparations.

.4 Section 31 23 19 - Control of Water.

.5 Section 31 23 23 - Impervious Fill.

.6 Section 31 23 24 - Granular Fill.

.7 Section 31 25 00 - Erosion and Sedimentation Control.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 American Society for Testing and Materials (ASTM):

.1 ASTM D422 - "Standard Test Method for Particle-Size Analysis of Soils**.**

.2 ASTM C535 - Standard Test Method for Resistance to Degradation of Large-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.3 ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

.2 Environmental Protection Plan (EPP).

.3 Sediment Management Plan.

1.4 DEFINITIONS

.1 Supplementary to definitions contained in the General Specification, the following shall apply:

.1 "Cofferdam(s)" shall include all of the temporary structures required to divert the river during construction.

.2 "Causeway(s)" shall include all of the temporary structures required for the haul road access across bodies of water to access impervious and granular deposits, including Deposit N-5 and Deposit G-3.

.3 "Supply" shall have the following meaning depending on the source of the materials:

.1 For materials to be obtained from borrow areas (i.e., sources other than quarries, stockpiles, Cofferdam removal, or excavations for the permanent structures or channels), the term "Supply" shall mean all Work necessary to excavate and load for transport, materials for placement in the fill structures. It shall also include all Work required for development, maintenance, and reclamation of the borrow area(s), mixing in the borrow area(s) by excavation or other methods, selective excavation procedures, and processing, if required to achieve the specified Gradation Limits and moisture contents.

.2 For materials to be obtained from quarries, the term "Supply" shall mean all Work necessary to drill and blast, muck, and load for transport, materials for placement in the fill structures. It shall also include all Work required for development, maintenance, and reclamation of the quarries; any selective excavation procedures and all material processing operations required to achieve the specific material Gradation Limits.

.3 For materials to be obtained from the excavations for the structures, channels, stockpiles, or Cofferdam removal, the term "Supply" shall mean all Work necessary to select, process if required to achieve specified Gradation Limits and moisture contents, and, should processing be required to meet Gradation Limits and moisture content requirements, reload for transport after processing, materials for placement in the fill structures.

.2 “Transport” or "Transporting" shall mean all Work necessary to haul materials from the borrow areas, stockpiles, or quarries, to the required locations in the structures or to haul materials from the required excavations to permanent disposal areas, temporary stockpiles, or to the required locations in the structures.

.3 “Place” or "Placing" shall mean all Work necessary to dump, spread, disc or otherwise breakup the material, mix, and compact, if necessary, fills in their final location in the structures. As required, it shall also include scarifying or roughening the surface of previously placed fill to ensure adequate bonding between lifts, all Work necessary for control of moisture contents, sluicing, and grading of slopes to their final lines and grades.

.4 “Gradation Limits” shall mean the gradation of the placed fill, after any required processing and/or conditioning and compaction. The gradation of the placed fill shall be determined using ASTM D422 “Standard Test Methods for Particle-Size Analysis of Soil”, ASTM International, for those fill materials or portions of the fill materials that are specified to pass the 75 mm sieve.

.5 “Compaction” shall mean all Work necessary to achieve the desired material density as specified within this Section of the Technical Specification.

.6 “Unsuitable” excavated materials shall mean material from the required excavations or Cofferdam removal, which does not meet the specified requirements for fill in the structures. Final decision as to the use of or unsuitability of any excavated materials shall be at the discretion of the Engineer.

.7 “Unusable” excavated materials shall mean suitable material from the required excavations or Cofferdam removal, that the Contractor can demonstrate is not required for fill for use in the designated Work areas, and is surplus to its requirements.

.8 “Initial Dewatering” shall mean pumping, sumping, ditching and all Work necessary to remove the water ponded within the area enclosed by a Cofferdam.

.9 “Continued Pumping” shall mean pumping, sumping, ditching and all Work as necessary to maintain the area within the confines of a Cofferdam and the excavations in a dewatered state.

.10 “Maintenance” shall mean all Work necessary to ensure the stability, integrity and imperviousness of all cofferdams. Maintenance may be required as a result of erosion of the fill due to water or ice action, to control seepage to tolerable limits, or to effect repairs due to sloughing or subsidence.

.11 “Topping-Up” shall mean the placement of fill on the crest of the Cofferdam as required to raise the crest to higher levels as determined by the Engineer.

.12 “Stage I Cofferdams” shall mean those cofferdams carried out for Stage I Diversion. The Stage I Cofferdams will include the following:

.1 Quarry Cofferdam: The Quarry Cofferdam is required to allow initial exploitation of Rock Quarry No.7, which is the material source for the construction of the North Channel Rock Groin and North Channel Stage I Cofferdam.

.2 North Channel Rock Groin: The North Channel Rock Groin will be used to impede the flow through the northern river channel and divert it through the river’s southern channel.

.3 North Channel Stage I Cofferdam: The North Channel Stage I Cofferdam will be used to divert the flow through the south river channel.

.4 Powerhouse Stage I Cofferdam: The purpose of the Powerhouse Stage I Cofferdam is to allow for dewatering of the Powerhouse area to facilitate starting excavation Work in-the-dry.

.5 Stage I Island Cofferdam: The purpose of the Stage I Island Cofferdam is to fill in a depression located on the Central Island between the edge of the North Channel Stage I Cofferdam and the hill crest of the island. The Cofferdam will prevent water entering the Powerhouse area during the Stage I Diversion.

.6 Spillway Stage I Cofferdam: The purpose of the Spillway Stage I Cofferdam is to allow dewatering of the Spillway area; following dewatering excavation Work in-the-dry will commence.

.7 Central Dam Stage I Cofferdam and Rock Groin: The Central Dam Stage I Rock Groin will be constructed to reduce water velocities along the wet-side slope of the Central Dam Stage I Cofferdam during placement of the transition and impervious fills. The construction of the Central Dam Stage I Cofferdam will allow dewatering of the Central Dam area, as well as the adjacent upstream area, therefore permitting construction of the Central Dam.

.13 “Stage II Cofferdams” shall mean those Cofferdams carried out as part of Stage II Diversion. The Stage II Cofferdams will include the following:

.1 Stage II Island Cofferdam: The Stage II Island Cofferdam will allow for the upstream areas of the Central Dam and Powerhouse to be retained in-the-dry during the Stage II Diversion period and the pre-impoundment stages of forebay impoundment that are linked to closure and construction of the Spillway Rollways.

.2 Tailrace Summer Level Cofferdam: The purpose of the Tailrace Summer Level Cofferdam is to allow dewatering of the Tailrace Channel and consequently performing the excavation work in-the-dry.

.3 Stage II Upstream and Downstream South Dam Cofferdams: The construction of these two Cofferdams along with the diversion of the river through the Spillway will be necessary to facilitate the construction of the South Dam.

.14 “Stage I Diversion” shall mean that period of time during which the river is diverted through south side of the southern river channel. This involves blocking off the north and central channels of the river by means of the Stage I Cofferdams.

.15 “Stage II Diversion” shall mean that period of time during which the river flow is diverted through the spillway, located in the northern section of the south river channel.

.16 "Removal in-the-Wet" shall mean the excavation of any fill material that is in direct contact with water of the existing natural watercourses at the Site, or in direct contact with water of the flooded cofferdammed area(s) after the cofferdammed area(s) has (have) been flooded upon the discretion of the Engineer. It shall also mean any fill or unclassified material which is located below river level and is required to be excavated.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate multiplied by the corresponding unit price set out therein for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 52 00 (a)i to 31 52 00 (a)ii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in square metres made based on the neat horizontal limits of Stage I Island Cofferdam and abutment contacts of Cofferdams set out in the Purchaser's Drawings and as determined by the Engineer.

.2 Measurement for Items 31 52 00 (b)i to 31 52 00 (e)xi in the Bill of Quantities, Unit Prices and Target Price Estimate shall be dry weight of the materials placed for cofferdams in tonnes, as set out in the Purchaser's Drawings and as determined by the Engineer. Tonnage tickets will be collected following each day for each truck delivered, unloaded and placed for each Cofferdam and Causeway.

.3 Measurement for Items 31 52 00 (f)i to 31 52 00 (f)x in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in cubic metres based on the volume of Class RT materials placed on the Cofferdams and Causeways, as set out in the Purchaser's Drawings and as determined by the Engineer.

.4 Measurement for Items 31 52 00 (g)i to 31 52 00 (g)ix in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in cubic metres based on the volume of water pumped from the Cofferdams and Causeways as measured using flow meters or other methods determined by the Engineer.

.5 Measurement for Items 31 52 00 (h)i to 31 52 00 (h)xiii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be by months, based on the number of months of operation of the Cofferdams and Causeways.

.6 Measurement for Items 31 52 00 (i)i to 31 52 00 (k)iii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in cubic metres, based on the removal quantities calculated from the as-built models of the Cofferdams and Causeways. The removal quantities will be based on the model to the neat line excavation elevations.

.7 Measurement for Items 31 52 00 (l) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in linear metres based on the measured culvert as shown in the Purchaser's Drawings and as determined by the Engineer.

.8 Measurement for Items 31 52 00 (m)i to 31 52 00 (n)iii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be the dry weight of the materials placed for the Cofferdam remnants and Cofferdams in tonnes, as set out in the Purchaser's Drawings and as determined by the Engineer. Tonnage tickets will

be collected each following day for each truck delivered, unloaded and placed for each Cofferdam and Causeway.

.9 No separate measurement or payment will be made for Supplying, Transporting, Placing or removing of the fill materials.

.10 No separate measurement or payment will be made for the construction, maintenance and removal of access ramps, roads and related items required by the Contractor to perform the Work as described herein.

.11 No separate measurement or payment will be made for supplying, installing, operating and maintaining of dewatering equipment and constructing ditches, sumps, wells, temporary culverts, temporary erosion protection, and all measures required to control the release of suspended solids in the adjacent water courses, and other Temporary Works necessary for the Initial Dewatering and Continued Pumping.

.3 Unit Price

.1 The unit prices for Items 31 52 00 (a)i to 31 52 00 (a)ii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for stripping of the Cofferdams as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (a)i shall cover stripping for Stage I Island Cofferdam.

.2 Item 31 52 00 (a)ii shall cover stripping for abutment contact of Cofferdams.

.2 The unit prices for Items 31 52 00 (b)i to 31 52 00 (b)vii, 31 52 00 (b)ix to 31 52 00 (c)vi, 31 52 00 (c)viii to 31 52 00 (d)x, 31 52 00 (d) xi to 31 52 00 (e)vii, and 31 52 00 (e)ix to 31 52 00 (e)xi in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for placement of Cofferdams materials as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (b)i shall cover Supply, Transport and Place Impervious Fill (Class A) for Quarry Cofferdam.

.2 Item 31 52 00 (b)ii shall cover Supply, Transport and Place Impervious Fill (Class A) for Central Dam Stage I Cofferdam.

.3 Item 31 52 00 (b)iii shall cover Supply, Transport and Place Impervious Fill (Class A) for North Channel Stage I Cofferdam.

.4 Item 31 52 00 (b)iv shall cover Supply, Transport and Place Impervious Fill (Class A) for Powerhouse Stage I Cofferdam.

.5 Item 31 52 00 (b)v shall cover Supply, Transport and Place Impervious Fill (Class A) for Spillway Stage I Cofferdam.

.6 Item 31 52 00 (b)vi shall cover Supply, Transport and Place Impervious Fill (Class A) for Stage I Island Cofferdam.

.7 Item 31 52 00 (b)vii shall cover Supply, Transport and Place Impervious Fill (Class A) for Stage II Island Cofferdam.

.8 Item 31 52 00 (b)ix shall cover Supply, Transport and Place Impervious Fill (Class A) for South Dam Stage II Upstream Cofferdam.

.9 Item 31 52 00 (b)x shall cover Supply, Transport and Place Impervious Fill (Class A) for South Dam Stage II Downstream Cofferdam.

.10 Item 31 52 00 (b)xi shall cover Supply, Transport and Place Impervious Fill (Class A) for Tailrace Channel Summer Level Cofferdam.

.11 Item 31 52 00 (c)i shall cover Supply, Transport and Place Transition Material (Class B) for North Channel Stage I Cofferdam.

.12 Item 31 52 00 (c)ii shall cover Supply, Transport and Place Transition Material (Class B) for Powerhouse Stage I Cofferdam.

.13 Item 31 52 00 (c)iii shall cover Supply, Transport and Place Transition Material (Class B) for Spillway Stage I Cofferdam.

.14 Item 31 52 00 (c)iv shall cover Supply, Transport and Place Transition Material (Class B) for Stage I Island Cofferdam.

.15 Item 31 52 00 (c)v shall cover Supply, Transport and Place Transition Material (Class B) for Central Dam Stage I Cofferdam.

.16 Item 31 52 00 (c)vi shall cover Supply, Transport and Place Transition Material (Class B) for Stage II Island Cofferdam.

.17 Item 31 52 00 (c)viii shall cover Supply, Transport and Place Transition Material (Class B) for South Dam Stage II Upstream Cofferdam.

.18 Item 31 52 00 (c)ix shall cover Supply, Transport and Place Transition Material (Class B) for South Dam Stage II Downstream Cofferdam.

.19 Item 31 52 00 (c)x shall cover Supply, Transport and Place Transition Material (Class B) for Tailrace Channel Summer Level Cofferdam.

.20 Item 31 52 00 (d)i shall cover Supply, Transport and Place Rockfill (Class C) for Causeway to Deposit N-5.

.21 Item 31 52 00 (d)ii shall cover Supply, Transport and Place Rockfill (Class C) for Causeway to Deposit G-3.

.22 Item 31 52 00 (d)iii shall cover Supply, Transport and Place Rockfill (Class C) for Quarry Cofferdam.

.23 Item 31 52 00 (d)iv shall cover Supply, Transport and Place Rockfill (Class C) for North Channel Rock Groin.

.24 Item 31 52 00(d)v shall cover Supply, Transport and Place Rockfill (Class C) for North Channel Stage I Cofferdam.

.25 Item 31 52 00 (d)vi shall cover Supply, Transport and Place Rockfill (Class C) for Powerhouse Stage I Cofferdam.

.26 Item 31 52 00 (d)vii shall cover Supply, Transport and Place Rockfill (Class C)for Spillway Stage I Cofferdam.

.27 Item 31 52 00 (d)viii shall cover Supply, Transport and Place Rockfill (Class C) for Stage I Island Cofferdam.

.28 Item 31 52 00 (d)ix shall cover Supply, Transport and Place Rockfill (Class C) for Central Dam Stage I Cofferdam.

.29 Item 31 52 00 (d)x shall cover Supply, Transport and Place Rockfill (Class C) for Stage II Island Cofferdam.

.30 Item 31 52 00 (d)xii shall cover Supply, Transport and Place Rockfill (Class C) for South Dam Stage II Upstream Cofferdam

.31 Item 31 52 00 (d)xiii shall cover Supply, Transport and Place Rockfill (Class C) for South Dam Stage II Downstream Cofferdam.

.32 Item 31 52 00 (d)xiv shall cover Supply, Transport and Place Rockfill (Class C) for Tailrace Channel Summer Level Cofferdam.

.33 Item 31 52 00 (e)i shall cover Supply, Transport and Place riprap armouring for Quarry Cofferdam.

.34 Item 31 52 00 (e)ii shall cover Supply, Transport and Place riprap armouring for North Channel Stage I Cofferdam.

.35 Item 31 52 00 (e)iii shall cover Supply, Transport and Place riprap armouring for Powerhouse Stage I Cofferdam.

.36 Item 31 52 00 (e)iv shall cover Supply, Transport and Place riprap armouring for Spillway Stage I Cofferdam.

.37 Item 31 52 00 (e)v shall cover Supply, Transport and Place riprap armouring for Stage I Island Cofferdam.

.38 Item 31 52 00 (e)vi shall cover Supply, Transport and Place riprap armouring for Central Dam Stage I Cofferdam.

.39 Item 31 52 00 (e)vii shall cover Supply, Transport and Place riprap armouring for Stage II Island Cofferdam.

.40 Item 31 52 00 (e)viii shall cover Supply, Transport and Place riprap armouring for Stage II Diversion Tie-In Cofferdams inside Spillway Cofferdam.

.40 Item 31 52 00 (e)ix shall cover Supply, Transport and Place riprap armouring for South Dam Stage II Upstream Cofferdam.

.41 Item 31 52 00 (e)x shall cover Supply, Transport and Place riprap armouring for South Dam Stage II Downstream Cofferdam.

.42 Item 31 52 00 (e)xi shall cover Supply, Transport and Place riprap armouring for Tailrace Channel Summer Level Cofferdam.

.3 The unit prices for Items 31 52 00.(b)viii, 31 52 00 (c)vii, 31 52 00 (d)xi in the Bill of Quantities, Unit Prices and Target Price Estimate, shall be for placement of Cofferdam materials as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (b)viii shall cover Supply, Transport and Place Impervious Fill (Class A) for Stage II Diversion Tie-In Cofferdams inside Spillway Cofferdam.

.2 Item 31 52 00 (c)vii shall cover Supply, Transport and Place Transition Material (Class B) for Stage II Diversion Tie-In Cofferdams inside Spillway Cofferdam.

.3 Item 31 52 00 (d)xi shall cover Supply, Transport and Place Rockfill (Class C) for Stage II Diversion Tie-In Cofferdams inside Spillway Cofferdam.

.4 The unit prices for Items 31 52 00 (f)i to 31 52 00 (f)x in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for placement of Cofferdam materials as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (f)i shall cover Supply, Transport and Place riprap Class RT for Causeway to Deposit N-5.

.2 Item 31 52 00 (f)ii shall cover Supply, Transport and Place riprap Class RT for Causeway to Deposit G-3.

.3 Item 31 52 00 (f)iii shall cover Supply, Transport and Place riprap Class RT for North Channel Stage I Cofferdam.

.4 Item 31 52 00 (f)iv shall cover Supply, Transport and Place riprap Class RT for Powerhouse Stage I Cofferdam.

.5 Item 31 52 00 (f)v shall cover Supply, Transport and Place riprap Class RT for Spillway Stage I Cofferdam.

.6 Item 31 52 00 (f)vi shall cover Supply, Transport and Place riprap Class RT for Stage I Island Cofferdam.

.7 Item 31 52 00 (f)vii shall cover Supply, Transport and Place riprap Class RT for Central Dam Stage I Cofferdam.

.8 Item 31 52 00 (f)viii shall cover Supply, Transport and Place riprap Class RT for Stage II Island Cofferdam.

.9 Item 31 52 00 (f)ix shall cover Supply, Transport and Place riprap Class RT for South Dam Stage II Downstream Cofferdam.

.10 Item 31 52 00 (f)x shall cover Supply, Transport and Place riprap Class RT for Tailrace Channel Summer Level Cofferdam.

.5 The unit prices for Items 31 52 00 (g)i to 31 52 00 (h)xiii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for Initial Dewatering and Maintenance of crest elevation and Continued Pumping for the Cofferdams and Causeways as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (g)i shall cover Initial Dewatering for Quarry Cofferdam.

.2 Item 31 52 00 (g)ii shall cover Initial Dewatering for North Channel Stage I Cofferdam.

.3 Item 31 52 00 (g)iii shall cover Initial Dewatering for Powerhouse Stage I Cofferdam.

.4 Item 31 52 00 (g)iv shall cover Initial Dewatering for Spillway Stage I Cofferdam.

.5 Item 31 52 00 (g)v shall cover Initial Dewatering for Stage I Island Cofferdam.

.6 Item 31 52 00 (g)vi shall cover Initial Dewatering for Central Dam Stage I Cofferdam.

.7 Item 31 52 00.(g)vii shall cover Initial Dewatering for Stage II Island Cofferdam.

.8 Item 31 52 00.(g)viii shall cover Initial Dewatering for South Dam Stage II Upstream Cofferdam.

.9 Item 31 52 00 (g)ix shall cover Initial Dewatering for Tailrace Channel Summer Level Cofferdam.

.6 The unit prices for Items 31 52 00 (h)i to 31 52 00 (h)xiii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for placement of Cofferdam materials as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (h)i shall cover Maintenance of crest elevation and Continued Pumping for Causeway to N-5.

.2 Item 31 52 00 (h)ii shall cover Maintenance of crest elevation and Continued Pumping for Causeway to G3.

.3 Item 31 52 00 (h)iii shall cover Maintenance of crest elevation and Continued Pumping for Quarry Cofferdam.

.4 Item 31 52 00 (h)iv shall cover Maintenance of crest elevation and Continued Pumping for North Channel Rock Groin.

.5 Item 31 52 00 (h)v shall cover Maintenance of crest elevation and Continued Pumping for North Channel Stage I Cofferdam.

.6 Item 31 52 00 (h)vi shall cover Maintenance of crest elevation and Continued Pumping for Powerhouse Stage I Cofferdam.

.7 Item 31 52 00 (h)vii shall cover Maintenance of crest elevation and Continued Pumping for Spillway Stage I Cofferdam.

.8 Item 31 52 00 (h)viii shall cover Maintenance of crest elevation and Continued Pumping for Stage I Island Cofferdam.

.9 Item 31 52 00 (h)ix shall cover Maintenance of crest elevation and Continued Pumping for Central Dam Stage I Cofferdam.

.10 Item 31 52 00 (h)x shall cover Maintenance of crest elevation and Continued Pumping for Stage II Island Cofferdam.

.11 Item 31 52 00 (h)xi shall cover Maintenance of crest elevation and Continued Pumping for South Dam Stage II Upstream Cofferdam.

.12 Item 31 52 00 (h)xii shall cover Maintenance of crest elevation and Continued Pumping for South Dam Stage II Downstream Cofferdam.

.13 Item 31 52 00 (h)xiii shall cover Maintenance of crest elevation and Continued Pumping for Tailrace Channel Summer Level Cofferdam.

.7 The unit prices for Items 31 52 00 (k)i to 31 52 00 (m)iii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for removal of the Cofferdams' and Causeways' material as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (i)i shall cover removal of materials "in-the-wet" for Causeway to Deposit N-5.

.2 Item 31 52 00 (i)ii shall cover removal of materials "in-the-wet" for Causeway to Deposit G-3.

.3 Item 31 52 00 (i)iii shall cover removal of materials "in-the-wet" for Powerhouse Stage I Cofferdam.

.4 Item 31 52 00 (i)iv shall cover removal of materials "in-the-wet" for Spillway Stage I Cofferdam.

.5 Item 31 52 00 (i)v shall cover removal of materials "in-the-wet" for Stage I Island Cofferdam.

.6 Item 31 52 00 (i)vi shall cover removal of materials "in-the-wet" for Central Dam Stage I Cofferdam.

.7 Item 31 52 00 (i)vii shall cover removal of materials "in-the-wet" for South Dam Stage II Downstream Cofferdam.

.8 Item 31 52 00 (i)viii shall cover removal of materials "in-the-wet" for Tailrace Channel Summer Level Cofferdam.

.9 Item 31 52 00 (j)i shall cover removal of materials "in-the-dry" for Causeway to Deposit N-5.

.10 Item 31 52 00 (j)ii shall cover removal of materials "in-the-dry" for Causeway to Deposit G-3.

.11 Item 31 52 00 (j)iii shall cover removal of materials "in-the-dry" for Powerhouse Stage I Cofferdam.

.12 Item 31 52 00 (j)iv shall cover removal of materials “in-the-dry” for Spillway Stage I Cofferdam.

.13 Item 31 52 00 (j)v shall cover removal of materials “in-the-dry” for Stage I Island Cofferdam.

.14 Item 31 52 00 (j)vi shall cover removal of materials “in-the-dry” for Stage II Island Cofferdam.

.15 Item 31 52 00 (j)vii shall cover removal of materials “in-the-dry” for Stage II Diversion Tie-In Cofferdams inside Spillway Cofferdam.

.16 Item 31 52 00 (j)viii shall cover removal of materials “in-the-dry” for South Dam Stage II Downstream Cofferdam.

.17 Item 31 52 00 (j)ix shall cover removal of materials “in-the-dry” for Tailrace Channel Summer Level Cofferdam.

.18 Item 31 52 00 (j)x shall cover removal of materials “in-the-dry” for Quarry Cofferdam.

.19 Item 31 52 00 (k)i shall cover removal of materials “in-the-dry” with stable ice cover formation for North Channel Rock Groin.

.20 Item 31 52 00 (k)ii shall cover removal of materials “in-the-dry” with stable ice cover formation for North Channel Stage I Cofferdam.

.21 Item 31 52 00 (k)iii shall cover removal of materials “in-the-dry” with stable ice cover formation.

.8 The unit prices for Item 31 52 00 (l) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for removal of the Causeways’ culverts as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (l) shall cover removal of culverts.

.9 The unit prices for Items 31 52 00 (m)i to 31 52 00 (m)v i in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for armouring of Cofferdam remnants as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (m)i shall cover armouring of Cofferdam remnants by placement of Transition Material (Class B) for Spillway Stage I Cofferdam.

.2 Item 31 52 00 (m)ii shall cover armouring of Cofferdam remnants by placement of Class C1 for Spillway Stage I Cofferdam.

.3 Item 31 52 00 (m)iii shall cover armouring of Cofferdam remnants by placement of Class C2 for Spillway Stage I Cofferdam.

.4 Item 31 52 00 (m)iv shall cover armouring of Cofferdam remnants by placement of Class C3 for Spillway Stage I Cofferdam.

.5 Item 31 52 00 (m)v shall cover armouring of Cofferdam remnants by placement of Class C4 for Spillway Stage I Cofferdam.

.10 The Unit Prices for Items 31 52 00 (n)i to 31 52 00 (n)iii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for shoreline erosion protection as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 52 00 (n)i shall cover shore protection by placement of Riprap erosion protection for South Dam Stage II Upstream Cofferdam.

.2 Item 31 52 00 (n)ii shall cover shore protection by placement of Class C1 Riprap for Causeway to Deposit G-3.

.3 Item 31 52 00 (n)iii shall cover shore protection by placement of Class C2 Riprap for Causeway to Deposit N-5.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification and as specified herein.

.2 The Contractor shall submit to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review, details of all access ramps, temporary roads and other features necessary for the Contractor's operations throughout the entire Site area. Drawings showing details of locations, grades, material types and other pertinent information shall be submitted to the Engineer at least one month prior to construction of said features.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Control of the General Specification.

1.8 RESPONSIBILITY

.1 The Cofferdams required to effect the Stage I and II Diversions are shown on the Purchaser's Drawings. The Contractor shall study the purpose, design philosophy, assumptions, limitations and other relevant information in order to effect an understanding of the arrangement, design and details of the Cofferdams and the scope of Maintenance required.

.2 Upon completion of the Stage I and Stage II Cofferdams, the Contractor shall maintain them in accordance with this Section of the Technical Specification, as shown on the Purchaser's Drawings and as determined by the Engineer.

.3 Upon completion of the Causeways, the Contractor shall maintain them in accordance with this Section of the Technical Specification, as shown on the Purchaser's Drawings and as determined by the Engineer.

.4 The Contractor shall be familiar with and understand the hydraulic modelling results provided in the Data for Proponents. The Contractor shall construct, dewater, maintain and remove the Cofferdams as shown on the Purchaser's Drawings, as determined by the Engineer, and as specified herein.

.5 The Contractor shall undertake whatever construction techniques or measures are required to comply with the limitations on increases to total suspended solids levels within the river, to the downstream of the Site, as documented in Section 7.26 Environmental Protection of the General Specification and the document titled Environmental Protection Plan. The monitoring of the total suspended levels within the river will be implemented as outlined in the Section 31 25 00 Erosion and Sedimentation Control.

.6 The Contractor shall be responsible for all Work required for the Initial Dewatering of the cofferdammed areas, as defined herein, and Continued Pumping required to maintain the areas enclosed by the Cofferdams and the excavations in a dewatered state. The Contractor's proposed methodology, arrangements, pumping capacities, and other pertinent details to performing the Work shall be subject to review by the Engineer.

.7 The Contractor shall be responsible for keeping the Cofferdams under surveillance at all times by personnel experienced in the design, construction and surveillance of Cofferdams of these types, and for performing Maintenance as is necessary.

.8 The Contractor shall be responsible for keeping the Causeways under surveillance at all times by personnel experienced in the design, construction and surveillance of Causeways of these types, and for performing Maintenance as is necessary.

.9 Should Maintenance be required, the Contractor shall inform the Engineer as to the nature of the Maintenance being initiated. Notwithstanding the Contractor's responsibility for Maintenance of the Cofferdams and Causeways, the Engineer may direct that additional maintenance be carried out if deemed required.

.10 The Contractor shall have sufficient equipment and personnel available at the Site at all times to carry out the necessary maintenance work commensurate with the size, scope and nature of the Cofferdams which have been constructed. The Contractor shall immediately deploy all such equipment as is necessary to effect Maintenance of the Cofferdam(s) and/or Causeway(s).

.11 Final closure of each Cofferdam shall be made by means of advancing a rockfill groin across the branch of the river to close against the shoreline. Each rockfill groin will ultimately be incorporated into its respective Cofferdams. The Contractor shall use the maximum resources in order to achieve the fastest progress possible. This Work shall be completed as early as possible, dependent only on river flow and weather and, in any case, not later than the date specified in the Construction Schedule set out in the Contractor's Submission.

1.9 STAGES OF WORK

.1 Cofferdamming and dewatering will be performed in two principal stages.

.2 The schedule for construction of the Cofferdams shall be such as to permit construction progress of the permanent structures to comply with the required commencement or completion dates for the various components, as shown on the Construction Schedule set out in the Contractor's Submission and as described in Section 3 Contract Schedule of the General Specification.

.3 The Cofferdams shall be constructed of rockfill, transition, semi-impervious and impervious fill, all as specified herein. The construction materials shall be placed to the lines and grades as shown on the Purchaser's Drawings or as determined by the Engineer. Riprap shall be placed as determined by the Engineer to prevent erosion of the Cofferdam fills.

.4 The Causeways shall be constructed of rockfill, and granular materials, all as specified herein. The construction materials shall be placed to the lines and grades as shown on the Purchaser's Drawings or as determined by the Engineer. Riprap shall be placed as determined by the Engineer to prevent erosion of the Causeways where required.

1.10 BORROW AREA OPERATIONS

.1 Operation and rehabilitation of borrow areas is the responsibility of the Contractor but shall be subject to the review of the Engineer.

.2 Clearing, grubbing, and stripping of borrow areas shall be performed in accordance with the procedures set out in Section 31 11 00 Clearing, Grubbing and Stripping of the Technical Specification. Topsoil shall be stripped and stockpiled adjacent to the borrow area for use in rehabilitation after completion of borrow area excavation.

.3 Borrow areas shall be excavated in a manner which will ensure that the maximum possible volume of suitable construction material, complying with the requirements specified herein, is obtained. Selective excavation, mixing, or processing may be

required to obtain material of the specified gradations and/or moisture contents. All oversized materials which do not meet the specified material requirements for use in construction shall be removed from the materials in the borrow areas, whenever possible.

.4 Impervious fill borrow areas shall be excavated in a manner which will ensure that the impervious fill produced is homogeneous and well pulverized, free of lumps of compact and intact material. Discing, blading, drying, and mixing may be required to obtain material satisfying the specified requirements.

.5 The Contractor shall, at all times, keep the stripping of the borrow area far enough in advance of the excavation to prevent contamination of borrow materials. Notwithstanding the above, in order to prevent undesirable erosion due to surface runoff, stripping shall not be advanced too far in advance of excavation.

.6 Zones, strata or lenses in the borrow area which are Unsuitable for use as construction materials shall be wasted within depleted portions of the borrow area, as authorized by the Engineer.

.7 Adequate measures shall be taken to provide proper drainage of surface water and to prevent ponding and infiltration in the borrow areas.

.8 Borrow areas and disposal piles shall be trimmed after completion of excavation to safe, stable slopes. Topsoil previously stripped from the borrow area shall be replaced, bladed and trimmed to a uniform depth over the sides and bottom of the borrow area to facilitate revegetation and the area left in a neat, workmanlike manner that is satisfactory to the Engineer. This work shall be in accordance with all applicable Laws, and is in compliance with the requirements contained in the Environmental Protection Plan.

Part 2 Products

2.1 MATERIALS

.1 Impervious Fill (Class A)

.1 Impervious fill for Cofferdam construction (Class A fill) shall be a mixture of clay and silt, well graded within the following limits, as will achieve a dense, impervious fill subject to a minimum of segregation, settlement, and erosion.

Sieve Size	Percent Passing by Weight Class A
150 mm	100
75 mm	98-100
37.5 mm	95-100
19.0 mm	90-100
No.4 (4.75 mm)	80-100
No.10 (2.0 mm)	70-100
No.40 (425 μm)	50-92
No.100 (150 μm)	38-80
No.200 (75 μm)	30-70
0.01 mm	10-40
0.002 mm	0-20

.2 Class A fill shall be placed to the lines and grades shown on the Purchaser's Drawings and as determined by the Engineer.

.3 Class A material shall not be placed in a frozen condition, and shall not be placed on a surface which is frozen or covered with snow or ice, unless otherwise determined by the Engineer. Placing of impervious materials in freezing weather will not be permitted except when authorized by the Engineer, and only when proper measures are taken to prevent freezing of the material during hauling, placement, and compaction.

.4 Class A fill, for those portions of the Cofferdam seals to be constructed in the wet, shall be placed by end dumping on top of the fill above water level. The fill shall then be pushed in such a manner that slips occur in a direction perpendicular to the axis of the Cofferdam. Impervious fill shall not be caused to roll or spill down the face of the fill into the water. The lateral extent of an advancing face of impervious fill shall be limited, as required by the Engineer, in order that the size of slip be controlled to the minimum practicable. The working or dumping level shall be as close to the water surface as practicable.

.5 Above water level, or within dewatered areas, Class A fill shall be placed in lifts not exceeding 0.30 m in thickness and shall be compacted by two complete passes of approved compaction plant as specified in Section 31 23 23 Impervious Fill and Random Fill of the Technical Specification. In areas where fill conditions do not permit Compaction as specified above, the Class A fill shall be placed and lightly compacted by equipment and methods authorized by the Engineer. The Compaction of the Class A above water level shall be directed toward obtaining a proper seal against leakage.

.2 Transition Fill (Class B)

.1 Transition fill for Cofferdam construction (Class B fill) shall be free draining sands and gravels or crushed rockfill, well graded within the following limits:

Sieve Size	Percent Passing by Weight (Class B)
100 mm	100
19.0 mm	70-100
9.5 mm	45-100
No.4 (4.75 mm)	30-90
No.40 (425 µm)	0-30
No.200 (75 µm)	0-10

.2 The gradation of the Class B fill shall be the gradation of the material in place in the Cofferdam(s) after any required processing and/or conditioning and Compaction.

.3 Class B fill shall be placed to the lines and grades shown on the Purchaser's Drawings and as determined by the Engineer.

.4 Class B material shall not be placed in a frozen condition and shall not be placed on a surface which is frozen or covered with snow or ice, unless otherwise authorized by the Engineer. Placing of Class B fill in freezing weather will not be permitted except when so authorized by the Engineer, and only when proper measures are taken to prevent freezing of the material during hauling, placement and Compaction.

.5 Class B fill, for those portions of the Cofferdam to be constructed in the wet, shall be placed by end-dumping, or other means authorized by the Engineer, on top of the fill above water level. To minimize the extent of segregation, the fill shall then be pushed in such a manner that slips occur in a direction perpendicular to the axis of the Cofferdam. Class B fill shall not be caused to roll or spill down the face of the fill into the water.

.6 The lateral extent of an advancing face of Class B fill shall be limited, as required by the Engineer, in order that the size of the slip be controlled to the minimum practical. The working or dumping level shall be as close to the water surface as possible.

.7 Above water level, or in dewatered areas, Class B fill shall be placed in lifts not exceeding 0.30 m in thickness and compacted by two complete passes of the vibratory roller specified in Section 31 23 24 Granular Fill of the Technical Specification, or alternatively by equivalent compactive effort by the hauling and spreading equipment, as authorized by the Engineer.

.8 Special attention shall be given to the boundary between the Class A impervious fill and the Class B transition material placed above water level to ensure adequate Compaction at this boundary.

.3 Rockfill (Class C)

.1 Rockfill for Cofferdam construction (Class C fill) shall be well graded quarry run rock consisting of hard, dense, durable rock, containing not more than 15% smaller than 0.10 m size. Large size rock fragments will be required to effect river closure. Depending upon river flows at the time of closure, it is anticipated that this material will have to be in excess of 1.0 m nominal size and as large as 1.8 m nominal size during the final phases of closure.

Particle Size	Percent Passing by Weight			
	Class C1	Class C2	Class C3	Class C4
1800 mm				100
1650 mm			100	0-100
1300 mm			0-100	0
1000 mm		100	0-100	
800 mm		50-100	0-10	
500 mm	100	0-100		
400 mm				
300 mm	50-100	0-50		
200 mm	30-100			
150 mm				
100 mm	0-80			
75 mm		0-10		
19 mm	0-35			
4.75 mm	0-10			

.2 The gradation of the Class C rockfills shall be the gradation of the material in place in the Cofferdam(s) after any required processing and/or conditioning and Compaction.

.3 Rockfill shall be placed to the lines and grades shown on the Purchaser's Drawings and as determined by the Engineer.

.4 When rockfill is to be placed underwater, it shall be done by end dumping the material on top of the fill near water level and by pushing the rockfill into the water. Above water level, rockfill shall be dumped and spread in layers as determined by the Engineer and shall be compacted by two complete coverages of a track of a crawler tractor weighing not less than 21 tonnes. Where fill conditions do not permit dumping and/or pushing the riprap into place, the Class C material may be placed in lifts by a backhoe/clamshell.

.5 The use of frozen rockfill will be acceptable provided the rock is free from ice coatings which would prohibit adequate rock-to-rock contact. Placing of dumped rockfill on a surface covered with snow or ice will not be permitted unless otherwise determined by the Engineer.

.4 Filter (Class E)

.1 Filter material for Cofferdam construction (Class E Filter) shall be 100% crushed material conforming to the Gradation Limits shown below.

Particle Size	Percent Passing by Weight (Class E)
400 mm	100
200 mm	60-100
19.0 mm	0-35

.2 The gradation of the Class E fill shall be the gradation of the material in place in the Cofferdam(s) after any required processing and/or conditioning and Compaction.

.3 Class E fill shall be placed to the lines and grades shown on the Purchaser's Drawings or as determined by the Engineer.

.4 Class E material shall not be placed in a frozen condition and shall not be placed on a surface which is frozen or covered with snow or ice, unless otherwise determined by the Engineer. Placing of Class E fill in freezing weather will not be permitted except when so determined by the Engineer, and only when proper measures are taken to prevent freezing of the material during hauling, placement and compaction.

.5 Class E fill, for those portions of the Cofferdam to be constructed in the wet, shall be placed by end-dumping, or other means authorized by the Engineer, on top of the fill above water level. To minimize the extent of segregation, the fill shall then be pushed in such a manner that slips occur in a direction perpendicular to the axis of the Cofferdam. Class E fill shall not be caused to roll or spill down the face of the fill into the water.

.6 The lateral extent of an advancing face of Class E fill shall be limited, as required by the Engineer, in order that the size of the slip be controlled to the minimum practical. The working or dumping level shall be as close to the water surface as possible.

.7 Above water level, or in dewatered areas, Class E fill shall be placed in lifts not exceeding 0.30 m in thickness and compacted by two complete passes of the vibratory roller specified in Section 31 23 24 Granular Fill of the Technical Specification, or alternatively by equivalent compactive effort by the hauling and spreading equipment, as determined by the Engineer.

Part 3 Execution

3.1 FOUNDATION PREPARATION

.1 Preparation of the overburden and bedrock foundations of the Cofferdams will be required wherever the foundation is accessible prior to fill placement. The required foundation preparation shall be as shown on the Purchaser's Drawings, as specified in Section 31 23 13 Foundation Preparation of the Technical Specification, and as determined by the Engineer.

3.2 CREST ELEVATIONS

.1 The crest levels required for the Stage I and II Cofferdams shall be as shown on the Purchaser's Drawings. However, in the event that anticipated flows are larger than the Cofferdam design flow, the Contractor may be required to top up the Cofferdam(s) as determined by the Engineer.

.2 To compliment known upstream operations, an inflow forecasting model will be in place during construction as described in Section 1.7 of this Section of the Technical Specification.

.3 Topping-Up of the Cofferdam(s) may be required with little or no advance notice, and the Contractor shall make available, without delay, any and all equipment and personnel as the Engineer deems necessary to effect the Topping-Up.

.4 Should, for any reason, Topping-Up be required, the Engineer and Contractor shall cooperate in the scheduling and execution of such Work so as to avoid or minimize the interference with other Work.

.5 Topping-Up, for any reason, will not be required for heights of less than 0.5 m increments. The Engineer will be the sole judge as to the amount of Topping-Up required.

3.3 MAINTAINING OF THE COFFERDAM CREST

.1 In order to carry out inspection of the Cofferdams and to facilitate the carrying out of Maintenance or Topping-Up of Cofferdams, the crests of all Cofferdams shall be kept clear of snow and ice and shall be free of rutting, potholes, or other impediments which would prohibit or otherwise interfere with ready access along the entire crest by light vehicles such as 3/4-ton pickup trucks.

.2 The Contractor shall supply and perform all surveys for the collection of information for the Maintenance of the Cofferdam crest levels. If requested by the Engineer, the Contractor shall submit to the Engineer all available survey data.

3.4 DEWATERING AND PUMPING

.1 The Contractor shall supply, install, maintain, and operate pumps, sumps, wells, discharge lines, stand-by power as specified herein, and all associated equipment and items required for the Initial Dewatering and the Continued Pumping to maintain the areas within the Cofferdams and the excavations in a dewatered state and pumping of the Powerhouse drainage sump, to the satisfaction of the Engineer. The Contractor shall also relocate the dewatering and pumping equipment should such be necessary to carry out this Work.

.2 The cost of excavation of temporary ditches, the installation of temporary culverts, measures to control the turbidity and release of suspended solids in the adjacent water courses, and temporary erosion control protection, and related items, all as required to divert surface runoff on either bank of the river from entering the cofferdammed areas or the excavations will be deemed to have been included in the unit prices in the Bill of Quantities, Unit Prices and Target Price Estimate for the various items of Work set out in this Section of the Technical Specification.

.3 Dewatering shall be a continuous operation and interruptions for any reason shall not be permitted.

.4 The Contractor shall not permit the accumulation of surface water within the cofferdammed areas and the excavations. In general, all surface and ground water shall be intercepted and directed away from the cofferdammed areas and the excavations.

.5 The location, arrangement and details of the dewatering equipment shall be subject to review by the Engineer. Discharge from the pumps shall be directed outside of the dewatered areas in such a way as to avoid (i) erosion of the river banks, riverbed and cofferdams and (ii) interference with work in other areas.

.6 Total pumping capacities and the number of pumps and sumps shall be commensurate with the size of the areas to be dewatered, the volume of water normally associated with the size and nature of the Cofferdams and their foundations and the Contractor's use of water within the Work area for various other construction activities. Minimum total pumping capacities to be installed and capable of operation shall not be less than:

.1 Stage I Diversion, continued pumping - 200 L/s.

.2 Stage II Diversion, continued pumping - 350 L/s.

.7 Notwithstanding the above, the Contractor shall have available on the Site and shall be prepared to deploy as necessary, sufficient pumps and associated equipment required to

handle the actual volume of water to be pumped to maintain the working areas in a dewatered state, as shown on the Purchaser's Drawings and as determined by the Engineer and as specified herein. The Contractor shall also have available an adequate number and range of spare pumps and parts.

.8 Notwithstanding the above, the Contractor shall have available on the Site and shall be prepared to deploy as necessary, sufficient backup generator(s) for the continued operation of the pumps and associated equipment required to handle the actual volume of water to be pumped to maintain the working areas in a dewatered state.

.9 All dewatering equipment shall be protected from freezing and shall remain fully operational in freezing weather.

.10 The Contractor shall supply, install, operate and maintain alternative standby facilities of sufficient capacity to maintain the work areas in the dewatered state. Such standby facilities shall be automatic starting in the event of a failure of the primary system.

.11 Pumping and associated Work to maintain the work areas in a dewatered state shall continue until all Work required to be done in the dry has been completed, and the Engineer has authorized the discontinuance of pumping.

3.5 REMOVAL OF COFFERDAMS

.1 As shown on the Purchaser's Drawings, certain portions of the Cofferdams shall be removed at various stages of the Work to allow unimpeded flow of the river during diversion and after completion of the Project.

.2 Commensurate with the water levels prevailing at the time of removal, as much of the Cofferdam fills as possible shall be removed “in-the-dry”. Fills to be removed in the dry shall include lowering the crest followed by the removal of as much material as possible on the "dry" side of the Cofferdam, all as to achieve a stable section of minimum dimensions, and as authorized by the Engineer. The cofferdammed area shall then be flooded, as determined by the Engineer. Following flooding, the removal of any additional materials that can safely be removed “in-the-dry” shall take place, followed by removal of the remaining fills “in-the-wet” to elevations as shown on the Purchaser's Drawings or as determined by the Engineer.

.3 Erosion and transport of Cofferdam fill or Cofferdam foundation material shall be prevented during the flooding of the Cofferdam area.

.4 The Contractor shall submit the proposed procedure for flooding the cofferdammed area and Cofferdam removal to the Engineer for review no later than 60 days prior to the planned activity.

.5 Materials removed from the Cofferdams may be used in the construction of Cofferdams, temporary roads and/or the permanent structures, subject to compliance with specified requirements herein. Materials removed from the Cofferdams and which are Unsuitable for use in construction, shall be transported and placed in the Excavated Materials Placement Area, as shown on the Purchaser's Drawings, or as otherwise determined by the Engineer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, except as herein provided, and performing all Work necessary for the procurement, deliveries, handling, assembly, installing in place to final locations and grouting of post-tensioned anchors complete with couplings, sleeves, grout tubes and appurtenances for the spillway slab as shown on the Purchaser's Drawings, Contractor's Documents, as determined by the Engineer and as specified herein.

.2 The Contractor shall provide all equipment necessary for the drilling of anchor holes, consolidation grouting, redrilling and water pressure testing of anchor holes.

.3 The Contractor shall furnish all stressing equipment, complete with calibrated pressure gauge and any other items necessary for performing post-tensioning and anchor testing, as determined by the Engineer.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 31 81 00 - Foundation Grouting.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

- .1 National Building Code of Canada.
- .2 Canadian Standards Association (CSA):
  - .1 A23.1 - Concrete Materials and Methods of Concrete Construction.
  - .2 A23.2 - Test Methods and Standard Practices for Concrete.
  - .3 G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel.
- .3 American Society for Testing and Materials (ASTM):
  - .1 A36/36M - Standard Specification for Structural Steel.
  - .2 A722 - Standard Specification for Uncoated High-strength Steel Bar for Prestressing Concrete.
- .4 Post Tensioning Institute (PTI):
  - .1 Recommendations for Prestressed Rock and Soil Anchors.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate multiplied by the corresponding unit price for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Item 31 68 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in linear metres based on the length of anchor shown in the Purchaser's Drawings, as determined by the Engineer or as herein provided.

.3 Unit Price

.1 The unit price for Item 31 68 00 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for submittals, fabricating, supplying, handling, assembly, installing in place, tensioning and grouting for 36 mm diameter post-tensioned anchors and appurtenances as specified herein. Included is the cost of anchor hole drilling, consolidation grouting, water pressure testing, load testing and anchor grouting as specified herein and as shown on the Purchaser's Drawings.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor’s Documents of the General Specification.

.2 The Contractor shall supply to the Engineer for his review in accordance with Subsection 21.7.9 Engineer’s Review:

.1 Mill test certificates for threadbar in accordance with the requirements of ASTM A722.

.2 Mill test certificates for stressing head assembly materials in accordance with G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel or A36/36M - Standard Specification for Structural Steel, as appropriate.

.3 Shop drawings detailing the anchor system. Drawings shall indicate threadbar type, length and positioning; spacer size, type and locations; centering device details and locations; grout tube lengths; head assembly design; and bond breaker details. All drawings shall be sealed by a Professional Engineer registered in Manitoba.

.4 Drilling records from the drilling of the post-tensioned rock anchor holes.

.5 Alignment records for each drill anchor drill hole.

.6 Grout placement records as outlined in Section 3.7.4 of this Section of the Technical Specification.

.7 Water pressure test records as outlined in Section 3.7.3 of this Section of the Technical Specification.

.8 Results of grout compressive strength tests performed in accordance with CSA A23.2.

.9 Stressing records from the anchor performance and proof tests. The information shall include the anchor location, test schedule, loads and related elongations as well as any observations during stressing.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Management of the General Specification.

.2 Installation of post tensioned anchors shall be performed by personnel experienced in this type of Work.

.3 All testing facilities shall be qualified to perform the testing they are undertaking, and be subject to the review of the Engineer.

1.7 HANDLING AND STORAGE REQUIREMENTS

.1 The handling and installation of the anchors shall be carried out in a careful manner to avoid damage to the anchors. The manufacturer's recommendations for lifting and transportation of anchors shall be carefully followed.

.2 Any damage resulting from handling and storage shall be repaired and subject to the review of the Engineer.

Part 2 Products

2.1 MATERIALS

.1 Anchors

.1 Anchors shall consist of a Grade 1034 MPa (150 ksi) threadbar produced in compliance with ASTM A722 - Standard Specification for Uncoated High-strength Steel Bar for Prestressing Concrete.

.2 Anchor Head:

.1 The anchor head shall include the anchor nut, steel bearing plate, plastic grease cap and any required shims. Minimum yield strength of bearing plate steel shall be 300 MPa, produced in accordance with ASTM A36/36M or CSA G40.20/G40.21 - General Requirements for Rolled or Welded Structural Quality Steel/ Structural Quality Steel.

.2 The anchor nut and bearing plate shall be fully compatible and be designed to reduce seating losses.

.3 Grout Tubes

.1 Grout tubes for initial grouting shall be nominally 20 mm OD, or as shown on Purchaser's Drawings. Grout tubes shall have an ultimate bursting strength of 3.4 MPa (500 psi). Means for reliably attaching the grout tubes to avoid crushing or damaging the tubes shall be incorporated.

.4 Anchor Head Protection

.1 A protective grease cap screwed to the threadbar, complete with O-ring gasket and injection and vent ports for injection of corrosion inhibitor shall be provided for the anchors as detailed on the Purchaser's Drawings.

.2 The corrosion inhibitor for the stressing head assembly shall meet the requirements for corrosion inhibiting compounds, as defined by the PTI in Table 4-1 of “Recommendations for Prestressed Rock and Soil Anchors”, or the Purchaser's approved equivalent.

.5 Anchor Grout

.1 Anchor grout shall be Basalite Concrete Products “Microsil”, or Purchaser's approved equivalent, with admixtures to adjust plasticity, viscosity and shrinkage of the grout product.

.2 Grout shall have a minimum strength of 30 MPa at 3 days.

.6 Consolidation Grout

.1 Consolidation grout will meet the requirements outlined in Section 31 81 00 Foundation Grouting of the Technical Specification.

.7 Drilling Equipment

.1 Drilling equipment shall be in accordance with the requirements of Section 31 81 00 Foundation Grouting of the Technical Specification. Equipment shall be suitable to drill holes of the size, depth and to the tolerances required by this Section of the Technical Specification and as shown on the Purchaser's Drawings for anchor placement.

2.2 SOURCE QUALITY CONTROL

.1 Mill test records for all components of the anchor system shall be provided to the Engineer.

Part 3 Execution

3.1 DRILL HOLES FOR POST-TENSIONED ANCHORS

.1 Holes shall be drilled to the diameter, depth, line and tolerances indicated on the Purchaser’s Drawings and Contractor’s Documents.

.2 Completed drill holes must be within the following tolerances:

.1 Location of hole within +/- 300 mm of location on Purchaser's Drawings.

.2 Angle ±2.0º of planned centerline.

.3 The Contractor shall check the alignment of each drill hole using a technique authorized by the Engineer for performing said measurements. A record of drill hole alignment shall be maintained.

.4 A minimum spacing of 4600 mm shall be maintained between a hole being drilled and a hole which is being grouted or which has been grouted within the past 24 hours. If grout flow indicating interconnection of the holes is encountered during drilling, drilling shall be suspended until grouting is completed, unless otherwise authorized by the Engineer.

.5 On completion of drilling of each hole, the Contractor shall immediately cap or plug the hole and shall protect it from entry of grease, oil, dirt, muck, grout, surface water or any other material.

3.2 WATER PRESSURE TESTING OF ANCHOR HOLES

.1 Before water pressure testing and before installation of the anchor, each hole shall be cleaned of all debris and dust by a method authorized by the Engineer.

.2 Each anchor hole shall be water pressure tested for water tightness at 0.35 atmosphere (35 kPa) above hydrostatic pressure when hole is completely filled with water. If water loss over a period of 10 minutes is greater than 1 litre/min, then the hole shall be consolidation grouted, re-drilled and re-tested. If necessary, this process will be repeated until satisfactory water tightness is achieved.

.3 The water testing shall be done by the gravity method (i.e., filling the hole and monitoring water level drop in the hole), or another method authorized by the Engineer.

.4 Holes adjacent to a hole being tested for water tightness shall be observed by the Contractor during the test so that any inter-hole connection can be more easily detected. Observations will be recorded if the leakage exceeds that specified, and the hole shall be consolidated grouted.

3.3 CONSOLIDATION GROUTING OF ANCHOR HOLES

.1 The materials, plant, methods and quality control for the consolidation grouting of anchor holes which do not meet the water pressure testing requirements shall be performed in accordance with Section 31 81 00 Foundation Grouting of the Technical Specification.

.2 Consolidation grouted holes shall be re-drilled commencing not sooner than 12 hours after the consolidation grout has been placed. The holes shall be re-tested and if the second water pressure test does not meet the requirements specified on the Purchaser's Drawings, the entire process shall be repeated.

3.4 INSTALLATION OF POST-TENSIONED ANCHORS

.1 Anchors shall be cleaned and assembled in the shop and installed in accordance with the most current version of the Post Tensioning Institute recommendations and in accordance with shop drawings reviewed by the Engineer and manufacturer's recommendations. Each anchor shall be thoroughly cleaned and all traces of oil shall be removed using a detergent and hot water, or other method authorized by the Engineer.

.2 Anchor drill holes shall be checked to ensure they are free of obstructions and thoroughly washed with water and air immediately prior to anchor installation.

.3 Once the anchor is inserted, it shall be firmly fixed in position to prevent any movement during grouting. The anchor shall be securely supported from the top of the hole to ensure that the bottom of the anchor and the bottom of the anchor end cap are completely encased in grout. The end cap shall not rest on the bottom of the hole. Care shall be taken by using anchor centering devices to ensure the anchor is centrally located in the hole.

3.5 GROUTING OF ANCHORS

.1 Anchors shall be grouted as soon as possible after installation, as shown on the Purchaser's Drawings.

.2 Grout shall be mixed in strict accordance with the Engineer's requirements.

.3 While mixing grout particular care shall be taken to ensure that:

.1 The dry cement is free of lumps before mixing.

.2 The mixing water is clean and free of injurious quantities of substances known to be harmful to Portland cement or pre-stressing steel such as chlorides, fluorides, sulphites and nitrates.

.4 The grout shall be continuously agitated even during grouting to prevent it from forming lumps and settling. Grout that has not been placed within 30 minutes after mixing shall be discarded.

.5 Grout shall be placed continuously at a uniform rate. Placement of grout shall continue until the grout exiting at the top of the hole has the same consistency as that being injected into the hole.

.6 The Contractor shall notify the Engineer 2 Working Days in advance as to when the grouting operation is to commence.

.7 Grouting shall not be performed in ambient air conditions below minus 5°C or into bedrock below 0°C. In case of grouting performed under conditions of freezing or near freezing temperatures, grout material including water shall be protected from freezing and heated to a suitable temperature, as determined by the Engineer. The temperature of all grout shall be between 5°C and 27°C or as determined by the Engineer, throughout the mixing and agitation period up to the time of injection.

.8 Grouted anchors shall remain undisturbed for a minimum of 2 days.

3.6 POST-TENSIONING AND TESTING OF ANCHORS

.1 Post-Tensioning

.1 Post-tensioning operations shall not begin prior to the anchor grout attaining a minimum unconfined compressive strength of 30 MPa, a minimum of two days has passed since grout placement and a minimum of 28 days since casting of the concrete slab.

.2 Threadbars shall be stressed in strict accordance with manufacturer's recommendations by experienced personnel using hydraulic jacks. Safety precautions shall be taken during post-tensioning to minimize risk of injury to personnel.

.3 The hydraulic jacks and load cells shall be calibrated allowing accurate reading and recording of the applied tension or pressure. The pressure gauges for the hydraulic jacks shall be calibrated immediately prior to being brought to the Site and shall be subject to periodic tests, as determined by the Engineer, for accuracy and satisfactory operation. A certified calibration curve shall be furnished for each jack gauge and load cell.

.4 Any component of the anchoring system that has been damaged or failed under test will be rejected.

.5 The process of stressing shall be conducted so that the applied tension and the elongation of the threadbar anchor can be measured continuously and recorded.

.2 Anchor Testing

.1 Each anchor shall be tested by either a Performance Test or Proof Test as described below.

.2 The maximum test load shall not exceed 80% of the guaranteed ultimate tensile strength (GUTS) of the threadbar.

.3 Carry out the following tests by loading the anchors in accordance with the following schedules. At each increment record the movement of the tendon to the nearest 0.025 mm with respect to an independent fixed reference point. Monitor the jack load with a pressure gauge or load cell. P = design load for the anchor (60% GUTS); AL = alignment load (5% GUTS).

.4 Loads must only be held at each load long enough to record the anchor elongation at each load level, and not longer than 1 minute.

.5 Hold the test load for 10 minutes. Record total movements with respect to a fixed reference point at 1, 2, 3, 4, 5, 6 and 10 minutes. If the total movement exceeds 1.0 mm between 1 minute and 10 minutes, the test load shall be held for an additional 50 minutes. Record total elongations at 20, 30, 40, 50, and 60 minutes.

.6 Performance Test:

.1 Ten (10) anchors shall be selected by the Engineer for Performance Testing.

.2 Performance Test Schedule:

1.	AL	15.	AL
2.	0.25 P	16.	0.25 P
3.	AL	17.	0.50 P
4.	0.25 P	18.	0.75 P
5.	0.50 P	19.	1.00 P
6.	AL	20.	1.20 P
7.	0.25 P	21.	AL
8.	0.50 P	22.	0.25 P
9.	0.75 P	23.	0.50 P
10.	AL	24.	0.75 P
11.	0.25 P	25.	1.00 P
12.	0.50 P	26.	1.20 P
13.	0.75 P	27.	1.33 P [TEST LOAD]
14.	1.00 P	28.	AL

.7 Proof Test

.1 Proof test all anchors that have not been performance tested.

.2 Proof Test Schedule:

1.	AL
2.	0.25 P
3.	0.50 P
4.	0.75 P
5.	1.00 P
6.	1.20 P
7.	1.33 P [TEST LOAD]

.3 Compare proof test results with the performance test results and provide report and findings to Engineer. Any significant variation from the performance test results warrants making a performance test on the next anchor.

.4 The Engineer shall investigate the anchor test results and determine whether the anchor is acceptable. An anchor shall be acceptable if all of the following are met:

.1 The total elastic movement obtained from a performance test exceeds 80% of the theoretical elastic elongation of the stressing length and is less than the theoretical elastic elongation of the stressing length plus 50% of the bond length.

.2 The creep movement does not exceed 1.0 mm/log cycle during the final time increment of the performance test regardless of tendon length and load.

.5 After the anchor is authorized by the Engineer it shall be locked off at 70% GUTS, compensating for seating losses at the transfer of load to the anchorage. If recommended by the manufacturer of the anchor a lift off test will be performed. The results of the lift off test will be included on the stressing record.

.6 The post tensioned anchors shall be anchored at the top by transferring the stressing load from the jack to suitably configured anchorage assembly whereby the threadbars are secured by anchor nuts and plates.

3.7 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

.2 Drill hole alignment shall be recorded for each anchor drill hole, verifying that all holes have been installed as shown on the Purchaser's Drawings and within the required tolerances.

.3 Drilling records for each hole shall be maintained. The information shall include list of equipment used, size and length of hole drilled, rate of drill penetration, nature and characteristics of materials encountered in each hole and the levels at which materials were encountered, levels at which water was encountered, levels at which cuttings, air or washwater were lost, encounters with foreign objects, bit usage and unusual incidents which occurred in the course of drilling.

.4 The Contractor shall record and submit daily on a form authorized by the Engineer the pressure, total quantity of water injected, quantity of water per foot of tested length, depth of test, type of test (packer, gravity, direct connection) for each water pressure test carried out.

.5 The following data concerning the consolidation and anchor grouting operations for each hole shall be recorded by the Contractor:

.1 Date and temperature.

.2 Water-cement ratio.

.3 Grout pressure.

.4 Quantity grouting placed.

.6 Compressive strength of grout shall be tested for in accordance with CSA A23.2. Samples shall be taken and the frequency of the tests shall be as determined by the Engineer following the review of the Contractor's grouting plan, the Contractor's experience with the grout mix, and consistency of test results.

.7 Stressing records shall be maintained and submitted for each anchor performance and proof test. The information shall include the anchor location, test schedule, loads and related elongations as well as any observations during stressing.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, except as herein provided, and performing all Work necessary for the drilling, washing, and pressure testing of holes; and supplying, transporting, storing, mixing and injecting cement grout and cement-sand grout and other admixture materials, to provide a grout curtain in the foundations of the main dams, and consolidation grouting, if required, of the foundations of the permanent structures, all as shown on the Purchaser's Drawings, Contractor's Documents, as determined by the Engineer and as specified herein.

.2 The Work also includes performing exploratory drilling, as required and determined by the Engineer.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 30 00 - Cast-in-Place Concrete.

.3 Section 05 50 00 - Miscellaneous Metals.

.4 Section 31 23 13 - Foundation Preparation.

1.3 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 21.7 Contractor's Documents of the General Specification.

.1 At least 30 days prior to the commencement of grouting, submit to Engineer for review in accordance with Subsection 21.7.9 Engineer's Review, a 'Grouting Plan'. The plan should include:

.1 Equipment to be used including schematic layout sketch showing the general layout of mixer, pump, gauges, valves, hoses, connection and all associated equipment.

.2 Within 1 week after completion of grouting, submit completed and signed copies of grouting records for all grouting to Engineer for review. Grouting records shall include: Project name, Engineer, name and signature of individual supervising the grouting and record keeping; date(s) and time(s) of all grouting; location and I.D. number of hole; hole diameter; type number and depth of packers for each grouting increment or stage; water/cement ratio and changes and time of change of water/cement ratio; number of bags of cement injected, wasted and left in hole; pressure, changes in pressure and time of change; volume of sand or bentonite added, gallons of water added to mix; and in general any changes in procedures, pressure, grout takes, mix or equipment that has direct affect on grouting operations.

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Canadian Standards Association CSA A23.1-00, Concrete Materials and Methods of Concrete Construction.

.2 Canadian Standards Association CSA A23.2-00, Methods of Test for Concrete.

.3 ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate for each Item as specified and incorporating any changes as identified through Section 27 Clarification and Changes to the Work and Adjustment of the General Specification.

.2 Measurement

.1 Measurement for Items 31 81 00 (a)i to 31 81 00 (b)v in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in linear metres of length of drilling grout holes and test holes (NQ3 coring) made from the collar of the hole at the exposed surface of concrete or rock, to the bottom of the hole drilled as set out in the Purchaser's Drawings and as determined by the Engineer.

.2 Measurement for Items 31 81 00 (c)i to 31 81 00 (c)vi in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in numbers of packer settings, including making connections and setting up successful packer positions and connections as set out in the Purchaser's Drawings and determined by the Engineer. Where double packers are used, the setting and making connections shall be considered as a single-packer setting.

.3 Measurement for Items 31 81 00 (d)i to 31 81 00 (d)v in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in hours required on washing and pressure testing of holes as specified herein.

.4 Measurement for Items 31 81 00 (e)i to 31 81 00 (g)v in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in kilograms made on the weight of dry volume of specified material incorporated into the grout mixes and placed in grout holes or exploratory holes as specified herein.

.5 For the purpose of measurement, the unit weight of cement and sand will be considered as being 1410 kg/m^3 and 1600 kg/m^3, respectively and as specified herein.

.6 No separate measurement or payment will be made for a grout hole that is lost or damaged due to mechanical failure of equipment, or inadequacy of grout supply.

.7 No separate measurement or payment will be made for a grout hole that is lost or damaged due to deleterious cement used in the grouting operation and for additional screening process required for cement found to contain lumps as specified herein.

.3 Unit Price

.1 The unit prices for Items 31 81 00 (a)i to 31 81 00 (b)v in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for rotary and percussion drilling and setups for drilling of grout holes through plain and reinforced concrete, rock, and grout which has been allowed to harden and for NQ3 core drilling of holes through plain and reinforced concrete, rock and grout as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 81 00 (a)i shall cover rotary and percussion drilling of grout holes through plain and reinforced concrete, rock and hardened grout, including drill setups for Powerhouse.

.2 Item 31 81 00 (a)ii shall cover rotary and percussion drilling of grout holes through plain and reinforced concrete, rock and hardened grout, including drill setups for Spillway.

.3 Item 31 81 00 (a)iii shall cover rotary and percussion drilling of grout holes through plain and reinforced concrete, rock and hardened grout, including drill setups for North Dam.

.4 Item 31 81 00 (a)iv shall cover rotary and percussion drilling of grout holes through plain and reinforced concrete, rock and hardened grout, including drill setups for South Dam.

.5 Item 31 81 00 (a)v shall cover rotary and percussion drilling of grout holes through plain and reinforced concrete, rock and hardened grout,; including drill setups for Central Dam.

.6 Item 31 81 00 (b)i shall cover NQ3 core drilling of holes through plain and reinforced concrete, rock and hardened grout, including drill setups for Powerhouse.

.7 Item 31 81 00 (b)ii shall cover NQ3 core drilling of holes through plain and reinforced concrete, rock and hardened grout, including drill setups for Spillway.

.8 Item 31 81 00 (b)iii shall cover NQ3 core drilling of holes through plain and reinforced concrete, rock and hardened grout, including drill setups for North Dam.

.9 Item 31 81 00 (b)iv shall cover NQ3 core drilling of holes through plain and reinforced concrete, rock and hardened grout, including drill setups for South Dam.

.10 Item 31 81 00 (b)v shall cover NQ3 core drilling of holes through plain and reinforced concrete, rock and hardened grout, including drill setups for Central Dam.

.4 The unit prices for Items 31 81 00 (c)i to 31 81 00 (c)v in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for placing packer assemblies and making connections for water pressure testing and for grouting, including the initial setting of the

packer(s) and resetting the packer(s) at subsequent depths including drill setups as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 81 00 (c)i shall cover place packer assemblies and make connections for water pressure testing and for grouting, including the initial setting of the packer(s) and resetting of the packer(s) at subsequent depths for Powerhouse.

.2 Item 31 81 00 (c)ii shall cover place packer assemblies and make connections for water pressure testing and for grouting, including the initial setting of the packer(s) and resetting of the packer(s) at subsequent depths for Spillway.

.3 Item 31 81 00 (c)iii shall cover place packer assemblies and make connections for water pressure testing and for grouting, including the initial setting of the packer(s) and resetting of the packer(s) at subsequent depths for North Dam.

.4 Item 31 81 00 (c)iv shall cover place packer assemblies and make connections for water pressure testing and for grouting, including the initial setting of the packer(s) and resetting of the packer(s) at subsequent depths for South Dam.

.5 Item 31 81 00 (c)v shall cover place packer assemblies and make connections for water pressure testing and for grouting, including the initial setting of the packer(s) and resetting of the packer(s) at subsequent depths for Central Dam.

.5 The unit prices for Items 31 81 00 (d)i to 31 81 00 (d)v in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for washing and pressure testing of holes as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 81 00 (d)i shall cover wash and pressure test holes for Powerhouse

.2 Item 31 81 00 (d)ii shall cover wash and pressure test holes for Spillway.

.3 Item 31 81 00 (d)iii shall cover wash and pressure test holes for North Dam.

.4 Item 31 81 00 (d)iv shall cover wash and pressure test holes for South Dam.

.5 Item 31 81 00 (d)v shall cover wash and pressure test holes for Central Dam.

.6 The unit prices for Items 31 81 00 (e)i to 31 81 00 (g)v in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supplying, transporting, storing, mixing and injecting of cement, sand and bentonite materials, including caulking of open joints or fractures as soon as grout leakage occurs at the surface, as well as hand-cleaning the rock surface in the vicinity of the surface leak as specified herein, as shown on the Purchaser's Drawings, and as follows:

.1 Item 31 81 00 (e)i shall cover supply, support, store, mix and inject cement grout materials for Powerhouse.

.2 Item 31 81 00 (e)ii shall cover supply, support, store, mix and inject cement grout materials for Spillway.

.3 Item 31 81 00 (e)iii shall cover supply, support, store, mix and inject cement grout materials for North Dam.

.4 Item 31 81 00 (e)iv shall cover supply, support, store, mix and inject cement grout materials for South Dam.

.5 Item 31 81 00 (e)v shall cover supply, support, store, mix and inject cement grout materials for Central Dam.

.6 Item 31 81 00 (f)i shall cover supply, transport, store, mix and inject sand incorporated into grout for Powerhouse.

.7 Item 31 81 00 (f)ii shall cover supply, transport, store, mix and inject sand incorporated into grout for Spillway.

.8 Item 31 81 00 (f)iii shall cover supply, transport, store, mix and inject sand incorporated into grout for North Dam.

.9 Item 31 81 00 (f)iv shall cover supply, transport, store, mix and inject sand incorporated into grout for South Dam.

.10 Item 31 81 00 (f)v shall cover supply, transport, store, mix and inject sand incorporated into grout for Central Dam.

.11 Item 31 81 00 (g)i shall cover supply, transport, store, mix and inject bentonite incorporated into grout for Powerhouse.

.12 Item 31 81 00 (g)ii shall cover supply, transport, store, mix and inject bentonite incorporated into grout for Spillway.

.13 Item 31 81 00 (g)iii shall cover supply, transport, store, mix and inject bentonite incorporated into grout for North Dam.

.14 Item 31 81 00 (g)iv shall cover supply, transport, store, mix and inject bentonite incorporated into grout for South Dam.

.15 Item 31 81 00 (g)v shall cover supply, transport, store, mix and inject bentonite incorporated into grout for Central Dam.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Cement grouting materials shall consist of the following.

.1 Cement: Cement used in grouting operations shall be Type GU supplied in bags by the Contractor.

.2 Admixture Sika Intraplast-N or Purchaser’s approved equivalent added at 0.5% by weight of cement.

.3 Water: Water shall be clean and free from injurious amounts of sewage, oil, acid, alkali, salts, organic matter, or any foreign solids to DSA A23.1 Standard.

.4 Sand: Sand shall consist of hard, dense, durable, uncoated rock fragments with not more than 5% of deleterious substances including organic impurities and clay lumps. When tested, in accordance with CSA A23.2-2A, “Sieve Analysis of Fine and Coarse Aggregate”, sand shall have a fineness modulus from 1.5 to 2.0 and shall fall within the following limits of gradation:

Standard Sieve Size	Percent Passing by Weight
1.25 mm	100
630 µm	45 - 100
315 µm	25 - 60
160 µm	12 - 30
80 µm	0 - 5

.2 Cement grout shall consist of a mixture of Portland Cement, admixture and water. Sand shall also be used in the grout mix, if required. Admixtures, including bentonite, shall be used where determined by the Engineer.

.3 The grout mix proportions will be determined by the Engineer, and will depend on the characteristics of each grout hole.

.4 Except as otherwise stated herein, the Contractor shall supply all materials required for the drilling and grouting.

.5 The Contractor shall supply and install embedded grout pipe in the primary reinforced concrete structures where grout holes are required, in order to facilitate grout hole drilling, in accordance with Section 05 50 00 Miscellaneous Metal of the Technical Specification.

2.2 PLANT AND EQUIPMENT

.1 All drilling and grouting equipment shall be of a type, capacity and in a mechanical condition suitable for performing the Work in an efficient and workman-like manner, as determined by the Engineer.

.2 Standard drilling equipment of the rotary and percussion type shall be used to perform the drilling as specified herein and as determined by the Engineer. Rotary type machines shall be capable of drilling NQ size holes to a depth of 50 m. Percussion drilling equipment shall be equipped with a water swivel for continuous flushing of holes during drilling and capable of drilling 48 mm diameter, minimum, holes to a depth of 30 m.

.3 Washing and pressure testing plant shall include pumps and packer or seal assemblies. The pumps furnished shall be of the gear, centrifugal, or other authorized types, with a maximum output of not less than 280 L/min at 1050 kPa, and shall be capable of maintaining constant pressures. There shall be a water supply with storage tanks sufficient for the pumps. An adequate air supply at a maximum pressure of 700 kPa shall be provided for washing operations.

.4 Two flow metres suitable for reading up to 10 L/min, and one for 10 L/min to 190 L/min, respectively, and two 150 mm Bourdon type pressure gauges with ranges from 0 to 210 kPa and 0 to 1400 kPa, respectively, all mounted on a suitable header, shall be supplied for each pump. Certified testing equipment shall be provided for checking flow and pressure gauges.

.5 The packers or seals supplied shall be of the mechanically expanded rubber sleeve, multiple leather cup, pneumatically expanded rubber sleeve types, or other types as authorized by the Engineer. Packers shall be capable of sealing holes at any specified elevation down to a maximum vertical depth of 50 m, and of withstanding, without leakage for a period of 10 minutes, water pressure equal to the maximum grout pressure. The type of packer shall be varied to suit rock conditions, as determined by the Engineer.

It should be possible to use these packers either singly or in pairs separated by up to 6 m of perforated pipe. There shall be sufficient perforations in the pipe to provide negligible obstruction to the flow of water. The diameter of the pipes used for separating the packers and for placing the packers in holes shall be the maximum possible for the size of the hole.

.6 Grout materials shall be maintained in suspension in a mechanically agitated sump or holding tank, equipped with screens to remove hardened grout which does not pass the 4.75 mm sieve.

.7 The grouting plant shall be capable of supplying, mixing, agitating, and pumping sanded grout to the satisfaction of the Engineer. Mixers shall be of the high speed colloidal type. Each grouting unit shall include at least one pump of the progressive cavity type with a capacity of at least 100 L/min of mixed grout at a maximum discharge pressure of 700 kPa. Batching apparatus shall be capable of accurately measuring quantities of grout materials incorporated into mixes. Mixers, holding tanks and sumps shall be calibrated in litres to facilitate modification of mixes. An adequate supply of grout materials shall be maintained at each grouting unit so that grouting can be performed without interruption.

.8 The plant shall be maintained in first-class operating condition at all times. Any grout hole that is lost or damaged due to mechanical failure of equipment, or inadequacy of grout supply, shall be replaced by the Contractor.

.9 A double-line pumping system shall be used, in which one line will supply grout from the pump to the header at the collar of the hole, and the other line will return grout from the header to the sump. The inside diameter of all lines, valves, and connections shall not be less than 25 mm. The number and sizes of obstructions in the lines shall be kept to a minimum. Grout may be mixed in a central plant and pumped to an agitated sump at a second pumping plant which shall be located not more than 50 m from the hole. The distance between the central plant and the agitated sump shall not exceed 60 m.

.10 The grout header shall be provided for feeding grout into the holes. The header shall include a supply connection, a connection with a valve to the holes, and a return line with a valve. Two 15 cm Bourdon type pressure gauges for the appropriate pressure range shall be fitted such that one indicates the pressure of the supply of grout at the header and the other indicates the back pressure of grout in the hole.

.11 For grouting with packers, a 25 mm minimum diameter flush jointed pipe shall extend between the ground surface and the level at which the packer assembly is set. The type and selection of packer used shall be as described for water testing or as determined by the Engineer.

.12 A sufficient quantity of cement shall be store at or near the site of the Work to insure that grouting operations will not be delayed by shortage of cement.

.13 When the individual elements of plant are so located that communication by normal voice between the elements is not satisfactory, the Engineer may require the Contractor to install a telephone system or other authorized means of communication.

Part 3 Execution

3.1 CONSOLIDATION GROUTING

.1 Consolidation grouting consists of the drilling and grouting of a pattern of shallow holes in the foundations. The requirement and extent of this type of grouting will be

determined by the Engineer on completion of excavation in the areas. It is anticipated that this type of grouting may be required locally under the impervious zone of the earthfill dams and under the concrete structures.

3.2 CURTAIN GROUTING

.1 Curtain grouting will consist of the construction of a grout curtain on the abutments, islands, and across the river bed through rock under the main dams and the concrete structures. The grout curtain in the foundations of the main earthfill dams shall be completed prior to the placement of the overlying fill. The grout curtain in the concrete structure foundations shall either be completed through sleeves installed in the partly completed intakes and spillway structures, or from the existing or excavated rock surface prior to the placement of concrete. Vertical and inclined holes will be required and the angle of inclination for each hole will be determined by the Engineer.

.2 Curtain grouting shall be performed by the stop grouting method, where each hole is grouted in sections isolated by a packer set at decreasing depths varying from 6 m to 3 m apart, as determined by the Engineer. The split spacing procedure, where initial holes are drilled and grouted prior to drilling and grouting intermediate or secondary holes, shall be followed.

.3 Prior to performing grouting operations from an exposed rock surface, the Contractor shall clean the rock surface by means of excavating loose materials from the rock surface using a backhoe equipped with a scraping bucket so that surface leaks can be identified. Should grout vent to the rock surface, the Contractor shall hand-clean the rock surface in the vicinity of any surface leak and caulk the leak as detailed in this Specification.

3.3 GROUTING PROCEDURES

.1 All grout holes and test holes shall be drilled to the depths and in the locations, sequence and orientations, as shown on the Purchaser's Drawings and as determined by the Engineer. All holes shall have a minimum diameter of 48 mm. The use of grease, “rod dope”, or other lubricant on drill rods will not be permitted. No grout hole will be drilled at an angle greater than 40° measured from the vertical with the exception of a series of fanned holes drilled from the rock surface adjacent to the spillway, service bay, and intakes, nor to a length greater than 30 m. Core recovery will not be required from grout holes, but may be required from test holes, as determined by the Engineer.

.2 Grout holes through reinforced concrete shall be grouted through grout nipples or grout pipes supplied and embedded in the concrete by the Contractor.

.3 Holes shall not be drilled within 24 m of a hole which is being grouted, nor within 12 m of a hole which has been grouted, until completion of the waiting period defined in Section 3.5 Waiting Periods below.

.4 Each hole shall be protected from clogging or obstruction by means of a cap or other suitable means at the collar, and any hole that becomes clogged or otherwise obstructed before completion of the grouting operation shall either be cleaned out in a manner authorized by the Engineer, or another hole shall be provided by the Contractor.

.5 Each hole shall be thoroughly washed immediately before pressure testing or pressure grouting of the hole is begun. Holes shall be washed out by means of alternate applications of air and water. Where percussion drilling equipment is used, washing may be done using the drill rods. Special wash rods, as specified, shall be used where the drill bit or core barrel, in the opinion of the Engineer, provides sufficient obstruction to the free flow of water and air so as to inhibit the washing operation. Packer seal assemblies

shall be used where washing between interconnected holes is required. Holes shall be washed for a minimum of 5 minutes with the pump operating at full capacity or until fracture filling material ceases to be removed as shown by the clearness of the return water.

.6 Water pressure testing shall be performed to determine the sequence for grouting and to facilitate selection of the initial grout mix. Pressure tests, using clear water, at pressures up to the required grouting pressure, shall follow the pressure washing operation and be done immediately prior to pressure grouting. Double packer assemblies shall be utilized to isolate 3 m lengths of holes unless, in the opinion of the Engineer, testing of any hole using increased packer spacing or use of a single packer will provide adequate information. Water pressure testing shall consist of three rising and two falling steps, with each step of 5 minute duration. The timing of the 5 minute duration shall commence after the pressure has stabilized to the required test pressure. The pressure to be used shall be determined by the Engineer.

.7 In the event that the cement is found to contain lumps of foreign matter of a nature and amount which, in the opinion of the Engineer, may be deleterious to the grouting operations, then as determined by the Engineer, screening through a standard 100 mesh screen may be required or the cement found to contain lumps will not be used. Such work will be included in the unit price identified for Items 31 81 00 (e)i to 31 81 00 (g)v.

.8 Grout mixes shall be varied as determined by the Engineer, to suit conditions encountered during grouting. Grouts shall be mixed for a minimum of 3 minutes before injection. In general, the grout mix used at the start of any section of a hole shall be neat cement grout with a water-cement ratio of 3:1 by bulk volume. The starting mix shall be injected at the specified pressure for a ten-minute period with the grout pump operating as nearly as possible at constant speed. If the rate of absorption of cement is observed to drop steadily, the starting mix shall be continued until refusal is reached. If the absorption of solids is high during the initial period, the water-cement ratio shall be gradually decreased, successively thicker mixes each being injected for 10 minute periods until grout consumption stabilizes or begins to decrease. When the absorption of thicker mixes begins to decrease, or causes the pressure to rise above specified limits, the water-cement ratio shall be increased until the refusal criteria are achieved.

.9 Grouting pressures shall be varied to suit local conditions, as determined by the Engineer, and shall be controlled to prevent surface upheaval and leakage of grout. In general, the maximum grouting pressure, as indicated by a gauge at the collar of the hole, shall be 70 kPa plus 10 kPa to 20 kPa per metre distance to the nearest rock or concrete surface. Where grouting is performed near bedrock cliffs or within 2 m of ground surface, grouting pressures shall, in general, be limited to low values, as required by the Engineer, that are consistent with the rock conditions and may be in the order of 10 kPa or less per metre distance to the nearest rock face.

.10 During the grouting of a hole, adjacent ungrouted holes shall be left uncapped to facilitate the passage of air, water, etc. If grout is found to flow from a hole, or holes adjacent to the hole being grouted, a multiple connection shall be made to the hole or holes affected, so that all such holes are grouted simultaneously. Such connections shall be made to a packer assembly which shall be set in the hole immediately above the points at which grout leaked into the hole. If grout flows from cracks or joints in the rock, these shall be caulked or otherwise suitably sealed; or, as determined by the Engineer, grouting shall be temporarily discontinued and resumed later when the initial grout has set.

.11 Injection of grout into any hole, or portion of any hole isolated by packers, shall continue until the hole, or isolated portion of the hole, absorbs less than 8 litres of neat cement

grout with a water-cement ratio of 3:1 by volume in 10 minutes, at the maximum grouting pressure. After completion of a grouting operation, back pressure observations shall be made. If back pressure exists, the grout shall be retained in the hole by means of a stop cock or other authorized device until the grout has set. After grouting, each hole shall be completely filled by injection or tremieing, where necessary, with a sanded grout.

.12 Grout which is mixed as authorize by the Engineer and which must be wasted because of its age or for any other reason other than failure of the grouting equipment or negligence on the part of the Contractor shall be measured and paid for in pursuant to Items 31 81 00 (e)i to 31 81 00 (g)v in the Bill of Quantities, Unit Prices and Target Price Estimate for the respective locations.

.13 During grouting operations the Contractor shall take such precautions as may be necessary to prevent drill cuttings, equipment exhaust oil, wash water, and grout, from entering natural water courses or from defacing or damaging any permanent structures. The Contractor shall dispose of all waste water and grout from the operations to the satisfaction of the Engineer.

.14 During grouting operations, the Contractor will keep detailed records of the grouting operations, such as a log of the grout holes, results of washing and pressure testing operations, time of each change of grouting operation, pressure, rate of pumping, amount of cement for each change in water/cement ratio, and other data deemed necessary by the Engineer.

3.4 COLD WEATHER GROUTING

.1 Grouting shall not be performed in frozen rock. In the case of grouting performed under conditions of freezing or near freezing temperatures, grout materials including water shall be protected from freezing and heated to a suitable temperature, as determined by the Engineer. The temperature of all grout shall be between 5°C and 27°C or as determined by the Engineer, throughout the mixing and agitation period up to the time of injection.

.2 The Contractor shall include in the unit prices for this Work all costs necessary to winterize the equipment and perform grouting operations during cold weather.

3.5 WAITING PERIODS

.1 As a limited season is available for foundation preparations and embankment core placing, the time normally allowed for grout to harden must be reduced to a minimum. This shall be accomplished by adding an accelerating admixture to the grout mix as authorized by the Engineer. Where such admixtures are used, a minimum of 6 hours will be required from completion of grouting until drilling or pressure testing any hole within 8 m. Where no accelerating admixture is used, the waiting time required shall be 12 hours.

3.6 EXPLORATORY HOLE DRILLING

.1 The Contractor shall perform exploratory drilling with NQ3 size holes through plain and reinforced concrete, rock and hardened grout, as determined by the Engineer. Exploratory NQ3 size holes of varying depths may be required, but the maximum depth shall not exceed 50 m. The amount of, and the requirement for, exploratory drilling will be determined by the Engineer and no change will be made in the unit price for this Work by reason of any variation in the amount of Work required.

.2 All exploratory drilling shall be performed with rotary drilling equipment unless otherwise authorized by the Engineer. The Contractor shall use a standard ball-bearing,

swivel-type, triple tube face discharge or wireline core barrel equipped with diamond bits. All exploratory drilling shall be performed in a workmanlike manner by competent and experienced drillers, and special care shall be exercised to obtain cores in as good condition as possible.

.3 The Contractor shall keep an accurate driller's log of all exploratory holes drilled. This shall be kept in a manner satisfactory to the Engineer, and submitted to the Engineer on completion of each hole. The log shall include a description of all materials encountered, their location in the holes and the location of special features such as seams, open cracks, soft or broken rock, points where loss or gain of drill water occurred, and any other item which may contribute to the objectives of the required exploratory drilling.

.4 The Contractor shall place the core in correct sequence in wooden core boxes furnished by the Contractor. The core shall be separated accurately by wooden blocks according to the measured distances in the holes, and shall be properly labeled. No box shall contain cores from more than one hole. The covers shall be fastened securely to the core boxes and the boxes shall be delivered to the Engineer's site materials laboratory.

.5 Exploratory holes shall be water pressure tested and grouted under pressure if conditions so indicate. In all such cases the holes shall be grouted to full depth in one operation. The unit price for drilling exploratory drill holes shall include costs of taking, boxing and delivery of cores to the Engineer's site materials laboratory.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary for the drilling and washing of holes for pressure relief drains in the foundations of concrete structures, and for drain holes in the rock excavation, as shown on the Purchaser's Drawings, Contractor's Documents, as determined by the Engineer and as specified herein.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 05 50 00 Miscellaneous Metal.

.3 31 81 00 Foundation Grouting.

1.2 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price for each Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 82 00 (a)I, 31 82 00 (a)ii, and 31 82 00 (c)i to 31 82 00 (c)iii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in linear metres of drain holes measured from the surface of the rock face adjacent to the drain hole to the end of the hole as set out in the Purchaser's Drawings and as determined by the Engineer.

.2 Measurement for Items 31 82 00 (b)I, and 31 82 00 (b)ii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in linear metres of installed collar, including piping connections, etc. as set out in the Purchaser's Drawings and as determined by the Engineer.

.3 Unit Price

.1 The unit prices for Items 31 82 00 (a)i to 31 82 00 (c)iii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for drilling drain holes and

installing collar including temporary hoses or piping to handle water prior backfilling with grout, as specified herein, as shown on the Purchaser's Drawings and in the 3D Project Model and as follows:

.1 Item 31 82 00 (a)i shall cover drilling 75 mm drain holes for Powerhouse.

.2 Item 31 82 00 (a)ii shall cover drilling 75 mm drain holes for Spillway.

.3 Item 31 82 00 (b)i shall cover installing of collars for drain holes for Powerhouse.

.4 Item 31 82 00 (b)ii shall cover installing of collars for drain holes for Spillway.

.5 Item 31 82 00 (c)i shall cover drilling 48 mm drain holes for Powerhouse.

.6 Item 31 82 00 (c)ii shall cover drilling 48 mm drain holes for Powerhouse Service Bay.

.7 Item 31 82 00 (c)iii shall cover drilling 48 mm drain holes for Spillway.

1.3 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 The Contractor shall supply and install drain hole collars in the Service Bay as shown on the Purchaser's Drawings or as determined by the Engineer, in accordance with Section 05 50 00 Miscellaneous Metal of the Technical Specification and as specified herein.

.2 The Contractor shall supply and install embedded pipe in reinforced concrete in the Powerhouse, where the foundation drain holes are required, in order to facilitate drain hole drilling, in accordance with Section 05 50 00 Miscellaneous Metal of the Technical Specification and as specified herein.

Part 3 Execution

3.1 FOUNDATION DRAIN HOLES

.1 Pressure relief holes in the foundations of concrete structures shall have a minimum diameter of 75 mm and shall be drilled at the inclinations and to the lengths shown on the Purchaser's Drawings or as determined by the Engineer. Either percussion or rotary type drills may be used. Drain holes for rock excavation drainage during and after construction shall have a minimum diameter of 48 mm and shall be percussion drilled.

.2 Holes shall be thoroughly washed by means of alternate applications of air and water. Washing shall be continued until, in the opinion of the Engineer, the return of water is reasonably clear.

.3 On completion of drilling and washing of pressure relief holes each hole shall be capped or plugged to prevent entry of foreign material during adjacent Work. The Contractor

shall exercise care to ensure that the holes are not blocked in any way. If, in the opinion of the Engineer, proper care has not been observed and the holes are suspected of being blocked or partly closed, they shall be recleaned by washing, chopping or drilling as necessary to the satisfaction of the Engineer. Completed drain holes shall have temporary caps or plugs removed once adjacent Work is finished.

.4 The Contractor shall continuously protect and maintain the pressure relief holes in working order. Pressure relief holes which become inoperative due to improper installation or from being plugged with debris shall be flushed, redeveloped, or replaced, to the satisfaction of the Engineer.

.5 Drain holes for temporary rock excavation drainage in the Principal Concrete Structures shall be backfilled with grout at low pressure, as authorized by the Engineer, immediately prior to placement of permanent concrete which will cover the drain hole, in accordance with Section 31 81 00 Foundation Grouting of the Technical Specification and as specified herein.

.6 Drain holes shall not be drilled until all grouting within a minimum distance of 30 m has been completed for a period of at least 12 hours.

.7 Pressure relief hole collars and embedded pipe for drain installation shall be installed in the primary concrete, as shown on the Purchaser's Drawings and as determined by the Engineer.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant, except as herein provided, and performing all Work necessary for supplying, fabrication, galvanizing, transporting, handling, assembling, and erecting chain link fences and gates and the parking lot fence wire, all as shown on the Purchaser's Drawings, Contractor's Documents, as determined by the Engineer, and as specified herein.

.2 The Work under this Section also includes all drilling and backfilling of holes for posts, all drill setups, and all drilling supplies, and the excavation of the trenches for installation of the grounding wires.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 03 30 00 – Cast-In-Place Concrete.

.3 Section 26 05 28 – Surface Grounding.

1.3 REFERENCES

.1 Manitoba Hydro standard fencing drawings as set out in the Purchaser's Drawings:

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 32 31 13 (a) to 32 31 13 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be in metres made to the neat lines shown in the Purchaser's Drawings and as determined by the Engineer.

.2 Measurement for Items 32 31 13 (c) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be the number of security gates as shown in the Purchaser's Drawings and as determined by the Engineer.

.3 Unit Price

.1 The unit prices for Items 32 31 13 (a) to 32 31 13 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for submittals, supplying, fabricating, galvanizing, transporting, handling, assembling, and erecting 7-ft high chain link fences and parking lot fences, including all drilling, concreting and backfilling of holes for posts, all drill setups, and all drilling supplies as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 32 31 13 (a) shall cover 7-ft high chain link fence and gates.

.2 Item 32 31 13 (b) shall cover parking lot fence.

The unit prices for Item 32 31 13 (c) in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for submittals, supplying, fabricating, galvanizing, transporting, handling, assembling, and erecting security gates, as shown on the Purchaser's Drawings.

1.5 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 All materials used in the construction of chain link fences and gates shall be as shown on the Purchaser's Drawings.

Part 3 Execution

3.1 INSTALLATION

.1 All chain link fences, gates and footings shall be accurately located as shown on the Purchaser's Drawings, or as determined by the Engineer.

.2 Installation of chain link fences, gates and footings shall be as shown on the Purchaser's Drawings.

.3 Care shall be taken to accurately locate all underground utilities in the vicinity prior to undertaking any drilling for the installation of fence posts, or tendering for the installation of the grounding wires.

.4 Any unfilled holes and trenches shall be covered and clearly identified.

.5 Grounding shall be in accordance with Section 26 05 28 Surface Grounding of the Technical Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary for supplying, handling, storing, assembling and installing corrugated steel pipe culverts, end sections, and all attachments, as shown on the Purchaser's Drawings, Contractor's Documents, as determined by the Engineer and as specified herein. This Work shall include excavation required for the culverts, and the supplying, placing and compacting of pipe bedding, covers and backfill materials.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 31 23 33 - Trenching and Backfilling.

.3 Section 31 25 00 - Erosion and Sedimentation Control

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Canadian Standards Association:

.1 CSA G401 - Corrugated Steel Pipe Products.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 33 42 00 (a)i to 33 42 00 (a)iv shall be in metres based on the neat lines and grades shown in the Purchaser's Drawings and as determined by the Engineer.

.3 Unit Price

.1 The unit prices for Items 33 42 00 (a)i to 33 42 00 (a)iv in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for handling, storing, assembling, supplying and installing corrugated steel pipe culverts, including connecting bands, end sections and all other parts required, including excavation for culverts, and supplying and placing of bedding, cover, and backfill materials as specified herein, as shown on the Purchaser's Drawings and as follows:

.1 Item 31 23 13 (a)i shall cover 1500 mm diameter culverts for Causeway to Deposit N-5.

.2 Item 31 23 13 (a)ii shall cover 1000 mm diameter culverts for Causeway to Deposit N-5.

.3 Item 31 23 13 (a)iii shall cover culverts up to 1000 mm.

.4 Item 31 23 13 (a)iv shall cover culverts larger than 1000 mm diameter.

1.5 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

1.6 TRANSPORTATION AND HANDLING

.1 The corrugated steel pipe products shall be transported and handled in such a manner as to avoid damaging the coating. Any damage to the coating shall be repaired by the Contractor in accordance with CSA G401, and as determined by the Engineer.

Part 2 Products

2.1 MATERIALS

.1 Corrugated Steel Pipe Products

.1 Corrugated steel pipe and coating shall be in accordance with CSA G401 and as indicated on the Purchaser's Drawings.

.2 Corrugated steel pipe sizes in the range 300 mm to 1,200 mm diameter shall have a corrugation profile 68 mm x 13 mm, unless specified otherwise on the Purchaser's Drawings.

.3 Pipe culverts shall be circular with wall thickness as indicated on the Purchaser's Drawings.

.4 Steel attachments, connecting bends and end sections shall be supplied by the same manufacturer as the pipes and shall have the same coating.

Part 3 Execution

3.1 TEMPORARY EROSION AND SEDIMENTATION CONTROL

.1 Provide temporary erosion and sedimentation control measures as required by regulatory requirements and Section 31 25 00 Erosion and Sedimentation Control of the Technical Specification to prevent soil erosion and discharge of soil-bearing water runoff.

.2 Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

.3 Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.2 INSTALLATION

.1 Trenching shall be carried out in accordance with Section 31 23 33 Trenching and Backfilling of the Technical Specification.

.2 The pipes shall be laid to the lines and grades as shown on the Purchaser's Drawings or as determined by the Engineer, with the separate sections joined firmly together by means of the coupling bands furnished by the manufacturer for that purpose. Installation of corrugated steel pipe products shall include all Work associated with all fittings, parts and end treatments as required.

.3 Culvert placement shall commence at the down-slope end, and proceed in an upslope direction. The corrugations or indentations of the coupler shall be matched with the culvert sections before tightening.

.4 Place pipe bedding, cover and backfill materials in accordance with Section 31 23 33 Trenching and Backfilling of the Technical Specification and as indicated on the Purchaser's Drawings.

.5 Culverts shall not be installed on sod, frozen earth or on a bed that contains boulders or rock fragments.

.6 Granular fill shall not be placed on a surface which is frozen or covered with snow, ice, debris, sod, or other deleterious material. Placement of granular fill in freezing weather shall only be permitted when proper measures are taken to prevent freezing of the fill prior to compaction, as authorized by the Engineer.

.7 When the grade line of the culvert crosses soft or unstable material, the foundation shall be excavated below the grade line and back-filled with sand, gravel, crushed stone or other suitable material as determined by the Engineer.

.8 End sections shall be installed as indicated on the Purchaser's Drawings and in accordance with manufacturer’s recommendations.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section of the Technical Specification covers the installation and field pre-commissioning of the protection and control systems for the generating units (G1-G7) and associated generator step-up (GSU) transformers (T1-T7), and 13.8-12.47 kV station service transformers (SST1-SST4).

.2 The protection and control system shall comprise of panels, protection and control intelligent electronic devices (IED), lockout and auxiliary relays, test blocks, terminals, overcurrent devices for DC and voltage transformer circuits, mounting hardware, wires and terminals for the connection of devices including external connections, firmware and software applications required for a functional system to protect the hydro generators, GSU transformers, 13.8-12.47 kV station service transformers and associated switchgear.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 26 05 21 - Wires and Cable Systems.

.4 Section 27 00 00 - Communication System.

.5 Section 25 11 00 - Unit control and Monitoring System.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ANSI and IEEE:

.1 IEEE C12.1 - Code for Electricity Metering.

.2 ANSI/EIA 310D - Panels, Racks and Associated Equipment.

.3 IEEE C37.1 - Standard for SCADA and Automation Systems.

.4 IEEE C37.21 - Standard for Control Switchboards.

.5 IEEE C37.90 - Standard for Relays and Relay Systems Associated with Electric Power Apparatus.

.6 IEEE C37.101 - IEEE Guide for Generator Ground Protection.

.7 IEEE C37.102 - IEEE Guide for AC Generator Protection.

.8 IEEE C37.106 - IEEE Guide for Abnormal Frequency Protection for Power Generating Plants.

.9 IEEE C37.110 - IEEE Guide for the Application of Current Transformers Used for Protective Relaying.

.10 IEEE C37.119 - IEEE Guide for Breaker Failure Protection of Power Circuit Breakers.

.11 ANSI/NETA ATS-2009 Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.

.2 Canadian Standards Agency (CSA):

.1 CSA C22.1 - Canadian Electrical Codes, Part I.

.2 CSA Z462 - Workplace Electrical Safety.

.4 Reference Documents

.1 Purchaser's Drawings.

.2 3D Project Models.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurements

.1 Measurement for equipment Items 33 72 00 (a) will be based on the quantity as shown in the Purchaser's Drawings, and as determined by the Engineer.

.3 Unit Price

.1 The unit prices for Items 33 72 00 (a) - Unit Protection Panels in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving, storage, site handling, preparation of surface for installation and installation including mounting hardware/anchors c/w grout, seals or firestops as required, cable and grounding connections including fittings and terminals, testing and pre-commissioning, touch-up painting, and hand over documentation of Unit #1 through Unit# 7 protection panels as specified herein and as determined by the Engineer.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Quality Assurance Submittals

.1 Field Inspection and Test Plan: Submit field inspection and test plan covering receipt of material at Site, storage, field installation, and testing and pre-commissioning.

.2 Field Inspection and Test Reports: Submit field inspection and test reports for Engineer's review.

.3 Closeout Submittals

.1 Drawings:

.1 Site as-built record drawings of panel interconnection drawings.

.2 Test Reports:

.1 Record of field tests, and pre-commissioning tests.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

.2 Qualifications

.1 The installers and relay technicians assigned for field installation, testing and commissioning shall be licensed with the Certified Technicians and Technologists Association of Manitoba (CTTAM). The Contractor shall have qualified staff trained in project control and quality assurance, and to support quality surveillance.

.3 Warranty

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Packing, shipping, handling and unloading:

.1 Site receiving and handling in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification and vendor instructions.

.2 The Contractor shall inspect the equipment upon receipt and submit and inspection report to the Engineer identifying any defect and damages.

1.8 WASTE MANAGEMENT AND DISPOSAL

.1 Shall be in accordance with the requirements of Section 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

Part 2 Products

2.1 SCOPE OF WORK

.1 The Contractor shall be responsible for the following Work:

.1 Take delivery from the Purchaser's site storage of:

.1 Generator G1, GSU Transformer T1 and 13.8-12.47 kV station service transformer SST1 protection and control panels arranged in three cubicles designated as Unit #1 Protection Cubicle A, Unit #1 Protection Cubicle B and Unit #1 Protection Cubicle C.

.2 Generator G2 and GSU Transformer T2 protection and control panels arranged in three cubicles.

.3 Generator G3, GSU Transformer T3 and 13.8-12.47 kV station service transformer SST2 protection and control panels arranged in three cubicles.

.4 Generator G4, GSU Transformer T4 protection and control panels arranged in three cubicles.

.5 Generator G5, GSU Transformer T5 and 13.8-12.47 kV station service transformer SST3 protection and control panels arranged in three cubicles.

.6 Generator G6, GSU Transformer T6 protection and control panels arranged in three cubicles.

.7 Generator G7, GSU Transformer T7 and 13.8-12.47 kV station service transformer SST4 protection and control panels arranged in three cubicles.

.2 Field installation, on the Mezzanine level, of the protection assemblies for all units including installation hardware and consumables required.

.3 Connections of panel assemblies' grounding bus to the station main grid.

.4 Visual and mechanical checks against defect and damage after installation, including wiring and panel connection checks.

.5 Cable connections including supply and installation of cable fittings and lugs, organization of cable in the trough in the panel and conductor terminations in accordance with Purchaser's Drawings.

.6 Support to the Engineer for commissioning and integration of the protection and control systems in the facility as required.

.2 Work Excluded

.1 Detail engineering of protection and control panels including panel general arrangement, AC schematics, DC schematics, wiring diagrams, and bill of material drawings.

.2 Supply of unit protection and control panels including shipment to the Site.

.3 Supply, installation and testing and commissioning of 138 kV line protection and control system.

.4 Supply, installation and testing and commissioning of remote terminal units.

.5 During testing of relay and control panels, and system commissioning, the Contractor shall provide equipment and labour as determined by the Engineer through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

2.2 DESIGN DESCRIPTION

.1 The final design of the protection and control system will be performed by the Project Designer.

.2 General Design Features

.1 The protection and control system shall consist of dual redundant schemes arranged as System A and System B to provide selective, reliable and sensitive protection for the equipment and equipment connections against faults and abnormal operating conditions.

.2 IEDs shall have the capability of communication using DNP3, Modbus and IEC61850 protocols over Ethernet.

.3 The protection systems shall be arranged in cubicles with the following features and options.

.1 Front access.

.2 IEDs and devices mounted on a 19” rack.

.3 Glass viewing door to check status of the devices without opening the door.

.4 Rear full sub-panel for mounting auxiliaries and terminal blocks.

.5 Door actuated contacts for monitoring required for cyber security.

.6 Solid back and side panels.

.7 Wire ducts for wire management.

.8 Lifting angles for lifting.

.9 Bottom cable entry through a gland plate.

.10 120 Vac convenience receptacle.

.4 The protections for a hydro generator, a GSU, and a station service transformer if applicable shall be arranged in a triple-bay line-up.

Part 3 Execution

3.1 MANUFACTURER'S INSTRUCTIONS

.1 Comply with manufacturer's written recommendations or specifications, including product technical bulletins, handling, storage and installation instructions, and datasheet.

3.2 INSTALLATION

.1 The Contractor shall install the panels in the locations shown in the Purchaser's 3D Project Model and supply hardware and anchors required for installations. The protection panel assemblies are located on the Mezzanine level.

.2 The panels shall be bonded to the facility grid in accordance with the Purchaser's Drawings.

.3 Install and terminate instrument, control and communication cables in accordance with the authorized connection diagram, and supply all glands for cable entry into the panel, heat shrinks, and terminal lugs.

3.3 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

.2 Inspect the panel for any damage and defects upon receiving the panels.

.3 Site Tests after Installation

.1 Visual and mechanical inspections (for all panels, under direct supervision of Engineer):

.1 Inspect for physical damage and defects.

.2 Check nameplate information for correctness.

.3 Check presence of foreign materials, moisture, dust, etc.

.4 For electro-mechanical relays, check:

.1 Cover and gasket or sealed housing.

.2 Relays and device mountings are secured and protected against misoperation due to vibration, shock, etc.

.5 Verify the correctness of panel wiring in accordance with the authorized panel drawings and schematics.

.6 Verify the correctness of external connections in accordance with the issued for construction connection diagram(s).

.2 Electrical Tests (all panels, under direct supervision of Engineer):

.1 Perform dielectric test of the panel wiring.

.2 Power-up the panels and check for normal status of the IEDs and devices.

.3 Commissioning (All Systems):

.1 Provide support to the Engineer for commissioning the system commissioning of the protection and control panels.

3.4 CLEANING

.1 Shall be in accordance with the requirements of Subsection 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

.2 Upon completion and verification of performance of installation, remove surplus materials, excess materials, rubbish, tools and equipment in accordance with the requirements of Subsection 7.40 Clean-Up and Removal of Plant, Surplus Materials and Debris of the General Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of all labour, Materials and Plant, and performing all Work necessary to provide and install W-Beam Guardrail and Posts for use as hazard avoidance barriers.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 33 42 00 - Corrugated Steel Pipe Culverts.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Alberta Transportation and Utilities Drawings (website http://www.transportation.alberta.ca/1847.htm):

.1 TEB 3.02 Rail Detail.

.2 TEB 3.03 End Section - Wing.

.3 TED 3.06 Bolt, Nut and Washer.

.2 Canadian Standards Association (CSA): Standards Sales, 178 Rexdale Boulevard, Rexdale, Ontario M9W 1RW:

.1 CSA G40.20 and G40.21 - MB7, Structural Quality Steels.

.2 CSA G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles.

.3 CSA W-59 M, Welded Steel Construction (Metal Arc Welding).

.4 CSA 080-M, Wood Preservation.

.3 American Society for Testing and Materials (ASTM); 1916 Race Street, Philadelphia, Pennsylvania 19103:

.1 ASTM A307, Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

.2 ASTM E316.3, Magnetic Gauge Testing of Galvanizing Coating.

.4 American Association of State Highway and Transportation Officials (AASHTO): 444 North Capital Street NW, Suite 225, Washington, D.C. 20001:

.1 AASHTO Standard Designation M-180-841, “Corrugated Sheet Steel Beams for Highway Guardrails”.

.5 American Road and Transportation Builders Association (ARTBA):

.1 ARTBA Technical Bulletin No. 268-B.

.6 National Lumber Grades Authority (NLGA): 1460-1055 West Hasting Street, Vancouver, B.C. V6E 2G8:

.1 NLGS Standard Grading Rules for Canadian Lumber.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 31 71 33 (a)i shall be in linear metres of length of guard rail installed, including supplying or materials, transportation, assembling and installation as set out in the Purchaser's Drawings and as determined by the Engineer.

.2 No separate measurement will be made for installation of guard rail posts, including excavation, backfilling and other associated work.

.3 Unit Price

.1 The unit prices for Items 31 71 33 (a)i in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for complete installation of the guard rails as specified herein and as shown on the Purchaser's Drawings.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor’s Documents of the General Specification.

.2 The Contractor shall submit, at least 30 days prior to the start of construction, complete plans of installation of the guard rail and posts, including storage, maintenance and other incidental Site work. The plan shall include a description of the methods and procedures, a sequence of operations with corresponding schedule, details of temporary structures and a description which includes the proposed equipment for use in this Work. The plan shall include design calculations, installation details, materials, sequencing of Work on drawings, and any other information required to fully describe the Contractor’s plans.

.3 The Contractor shall submit to the Engineer for review, details of the plan for installation of the guard rail and post, including a copy of the manufacturer’s certificate verifying that the material supplied conform to the CSA specifications for structural quality steels. Drawings showing details of guard rail and posts, locations, and other pertinent information shall be submitted to the Engineer at least 30 days prior to installation.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

Part 2 Products

2.1 GENERAL

.1 The Contractor shall furnish all materials, equipment, labour, and appurtenances required for furnishing, installing, and removing water control facilities and shall also supply sufficient standby pumping and auxiliary equipment to preclude any interruption of pumping operations during periods of breakdown, off shift hours, holidays and maintenance.

.2 Rails and Terminal Elements:

.1 W-Beam Guardrail shall consist of rail sections fabricated to develop a continuous beam strength with the necessary safety end feature components.

.2 All rail sections and other components shall match the design profiles and dimensions of the AASHTO/ARTBA hardware requirements for full interchangeability of similar components regardless of the manufacturer.

.3 The name or trademark of the manufacturer, the metal thickness and the year of production shall be clearly and permanently stamped on each component clear of the splicing overlap and on the face opposite the traffic side.

.4 The rails and terminal elements shall be manufactured from open hearth, electric furnace or basic oxygen semi-spring steel sheet and hot dip galvanized after fabrication, all in general accordance with the AASHTO Standard Designation M180-841 and shall conform to the relevant TEB Drawings (TED 3.02 and TEB 3.03).

.5 Rails shall be punched for splice and post bolts in strict conformity with the AASHTO Standard to the designated number and centre-to-centre spacing of posts. No punching, cutting or welding will be permitted on Site except for special details in unforeseen and exceptional cases with the prior authorization of the Engineer.

.6 If any guardrail installation requires curved w-beam rails, the Contractor shall form these to the radius specified by the Engineer.

.7 The rails and terminal elements shall be manufactured according to the following standards:

.1 Metal properties of the base metal for the rails shall conform to the following requirements:

.1 Minimum yield point: 345 MP_a.

.2 Minimum tensile strength: 483 MP_a.

.3 Minimum elongation: 12% in 50 mm length.

.2 Sheet thickness shall be in accordance with Table 1 (Class A, Type 2) of AASHTO Standard Designation M-180-841 with a nominal base metal thickness of 2.8 mm (2.67 mm minimum),

.3 Sheet width for the w-beam rail shall be 483 mm, with a permissible tolerance of minus 3.2 mm.

.4 Welding for the fabrication of terminal elements shall conform to the requirements of CSA W59M.

.8 Bolts, Nuts and Washers:

.1 Bolts shall conform to ASTM A307, nuts shall conform to ASTM A563, and shall be hot dip galvanized in accordance with CSA G164M (Drawing TEB 3.06).

.9 Wooden Posts:

.1 Posts and offset blocks shall be either Douglas Fir, Hemlock, Lodgepole Pine or better and shall meet the requirement of the National Lumber Grades Authority (NLGA) for No. 1 Structural Posts and timbers graded conforming to the NLGA Standard Grading Rules for Canadian Lumber.

.2 Posts and Blocks shall be rough sawn with holes drilled to the finished dimensions as shown on the Purchaser's Drawings.

.3 Stamping and drilling shall be completed prior to treating posts. Blocks shall be pressure treated in accordance with the current requirements of CSA Standard 080, with a water borne preservative of Chromated Copper Arsenate (CCA) or Ammoniacal Copper Arsenate (ACA) to 8 kilograms per cubic metre.

.4 The penetration and retention of preservatives shall conform to the requirements of CSA Standard 080.14 Table 1, minimum retention of preservatives in pressure treated wood for highway construction, under the headings “Post-Guardrail, Guide, Sign and Sight” for posts and “Bridgehand Rails, Guard Rails and Posts” (not in contact with ground or water.

.10 Reflectors:

.1 Reflectors shall consist of white double-sided sheeting 108 mm x 76 mm (minimum) which shall meet ASTM D4956, Type VIII or Type IX brightness requirements.

.2 Reflectors shall be attached to every sixth post.

.11 Equipment:

.1 The Contractor shall supply all equipment necessary to complete this Work.

Part 3 Execution

3.1 PROCEDURE

.1 Posts shall be accurately set to the required depth and alignment in a smooth, continuous installation, as shown in the Purchaser's Drawings or as determined by the Engineer. Permissible tolerance for plumb and grade of posts shall be 6 mm maximum.

.2 Holes for the guardrail posts shall be excavated by drill or other means authorized by the Engineer. The diameter of the holes drilled for guardrail posts shall be sufficient size to allow for pneumatic tamping.

.3 Unsuitable material at the bottom of the holes excavated for the guardrail post shall be replaced with granular material as determined by the Engineer. The Contractor shall thoroughly compact the bottom of the hole. The guardrail posts shall rest directly and solidly on the bottom of the hole at the time of installation.

.4 Excavated material which is unsuitable for use as backfill shall be substituted with granular material by the Contractor. Backfill shall be thoroughly compacted using pneumatic tampers, in layers not exceeding 150 mm. For the full depth of the excavation, cementitious materials shall not be used for post support unless specifically authorized by the Engineer.

.5 Guardrail laps shall be in the direction of traffic flow. Bolts shall be tightened to a torque of 100 Nm. Metal reflectors (Scotchlite or equivalent) shall be attached to the top of every sixth guardrail post with two 50 mm galvanized nails.

.6 The Contractor shall take all necessary precautions to eliminate damage to galvanizing. Minor abrasions shall be repaired by painting with two coats of zinc-rich paint. Major abrasions shall be repaired by re-galvanizing. The method to be used for repair of any damage shall be authorized by the Engineer before such work is commenced. The Contractor shall carry out the repair or replace of components to the satisfaction of the Engineer.

.7 Surplus excavated material and debris shall be removed from the Site and disposed of by the Contractor.

3.2 ACCEPTANCE AND INSPECTION OF MATERIAL

.1 General

.1 The Contractor shall provide the Engineer with a copy of the manufacturer's certificate verifying that materials supplied conform to Section 16 of CSA G40.20M for each of the mechanical and chemical tests.

.2 Inspection of W-Beam Guardrail Material

.1 The dimensions of finished guardrail shall have a tolerance of $\pm$ 3mm.

.2 Hot dip galvanized coating shall be smooth, free of beading or sharp projections at edges. Coating adherence shall prevent the peeling of any portion of the zinc coating so as to expose the base metal by cutting or prying with a stout knife under considerable pressure (bond check). A magnetic gauge will be used for checking thickness in accordance with ASTM E316.3(c).

.3 Warped or otherwise deformed rails and terminal elements will be rejected, as will those with injurious defects or excessive roughness of the zinc coating. When the rail is laid on a flat surface, the warpage shall not be greater than 5 cm.

.3 Inspection of Wooden Posts and Blocks

.1 The Engineer may verify the penetration and retention of the preservative by the assay method. Posts and blocks shall be subject to inspection by the Engineer when the bundles are opened immediately prior to use.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary, including receiving at Site, unloading, site storage and handling to complete the installation, site testing and commissioning of the following Purchaser-supplied Items, as shown on the Purchaser's Drawings, as determined by the Engineer and as specified herein:

- .1 Intake bulkhead gates.
- .2 Draft tube bulkhead gates.
- .3 Spillway stoplogs.
- .4 Trashracks.

.2 Work performed by others:

- .1 Fabrication, supply, and delivery of bulkhead gates and trashracks.
- .2 Modification and delivery of temporary spillway stoplogs.
- .3 Supply and installation of intake bulkhead monorail crane, draft tube gate bridge crane, spillway stoplog monorail crane.
- .4 Supply of followers for the above cranes and installation of the followers on crane sheave blocks.

1.2 RELATED SECTIONS

.1 Sections and Subsections of the General Specification as set out below.

.2 Section 35 20 17 - Embedded Guides.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

- .1 CAN/CSA-Z460-05 (R2010) - Control of Hazardous Energy - Lockout and Other Methods.
- .2 Manitoba Workplace Safety and Health Act and Regulations.

.4 In shop and crane start-up tests as applicable.

.5 Operation and maintenance manual of bulkhead gate and stoplog cranes (to be provided by Purchaser at time of delivery of cranes to Site).

.6 Cofferdam removal procedures.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 No separate measurement will be made for the following Items:

.1 35 20 13 (a)i - Intake Bulkhead Gate.

.2 35 20 13 (a)ii - Draft Tube Bulkhead Gate.

.3 26 32 13 (b) - Spillway Stoplogs.

.2 Measurement for Item 35 20 13 (c) - Trashracks will be based on the quantity of Trashrack sections shown in the Purchaser's Drawings.

.3 Unit Price

.1 The unit price for Items 35 20 13 (a)i to 35 20 13 (b) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving at Site, unloading, site storage, handling, installation, site testing and commissioning of the equipment specified herein.

.1 All pre-commissioning tests, including leakage checks, storage checks and filling tests, are considered incidental to the Work and no separate measurement or payment shall be made. Include the costs for these Items in the proposed unit prices for the applicable Items to which it applies. If tests are performed in winter, Contractor may be required to have provisions (steam lances or radiant heaters, etc) to de-ice the gates and guides if needed.

.2 The unit prices for Item 35 20 13 (c) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving at Site, unloading, site storage, handling, installation, site testing and commissioning of the equipment specified herein.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor’s Documents of the General Specification.

.2 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including installation and test plans, testing procedures, and commissioning procedures.

.3 Safe Work plans.

.4 Testing and commissioning reports including test record sheets.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The Contractor shall be responsible for receiving at Site, offloading and handling the Intake Bulkhead and Draft Tube Bulkhead Gates, Spillway Stoplogs and Trashracks.

.3 Gates, stoplogs and trashracks shall be stored in a secure area that will prevent contamination from deleterious materials. Ensure that gates, stoplogs and trashracks are stored in a safe manner and are secured from tipping.

.4 Handle all items with care to avoid damage prior to installation, in particular, take care that the seals are not damaged. Follow manufacturer's storage and handling instructions as reviewed by the Engineer.

.5 Include all labour and equipment, including temporary mobile cranes, to transport all gates covered in this Section of the Technical Specification to their respective installation areas (intake deck, tailrace, spillway).

.6 Provide temporary mobile cranes as required to install trashracks and temporary spillway stoplogs.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 PURCHASER-SUPPLIED PRODUCTS

.1 The Intake Bulkhead Gates, Draft Tube Bulkhead Gates, Spillway Stoplogs and Trashracks components will be supplied to the Contractor at the Purchaser's storage yard.

.1 The bulkhead and draft tube gates, spillway stoplogs and trashracks details are shown on the Purchaser's Drawings.

.2 Temporary Spillway Stoplogs can be provided by the Purchaser from existing stations. The Contractor shall provide a required date to receive all stoplogs at the Site in its Contract Schedule.

2.2 MATERIALS

.1 All materials for performing this Work other than the gates, stoplogs, and trashracks and the cranes as listed in Section 1.1 above are to be supplied by the Contractor.

Part 3 Execution

3.1 EXAMINATION

.1 Alignment checks of guides to be completed as specified in Section 35 20 17 Embedded Guides of the Technical Specification prior to testing.

.2 All guide slots shall be verified to be free of debris prior to installation and testing.

3.2 INSTALLATION REQUIREMENTS

.1 Contractor is responsible to remove any debris found in the slots during examination.

.2 Install all bulkhead gates, stoplogs, and trashracks as shown on their respective assembly drawings.

.3 After commissioning, gates shall be placed in service or placed in storage as required.

.4 Trashracks

.1 After dry testing the trashracks, complete installation of all trashracks in slots.

.5 Temporary Spillway Stoplogs

.1 Perform pre-operational checks as required to verify condition prior to installation. Notify the Engineer of any suspected installation issues prior to installation and wait for direction before proceeding with this Work.

.2 Install temporary Spillway Stoplogs during diversion to permit construction of rollways. During diversion, due to the Spillway gate height, some overtopping of the Spillway gate may occur and the stoplog sections may have to be installed under partial flow conditions.

3.3 FIELD QUALITY CONTROL

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

.2 Commissioning tests will be witnessed by Purchaser and others as required. Notify Purchaser two Working Days in advance of tests.

3.4 PRE-COMMISSIONING

.1 General

.1 Contractor must read, understand and apply all of CSA Z460-05 to ensure hazardous energy is controlled for worker protection.

.2 For safety, personnel and equipment not associated with the test shall be kept clear of the test area.

.3 All tests shall be performed in compliance with Subsection 21.10 Testing of the General Specification, the Contractor's Safety Management Plan and Manitoba Workplace Safety and Health Act and Regulations.

.4 Tests shall be performed in sequence to minimize the possibility of an accident causing injury to personnel and/or damage to the equipment. Any faults found shall be corrected before proceeding with the next test unless so determined by the Engineer.

.5 If tests are performed in winter and there is ice on the gates/stoplogs and guides, Contractor will be required to have provisions (steam lances or radiant heaters, etc) to de-ice the gates and guides if needed.

.2 Tests shall include

.1 Trashracks:

.1 Test in the dry to verify the trashracks will move smoothly and without binding throughout the range of travel.

.2 Follower Engagement - Observe engagement and disengagement of lifting hooks.

.2 Intake Bulkhead Gate:

.1 Pre-Operational Checks - visual inspection.

.2 Tests conducted in the dry.

.1 Follower Engagement - Observe engagement and disengagement of lifting hooks.

.2 Bulkhead Gate Test Fit - Run one gate up and down in each opening with follower.

.3 Bulkhead Gate Fit Up Test - Install all gates in one opening.

.4 Service Bay Bulkhead Gate Storage Fit Test - Install gates in service bay gate storage area.

.3 Operational Tests Conducted in the Wet After Unit Installation:

.1 Leak Test - Using gates for one unit.

.2 Filling Test using bypass valve (between intake service gate and bulkhead gate for one unit).

.3 Draft Tube Gates

.1 Pre-Operational Checks - visual inspection.

.2 Tests conducted in the dry:

.1 Follower Engagement - Observe engagement and disengagement of lifting hooks.

.2 Gate Test Fit - Run one stoplog up and down in each opening with follower.

.3 Gate Fit Up Test - Install all gates for one unit.

.4 Place a gate in its storage location - check safety features for restraining gate in place.

.3 Operational Tests Conducted in the Wet Prior to Unit Installation:

.1 Operation of gates and follower using crane.

.2 Leak Test of all gates (2 units). Refer to cofferdam removal procedures.

.4 Operational Tests Conducted in the Wet After Unit Installation:

.1 Demonstrate each draft tube can be dewatered after units are placed in service. Intakes gates will be lowered and unit dewatered to tailwater level.

.1 Check leakage.

.4 Spillway Stoplogs (Permanent – upstream and Temporary - Downstream)

.1 Test in same manner as for Intake Bulkhead gates, where the leak and filling test will be performed on one bay instead of one unit.

.2 Storage method shown on the Purchaser's Drawings for the permanent upstream stoplogs to be checked and demonstrate the gates are stored in a safe and secured manner.

.5 Seals shall be allowed to sit under water pressure load for 18 to 24 hours prior to evaluation of leakage.

.3 General minimum requirements for tests applicable to all gates and stoplogs are as follows:

.1 Pre-Operational Check requirements shall be detailed by the Contractor.

.2 Follower Engagement checks shall demonstrate the following as shown on the Purchaser's Drawings:

.1 Gate lifting points are fully seated in follower hooks as indicated on the Purchaser's Drawings with slack in follower lifting ropes removed but before the gate is lifted.

.2 With gate lifted approximately 5 mm off the floor or less, demonstrate that the tiller rope hoist will not disengage the hooks. Ensure during test that personnel are kept safe and gate is protected from damage in event the hooks do disengage and fail the test.

.3 Simulate a skewed gate (as if jammed) by placing an obstruction on one side of the gate such that one side of the follower ropes trip the slack rope switch and the other rope still has tension with that side of gate no more than 5 mm off the floor. In this condition, demonstrate that the tiller rope hoist will not disengage the hooks.

Note: Follower hook engagement checks may be changed during detailed design.

.3 Operation Tests in dry and wet shall demonstrate the gate and follower assembly can be raised and lowered without binding in the guides and that the crane motor load is within an expected range (as indicated by motor current or another measure).

.4 Leakage Checks

.1 Gate/Stoplog leakage checks are to check if the gates leak. Areas of leakage shall be observed and noted in the test record sheets.

.5 Storage Checks

.1 The Contractor shall check gate/stoplog storage method as indicated on the Purchaser's Drawings and demonstrate the gates/stoplogs are stored in a safe and secured manner. The Contractor shall provide how storage method is evaluated for review by the Engineer.

.6 Filling Tests

.1 Shall measure and record the time to fill area being tested. Acceptable time ranges to be provided to the Contractor by the Engineer prior to the test.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, Contractor's Documents, as determined by the Engineer and as specified herein for the supply, off-loading, handling, site storage, and installation of the following Items:

.1 Intake bulkhead gate guides, lintel and sill beams.

.2 Intake trashrack guides and seating beams.

.3 Draft tube gate guides, lintel and sill beams.

.4 Spillway stoplog guides and sill beams.

.2 Work performed by others:

.1 Supply and installation of intake gate guides, lintel beams and sill beams.

.2 Supply and installation of spillway gate guides and sill beams.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 03 15 19 - Embedded Anchors.

.3 Section 03 30 00 - Cast-in-Place-Concrete.

.4 Section 03 60 00 - Equipment Grouting.

.5 Section 05 50 00 - Miscellaneous Metal.

.6 Section 09 90 00 - Painting and Coating.

.7 Section 35 20 13 - Bulkhead Gates, Stoplogs, and Trashracks.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 CSA S16-09 - Design of Steel Structures.

.2 CSA W59-03 (R2008) - Welded Steel Construction (Metal Arc Welding).

.4 Manitoba Workplace Safety and Health Act and Regulations.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Items 35 20 17 (a)i to (d)iii will be based on the length of embedded parts in metres shown in the Purchaser's Drawings.

.3 Unit Price

.1 The unit prices for Items 35 20 17 (a)i to 35 20 17 (d)iii in the Bill of Quantities, Unit Prices and Target Price Estimate shall be for supply, shop-painting, delivery, unloading, site storage, handling, installation, touch-up painting, shop and field quality control of the embedded guides specified herein.

.1 Handling, installing and removing temporary bracing and any other members employed by the Contractor for the installation of components specified herein are considered incidental to this Work and no separate measurement or payment shall be made. Include the costs for these Items in the unit prices for the corresponding Items to which this Work applies.

.2 Include costs for embedded anchors in the unit prices referenced in Section 03 15 19 Embedded Anchors of the Technical Specification.

.3 Include costs for concrete in the unit prices referenced in Section 03 30 00 Cast-In-Place Concrete of the Technical Specification.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor’s Documents of the General Specification.

.2 Embedded parts fabrication submittals shall be as specified in Section 05 50 00 Miscellaneous Metal of the Technical Specification.

.3 Submit for Engineer review in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification installation and test plans, including alignment procedures.

.4 Alignment check records.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor’s Quality Management Plan.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 The Contractor shall include transportation and delivery of embedded parts supplied by the Contractor but fabricated off Site.

.3 Provide all labour, equipment, Materials, and Plant for site transporting and handling for the installation of the embedded portions of the gate guides, sills and lintel beams.

.4 Materials delivered to the Site shall be clearly tagged for easy identification. Tagging shall be weatherproof for outdoor storage.

.5 All items shall be handled with care to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Structural members shall be fabricated from steel plates to CSA-G40.20/G40.21-M 350W and sections to CSA-G40.20/ G40.21-M 300W.

.2 The vertical, lintel beam, and sill beam seal faces shall be corrosion resistant steel to ASTM A167 type 304L (annealed).

.3 All bolts shall be provided with grade marking located on the top of the bolt head.

.4 High strength bolts and hardened washers shall be galvanized steel to ASTM A325M and ASTM F436M.

.5 Material for temporary bracing and supports shall be as set out in the Purchaser's Drawings.

.6 Concrete for embedment of guides, lintel and sill beams (secondary concrete) shall be as specified in Section 03 30 00 Cast-In-Place Concrete of the Technical Specification.

.7 Grouting shall be as specified in Section 03 60 00 Equipment Grouting of the Technical Specification.

2.2 FABRICATION

.1 Embedded parts to be supplied by the Contractor shall be fabricated as shown on the Purchaser's Drawings and in accordance with Section 05 50 00 Miscellaneous Metal of the Technical Specification, except that embedded parts are not to be galvanized.

2.3 FINISHES

.1 Parts that are machined, stainless steel and parts that are embedded in concrete are not to be painted. All other areas of the embedded guides shall be painted as per Section 09 90 00 Painting and Coating of the Technical Specification.

Part 3 Execution

3.1 PREPARATION AND INSPECTION

.1 Placement of embedded anchors shall be as specified in Section 03 15 19 Embedded Anchors of the Technical Specification and the Purchaser's Drawings.

.2 Preparation for installing guides and pouring concrete shall be as specified in Sections 03 30 00 Cast-In-Place Concrete and 03 60 00 Equipment Grouting of the Technical Specification and the Purchaser's Drawings.

.3 Provide all submittals on inspections and tests as required by the Sections referred to above.

3.2 INSTALLATION

.1 Guide components, excluding those for trashracks, to be installed in secondary concrete. Trashrack guide components to be installed in primary concrete. Install the guides as set out in the Purchaser's Drawings, as determined by the Engineer and as specified herein. Provide all labour and miscellaneous material required to embed the guide components. This shall include all temporary bracing, supports, and concrete required to embed the guides.

.2 Sill and lintel beams to be installed in secondary concrete as shown on the Purchaser's Drawings, as determined by the Engineer and as specified herein. The Contractor shall also supply and install all concrete required to embed the guide components.

.3 Erection of structural steel for embedment shall conform to Canadian Standards Association CAN/CSA-S16, except as noted herein.

.4 The parts for the gate guides, sill and lintel beams shall be set, adjusted and held in position using anchors embedded in primary concrete, except for the trashrack guides which shall be held by temporary bracing as indicated by the Purchaser's Drawings, so that after pouring of the concrete (primary for the trashrack guides and secondary for the other embedded guides) the embedded parts are in accordance with the tolerances listed in the attached schedule:

.1 Table 1 - “Tolerances for Installation of Guides, Sill Beams and Lintel Beams for Spillway Stoplogs, Intake Bulkhead Gates, and Draft Tube Gates Embedded in Secondary Concrete”.

Table 1: Tolerances for Installation of Guides, Sill and Lintel Beams for Spillway Stoplogs, Intake Bulkhead Gates, and Draft Tube Gates Embedded in Secondary Concrete

Component	Tolerance
Bearing and Seal Paths:	
Vertical alignment – Draft Tube Gates	+/- 1.5 mm over the full length
Vertical alignment – All Other Gates	+/- 3 mm over the full length
Straight edge check – Draft Tube Gates	0.75 mm in ANY 1,800 mm
Straight edge check – All Other Gates	1.5 mm in ANY 1,800 mm
Gauge distance across water passage	+/- 5 mm
Sill and Lintel Beams:	
Horizontal alignment	+/- 0.75 mm over the full length
Straight edge check	0.75 mm in ANY 1,800 mm
Gauge distance sill beam to lintel beam	+/- 3 mm
Guide Extensions above Lintel Beam:	
Vertical alignment	+/- 5 mm over the full length
Gauge distance across water passage	+/- 5 mm

.2 Table 2 - "Tolerances for Installation of Intake Trashrack Guides in Primary Concrete".

Table 2: Tolerances for Installation of Guides and Seating Beams for Intake Trashracks in Primary Concrete

Component	Tolerance
Bearing Paths:	
Vertical alignment	+/- 5 mm over the full length
Straight edge check	1.5 mm in ANY 1,800 mm
Gauge distance across water passage	+/- 5 mm
Seating Beams:	
Vertical alignment	+/- 0.75 mm over the full length

.5 The Contractor shall establish two vertical basic reference planes for alignment of the parts in each waterpassage. One plane shall be at right angles to the waterpassage and parallel to the vertical bearing and sealing path surfaces and the other plane shall be parallel to the centreline of the waterpassage. Tolerances for alignment specified in the table shall be related to measurements made from either one or both of these reference planes. The Contractor shall supply steel gauge members for assistance in aligning gate guides.

.6 The vertical guide members shall be installed so that they are square with the reference planes so as to avoid warped and skewed seal and bearing path surfaces. The junction of the sealing surfaces at the sill beam and the vertical seal paths shall be square. Sealing surfaces at the junction of the lintel beam and vertical seal paths shall be flush and in one plane.

.7 Once initial alignment of the guides, sill and lintel beams are achieved and prior to embedment, torque anchor nuts as required by the Purchaser's Drawings and confirm installation is still within tolerance.

.8 Components to be embedded shall be supplied in lengths shown in the Purchaser's Drawings and will require splices. Prior to embedment, and as part of the Work under this Section, the Contractor shall apply seal welds to the joints. Seal welds shall be

ground smooth and painted with one coat of primer and one finish coat, as shown on the Purchaser's Drawings and as specified in Section 09 90 00 Painting and Coating of the Technical Specification.

3.3 FIELD QUALITY CONTROL

.1 Prior to and after embedment of the parts, the Contractor shall perform all necessary alignment checks as required by the Engineer to determine that the specified tolerances have been achieved.

.2 Alignment checks to be witnessed by Engineer. Notify Purchaser two Working Days in advance of alignment checks.

.3 All alignment check records to be maintained and submitted.

.4 Any embedded structural steel that is incorrectly placed or that moves during embedment to an extent that tolerances, as specified herein, are exceeded to the point where its proper operation will be affected, shall be removed and replaced correctly or shall be corrected by other authorized means to the complete satisfaction of the Engineer.

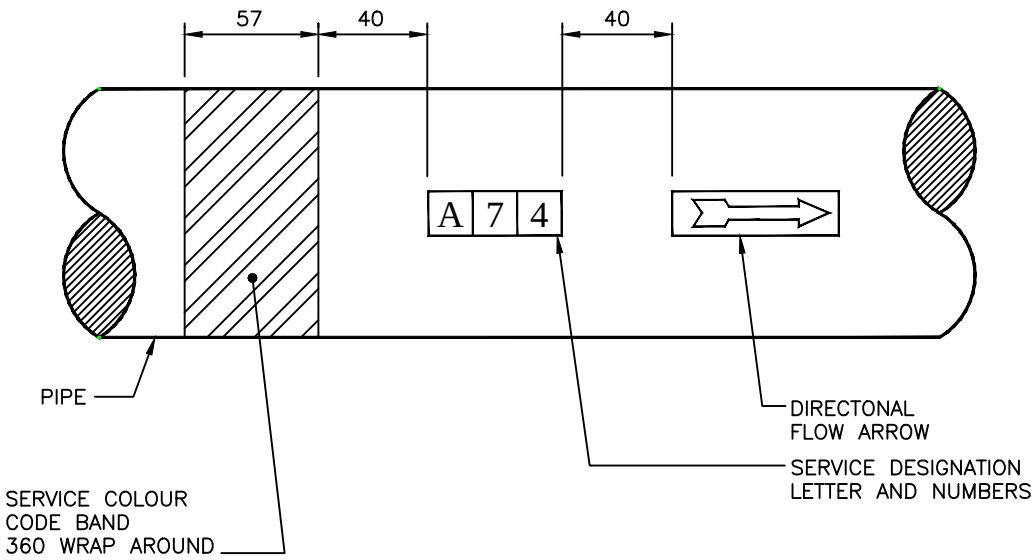
3.4 COMMISSIONING

.1 Performance of gate movement in the guides shall be tested during installation of their respective gates. Refer to Section 35 20 13 Bulkhead Gates, Stoplogs and Trashracks of the Technical Specification.

.2 Intake gate and spillway gates will be installed and commissioned by others.

END OF SECTION

STD–01 – SYSTEM IDENTIFICATION AND COLOUR CODING



NOTES:

1. W.H. BRADY CO., OR APPROVED EQUAL, MARKERS SHALL BE USED FOR PIPELINE IDENTIFICATION.

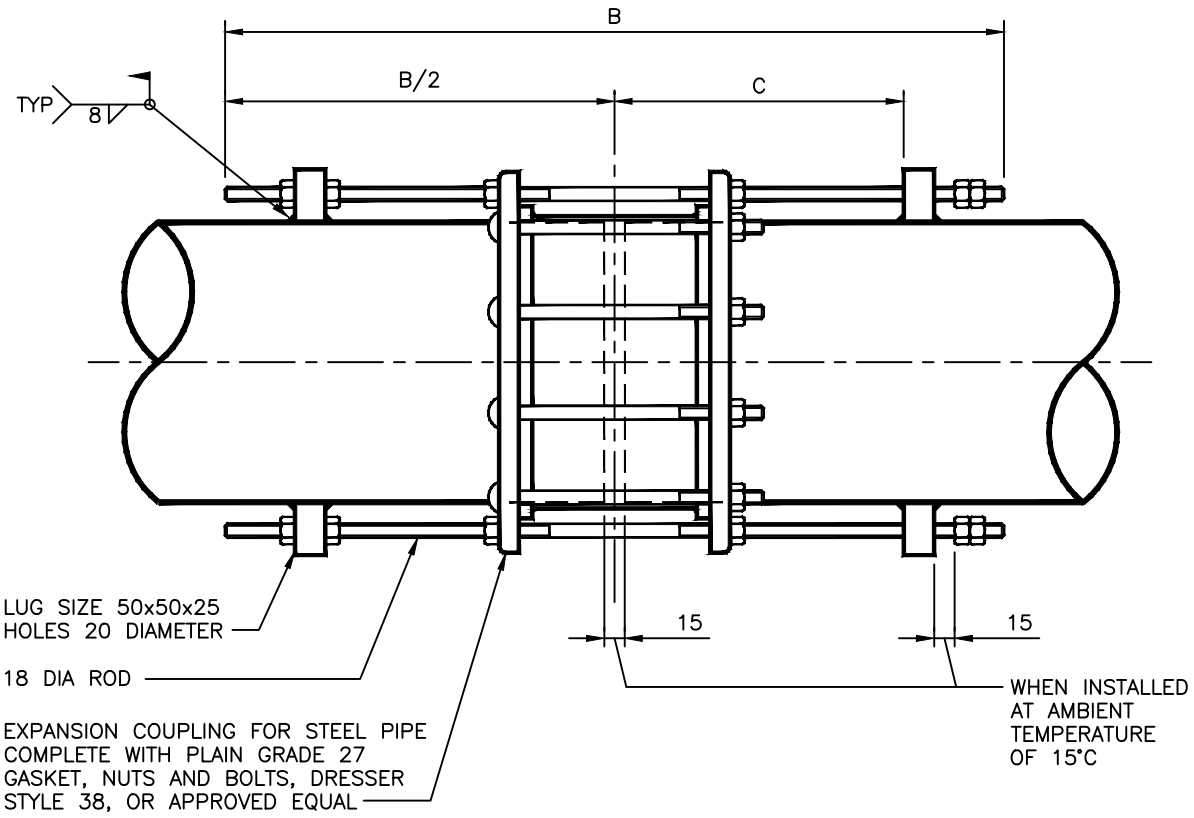
   THE FOLLOWING MARKERS SERIES SHALL BE USED FOR SERVICE DESIGNATION LETTERS AND NUMBERS:
   - FOR PIPELINES 25mm AND SMALLER SERIES Y05
   - FOR PIPELINES 32mm TO 90mm SERIES Y75
   - FOR PIPELINES 100mm AND LARGER SERIES Y225

   THE FOLLOWING MARKER STYLES SHALL BE USED FOR DIRECTIONAL FLOW ARROWS:
   - FOR PIPELINES 25mm AND SMALLER STYLE 38S
   - FOR PIPELINES 32mm TO 90mm STYLE 468S
   - FOR PIPELINES 100mm AND LARGER STYLE 123S

2. USE NOMINAL PIPE SIZE FOR OUTSIDE DIAMETER WHEN LABELLING INSULATED PIPE.

HATCH	MANITOBA HYDRO					
	KEEYASK GENERATING STATION					
	EXPOSED PIPING STANDARDS	NO.	DATE	BY	CKD	APP
		REVISIONS				
	MECHANICAL PIPING STANDARD SYSTEM IDENTIFICATION AND COLOUR CODING	DWG. NO. STD–01				
		DRAWN	CHECKED	APPROVED		
		DATE	SHEET	REV		
			1 OF 1	00		

STD–02 – EXPANSION COUPLING HARNESS FOR EXPOSED STEEL PIPE



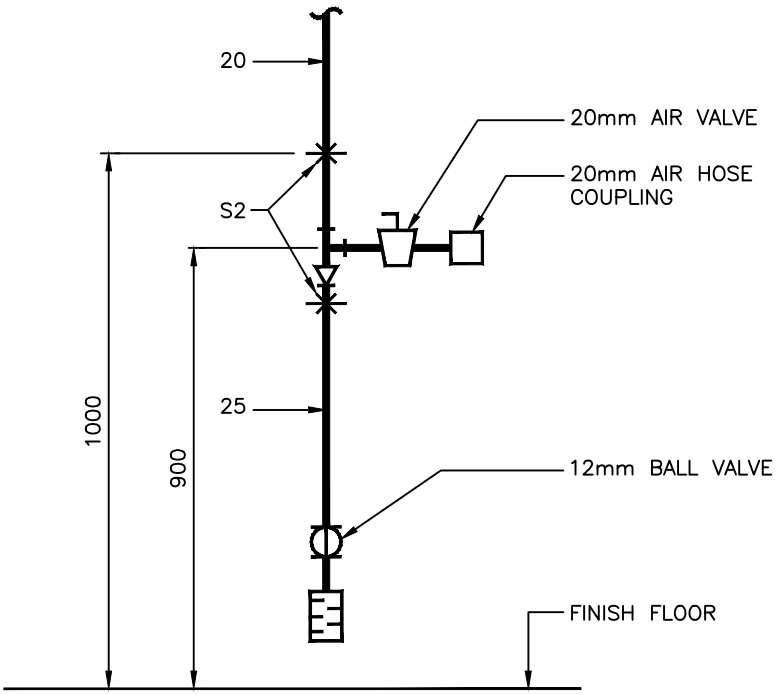
NOMINAL PIPE SIZE	IN MILLIMETERS	
A	B	C
100	600	215
150	700	265
200	750	275
250	750	275
300	750	275
350	750	275
400	750	275
500	750	275

NOTES:

1. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.
2. COUPLING SHALL BE CENTRALLY LOCATED AT PIPE JOINT.
3. LUGS SHALL BE FABRICATED IN FIELD FROM ASTM A36 STEEL BAR.
4. PIPELINES 100mm AND LARGER SHALL HAVE TWO TIE–RODS 180° APART AS SHOWN.

HATCH	MANITOBA HYDRO				
	KEEYASK GENERATING STATION	NO.	DATE	BY	CKD	APP
	EXPOSED PIPING STANDARDS	REVISIONS				
		DWG. NO. STD–02			
	STANDARD MECHANICAL DETAILS EXPANSION COUPLING HARNESS FOR EXPOSED STEEL PIPE	DRAWN	CHECKED	APPROVED	
		DATE	SHEET	REV	
			1 OF 1	00	

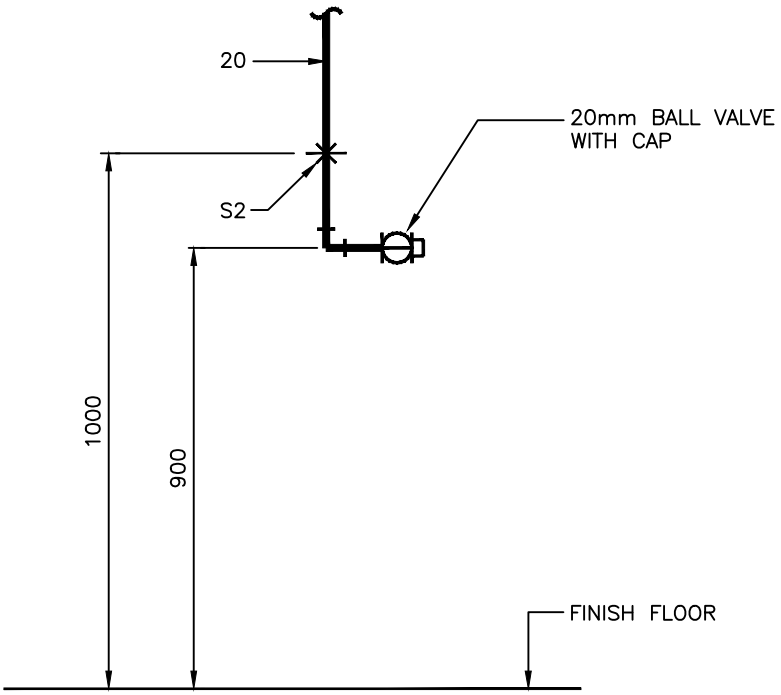
STD–03 – SERVICE AIR STATION



SERVICE AIR STATION

HATCH	MANITOBA HYDRO					
	KEEYASK GENERATING STATION	NO.	DATE	BY	CKD	APP
	EXPOSED PIPING STANDARDS	REVISIONS				
		DWG. NO. STD–03				
	STANDARD MECHANICAL DETAILS SERVICE AIR STATION	DRAWN	CHECKED	APPROVED		
		DATE	SHEET	REV		
			1 OF 1	00		

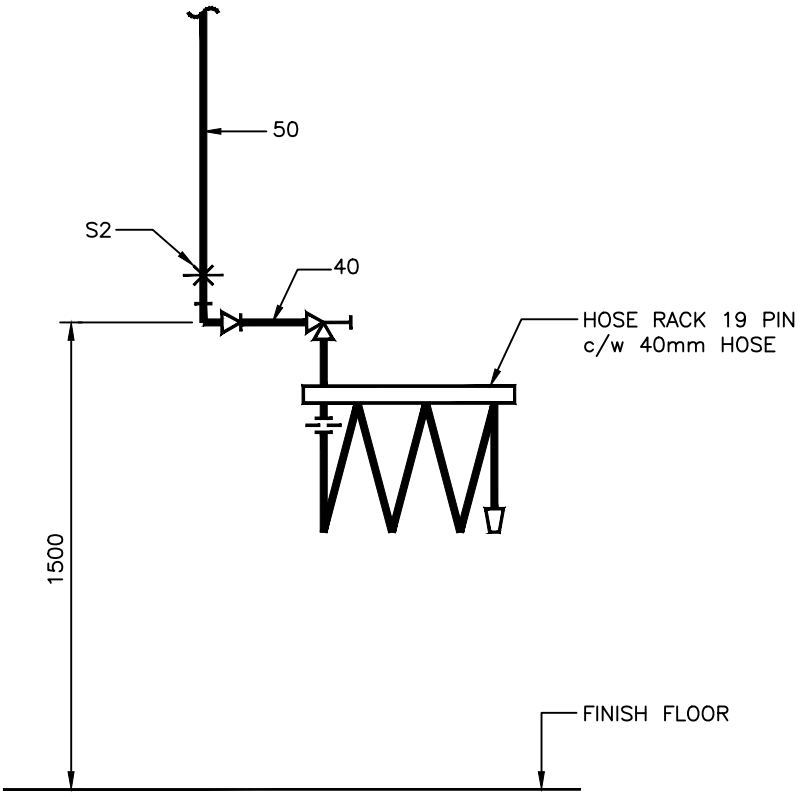
STD–03A – SERVICE WATER STATION



SERVICE WATER STATION

HATCH	MANITOBA HYDRO					
	KEEYASK GENERATING STATION	NO.	DATE	BY	CKD	APP
	EXPOSED PIPING STANDARDS	REVISIONS				
		DWG. NO. STD–03A				
	STANDARD MECHANICAL DETAILS SERVICE WATER STATION	DRAWN	CHECKED	APPROVED		
		DATE	SHEET	REV		
			1 OF 1	00		

STD–04 – HOSE STATION



HOSE STATION

HOSE THREADS:

1½" – STRAIGHT IRON PIPE STANDARD, 1⅞" O.D. MALE WITH 11½ T.P.I.

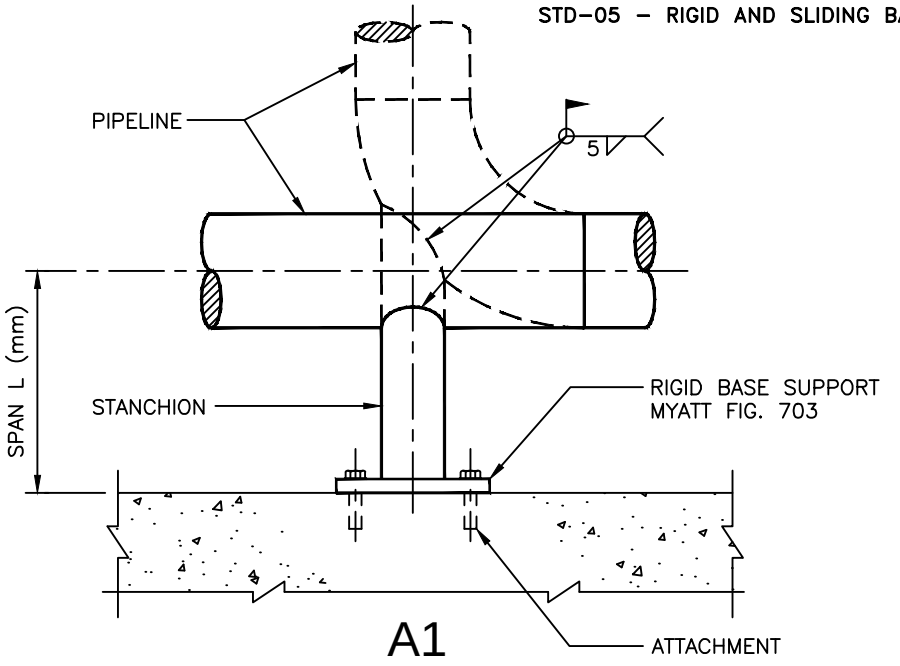
2½" – WESTERN CANADA FIRE UNDERWRITERS, CITY OF WINNIPEG, 3¼" O.D. MALE WITH 6 T.P.I.

TYPE	HOSE LENGTH
A	15000mm
B	23000mm
C	30000mm

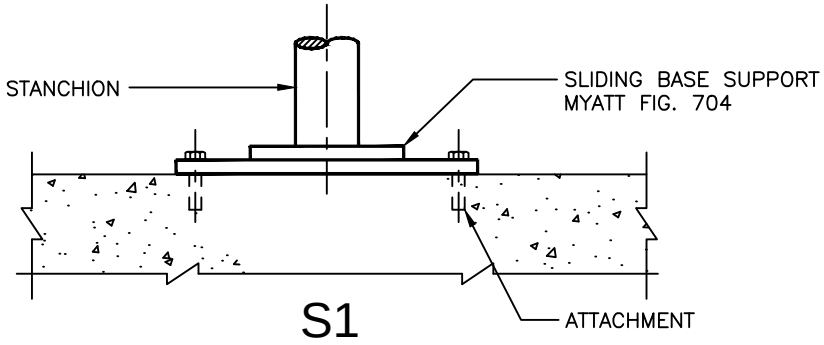
HATCH	MANITOBA HYDRO				
	KEEYASK GENERATING STATION	NO.	DATE	BY	CKD APP
	EXPOSED PIPING STANDARDS	REVISIONS			
		DWG. NO. STD–04			
	STANDARD MECHANICAL DETAILS HOSE STATION	DRAWN	CHECKED	APPROVED	
		DATE	SHEET	REV	
			1 OF 1	00	

A1 & S1

STD–05 – RIGID AND SLIDING BASE SUPPORTS



A1



S1

NOMINAL PIPE SIZE (mm)	RECOM MAX LOAD (KG)	L MAX (MM)	STANCHION	ATTACHMENT (ANCHOR BOLTS)	
				NO.	SIZE
65	200	1000	ø50 STD PIPE	2	M14
80	350	1000	ø50 STD PIPE	2	M14
100	525	2000	ø50 STD PIPE	2	M14
150	1125	2000	4WF13	4	M18
200	1350	2000	6B12	4	M20
250	1725	2000	6WF15.5	4	M20
300	1800	2000	6WF15.5	4	M20
350	2725	3050	8WF31	4	M20
400	2950	3050	8WF31	4	M20

HATCH

MANITOBA HYDRO

KEEYASK GENERATING STATION

EXPOSED PIPING STANDARDS

STANDARD MECHANICAL DETAILS
RIGID AND SLIDING
BASE SUPPORTS

NO.	DATE	BY	CKD	APP

REVISIONS

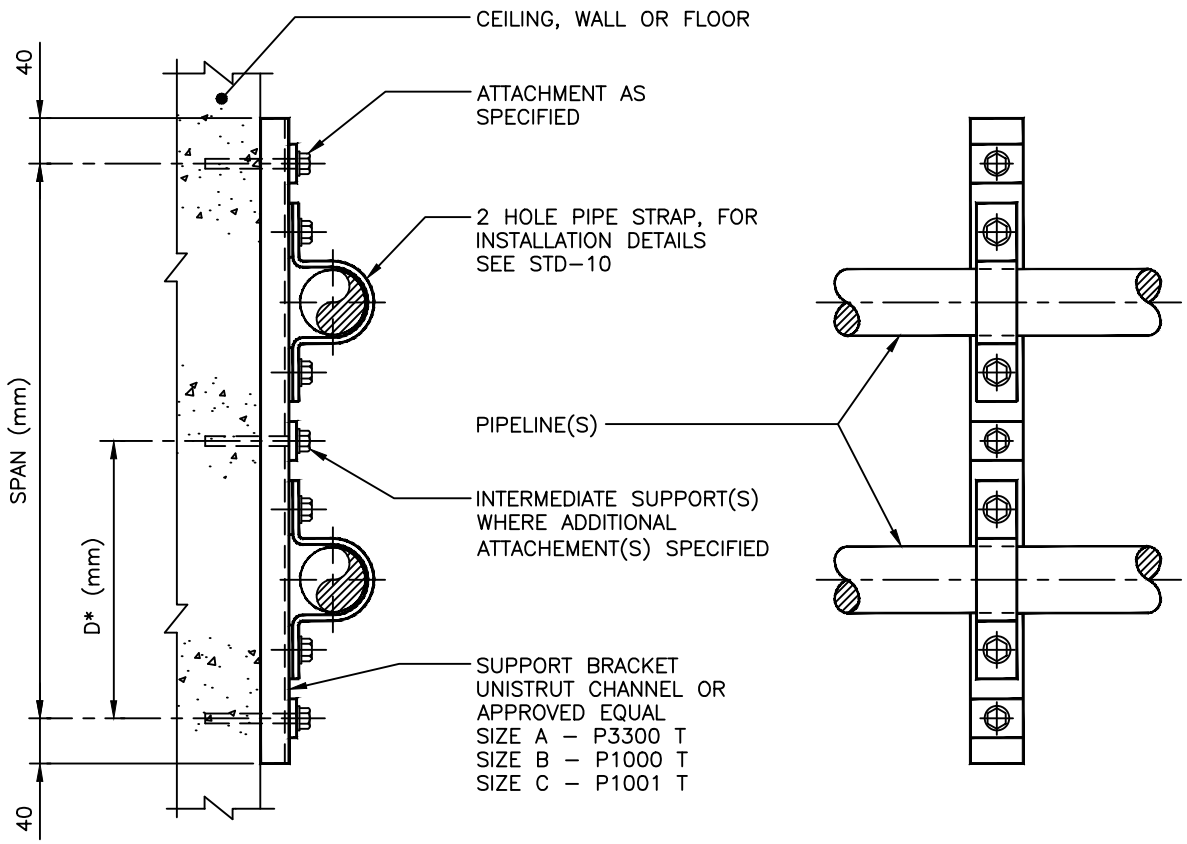
DWG. NO. STD–05

DRAWN	CHECKED	APPROVED

DATE	SHEET	REV
	1 OF 1	00

A2 & S2

STD–06 – PIPE ANCHOR AND PIPE SUPPORT



BRACKET ALLOWABLE LOAD(kg)			
SIZE / *D	A	B	C
250	150	420	1195
500	75	210	595
750	50	140	395
1000	35	100	295
1250	30	80	235
1500	25	70	195
1750	20	60	170
2000	18	50	145

* REFERS TO DISTANCE BETWEEN ATTACHMENTS

NOTE:

1. ADDITIONAL ATTACHMENTS WHEN SPECIFIED SHALL BE EQUALY SPACED BETWEEN END ATTACHMENTS.

NO.	DATE	BY	CKD	APP	
REVISIONS					
DWG. NO. STD–06					
DRAWN	CHECKED	APPROVED			
DATE	SHEET	REV			
	1 OF 1	00			

HATCH

MANITOBA HYDRO

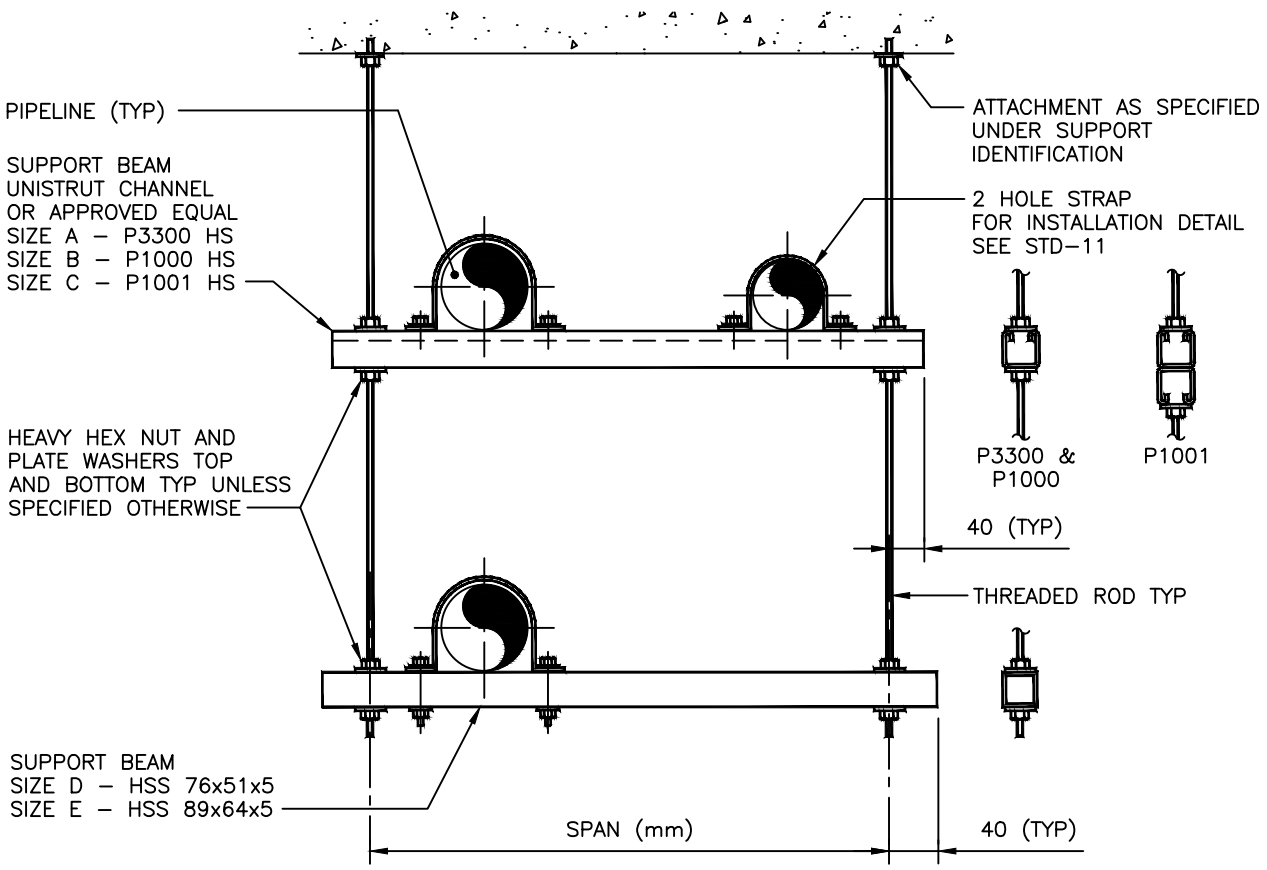
KEEYASK GENERATING STATION

EXPOSED PIPING STANDARDS

MECHANICAL STANDARD DETAILS
PIPE ANCHOR AND PIPE SUPPORT

STD–07 – TRAPEZE HANGER

S3



ALLOWABLE LOAD PER ROD (kg)	
SIZE	
M10	275
M14	500
M18	800
M20	1200
M22	1700

BEAM ALLOWABLE LOAD (kg)					
SIZE / SPAN	A	B	C	D	E
500	75	200	595	1050	1600
750	50	140	395	700	1050
1000	35	105	295	525	800
1250	30	80	235	425	645
1500	25	70	195	350	535
1750	20	60	170	300	460
2000	18	50	145	265	400

HATCH

MANITOBA HYDRO

KEEYASK GENERATING STATION

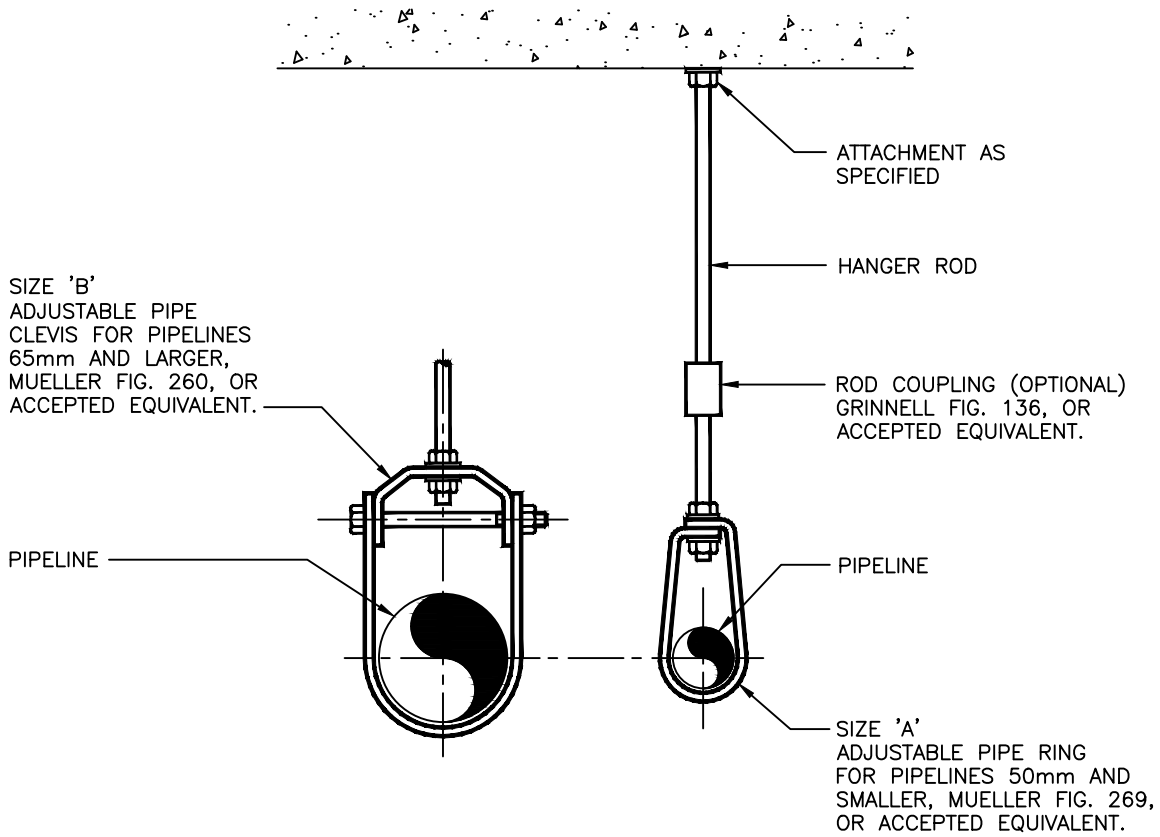
EXPOSED PIPING STANDARDS

STANDARD MECHANICAL DETAILS
TRAPEZE HANGER

NO.	DATE	BY	CKD	APP
REVISIONS				
DWG. NO. STD–07				
DRAWN	CHECKED	APPROVED		
DATE	SHEET	REV		
	1 OF 1	00		

STD–08 – PIPE HANGER

S4



ALLOWABLE LOAD PER ROD (kg)	
SIZE	
10	275
15	500
18	800
20	1200
22	1700
24	2250
30	3600
36	5250

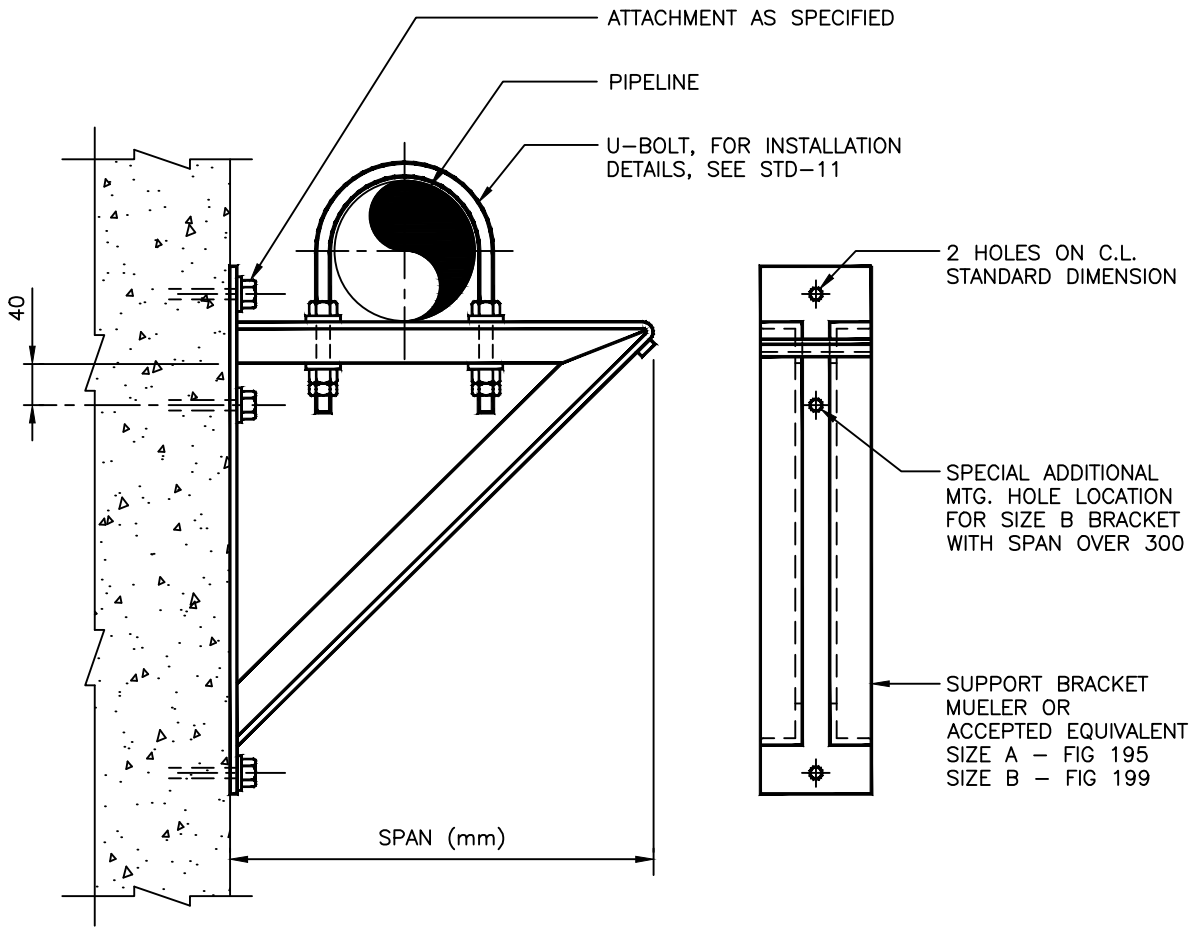
NOTE:

1. HANGER ROD SHALL BE MINNIMUM 10mm FOR 50mm AND SMALLER PIPE, FOR PIPE 65mm AND LARGER USE A MIMIMUM OF 12mm ROD.

HATCH	MANITOBA HYDRO				
	KEEYASK GENERATING STATION	NO.	DATE	BY	CKD	APP
	EXPOSED PIPING STANDARDS	REVISIONS				
		DWG. NO. STD–08			
	STANDARD MECHANICAL DETAILS PIPE HANGER	DRAWN	CHECKED	APPROVED	
		DATE	SHEET	REV	
			1 OF 1	00	

STD–09 – PIPE ANCHOR & PIPE SUPPORT

A5 & S5



MAX. ALLOWABLE LOAD (kg)		
SIZE / SPAN	A	B
300	675	1350
450	675	1350
600	675	1350
750	---	1350
900	---	1350
1050	---	1350

HATCH

MANITOBA HYDRO

KEEYASK GENERATING STATION

EXPOSED PIPING STANDARDS

STANDARD MECHANICAL DETAILS
PIPE ANCHOR & PIPE SUPPORT

NO.	DATE	BY	CKD	APP

REVISIONS

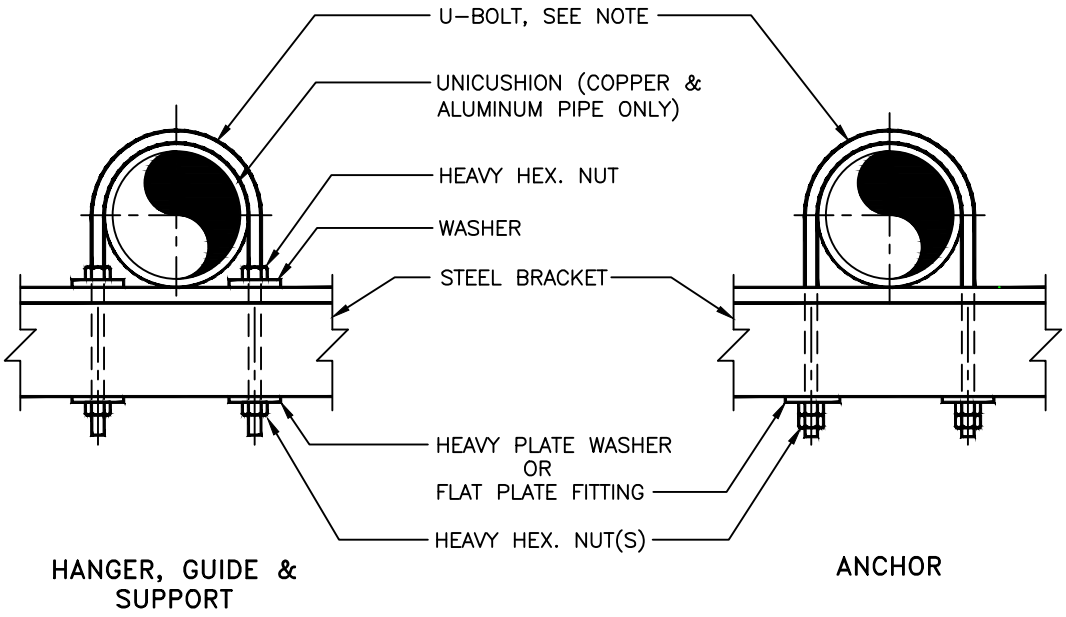
DWG. NO. STD–09

DRAWN	CHECKED	APPROVED

DATE	SHEET	REV
	1 OF 1	00

STD–10 – U–BOLTS

STANDARD PIPE INSTALLATION DETAILS



U–BOLTS

ALLOWABLE LOAD (kg)					
PIPE SIZE	ROD SIZE	LOAD	PIPE SIZE	ROD SIZE	LOAD
15	M6	200	200	M18	1600
20	M6	200	250	M20	2450
25	M6	200	300	M22	3400
32	M10	550	350	M22	3400
40	M10	550	400	M22	3400
50	M10	550	450	M24	4500
65	M14	1000	500	M24	4500
80	M14	1000	600	M24	4500
100	M14	1000	750	M24	4500
150	M18	1600			

NOTES:

1. COPPER/ALUMINUM PIPES AND TUBES SHALL BE ISOLATED FROM THE SUPPORT WITH ONE WRAP ON UNISTRUT UNICUSHION.
2. ASSEMBLY MAY BE INSTALLED INVERTED TO ALLOW PIPE TO HANG. LOADS ARE ASSUMED SUSPENDED.

HATCH	MANITOBA HYDRO				
	KEEYASK GENERATING STATION				
	EXPOSED PIPING STANDARDS				
	STANDARD MECHANICAL DETAILS PIPE INSTALLATION DETAIL U–BOLTS				

NO.	DATE	BY	CKD	APP

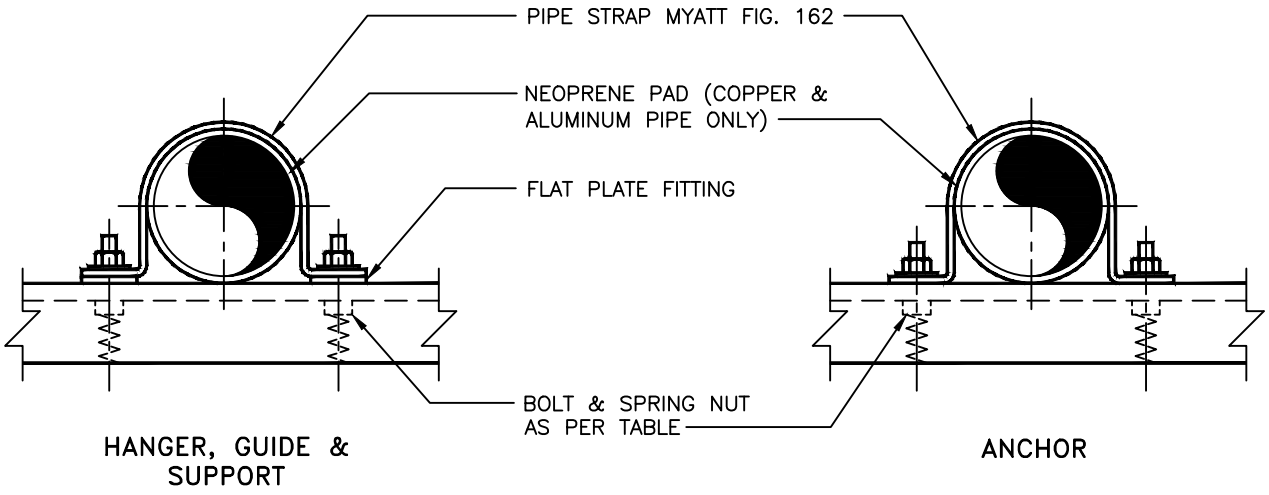
REVISIONS

DWG. NO. STD–10

DRAWN	CHECKED	APPROVED
DATE	SHEET	REV
	1 OF 1	00

STD–11 – 2–HOLE PIPE STRAP

STANDARD PIPE INSTALLATION DETAILS



PIPE STRAP, 2–HOLE

WITH P1000, P3000, & P5000

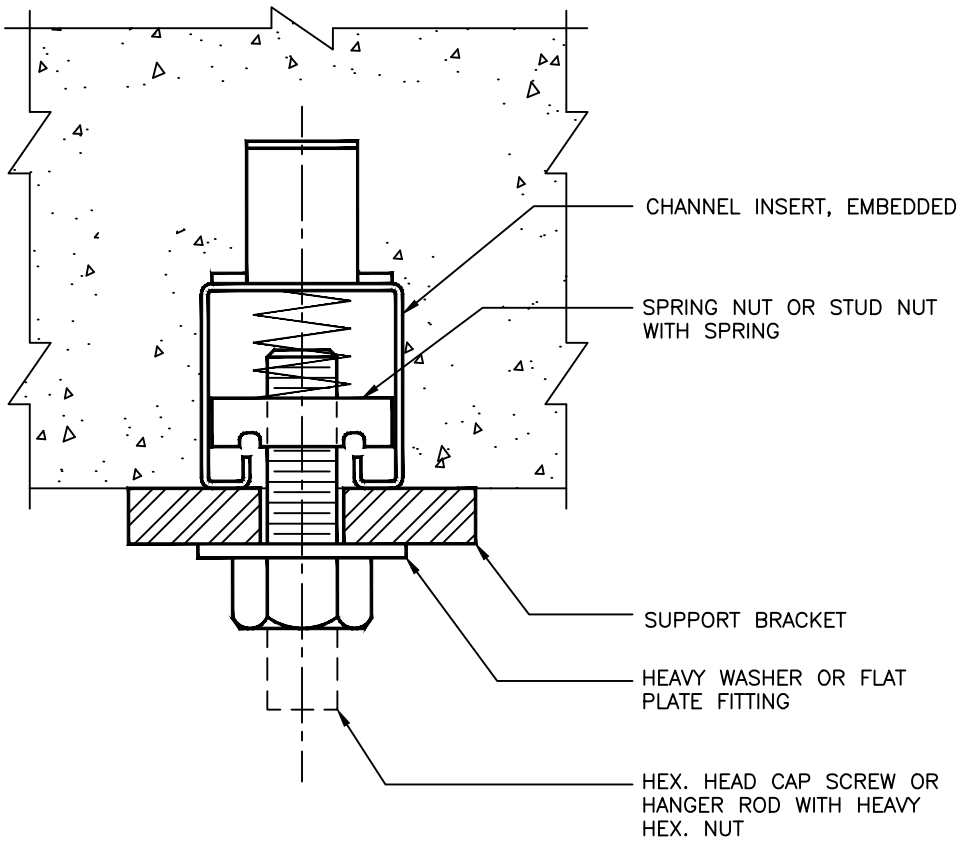
ALLOWABLE LOAD (kg)				BOLT TORQUE (N–m)
PIPE SIZE (mm)	BOLT SIZE (mm)	LOAD/BOLT		
		TENSILE	SLIP	NOM.
20	6	400	200	8
25	6	400	200	8
32	10	650	500	25
40	10	650	500	25
50	10	650	500	25
65	10	650	500	25
80	10	650	500	25
100	14	1300	1000	70
150	14	1300	1000	70
200	18	1700	1000	135
250	20	1700	1150	170
300	20	1700	1150	170

NOTE:

1. COPPER/ALUMINUM PIPES AND TUBES SHALL BE ISOLATED FROM SUPPORT WITH ONE WRAP OF UNISTRUT UNICUSHION.

HATCH	MANITOBA HYDRO	NO.	DATE	BY	CKD	APP
	KEEYASK GENERATING STATION	REVISIONS				
	EXPOSED PIPING STANDARDS	DWG. NO. STD–11				
	STANDARD MECHANICAL DETAILS PIPE INSTALLATION DETAIL 2–HOLE PIPE STRAP	DRAWN	CHECKED	APPROVED		
		DATE	SHEET	REV		
			1 OF 1	00		

STD–12 – EMBEDDED CHANNEL INSERT



ATTACHMENT : TYPE A

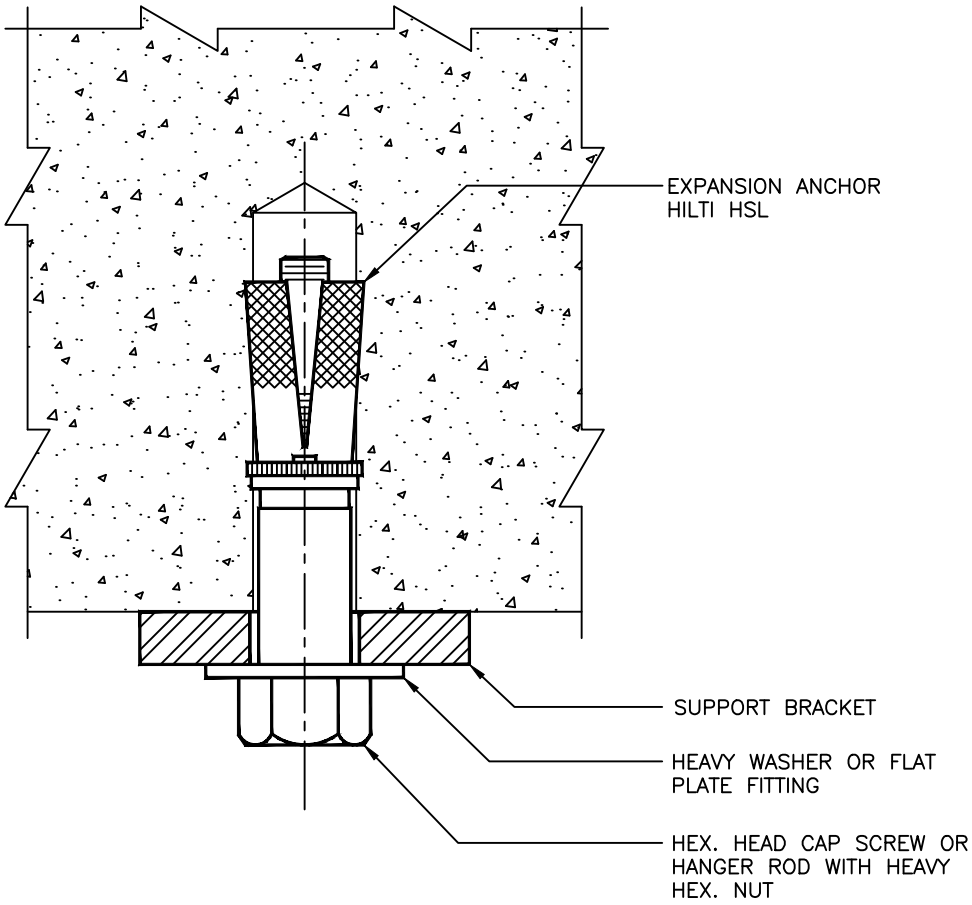
ALLOWABLE LOAD (kg)			
BOLT SIZE	TENSILE	SLIP	BOLT TORQUE NOM. (N–m)
M6	200	100	8
M10	325	250	25
M14	650	500	70
M18	850	500	135
M20	850	575	170

NOTE:

1. ABOVE LOADS ARE LIMITED BY THE PULL OUT OF NUT.
2. SLIP IS RESISTANCE TO SLIP PARALLEL TO THE SLOT.

HATCH	MANITOBA HYDRO				
	KEEYASK GENERATING STATION	NO.	DATE	BY	CKD	APP
	EXPOSED PIPING STANDARDS	REVISIONS				
		DWG. NO. STD–12				
	STANDARD MECHANICAL DETAILS EMBEDDED CHANNEL INSERT	DRAWN	CHECKED	APPROVED		
		DATE	SHEET	REV		
			1 OF 1	00		

STD–13 – EXPANSION ANCHOR



ATTACHMENT : TYPE B

ALLOWABLE LOAD (kg)					
BOLT SIZE	TENSILE	SHEAR	TORQUE NOM. N–m	SPACING mm	EDGE DIST. mm
M8	150	125	25	195	165
M10	250	200	50	225	190
M12	350	250	75	240	225
M16	650	550	190	315	300
M20	1000	850	360	395	350
M24	1200	1250	650	470	390

BASED ON 21 kPa (3000 PSI) CONCRETE
SAFETY FACTOR = 10 FOR TENSILE, FOR NON REVERSING VIBRATORY LOADS
SAFETY FACTOR = 4 FOR SHEAR

NO.	DATE	BY	CKD	APP	
REVISIONS					
DWG. NO. STD–13					
DRAWN	CHECKED	APPROVED			
DATE	SHEET	REV			
	1 OF 1	00			

HATCH

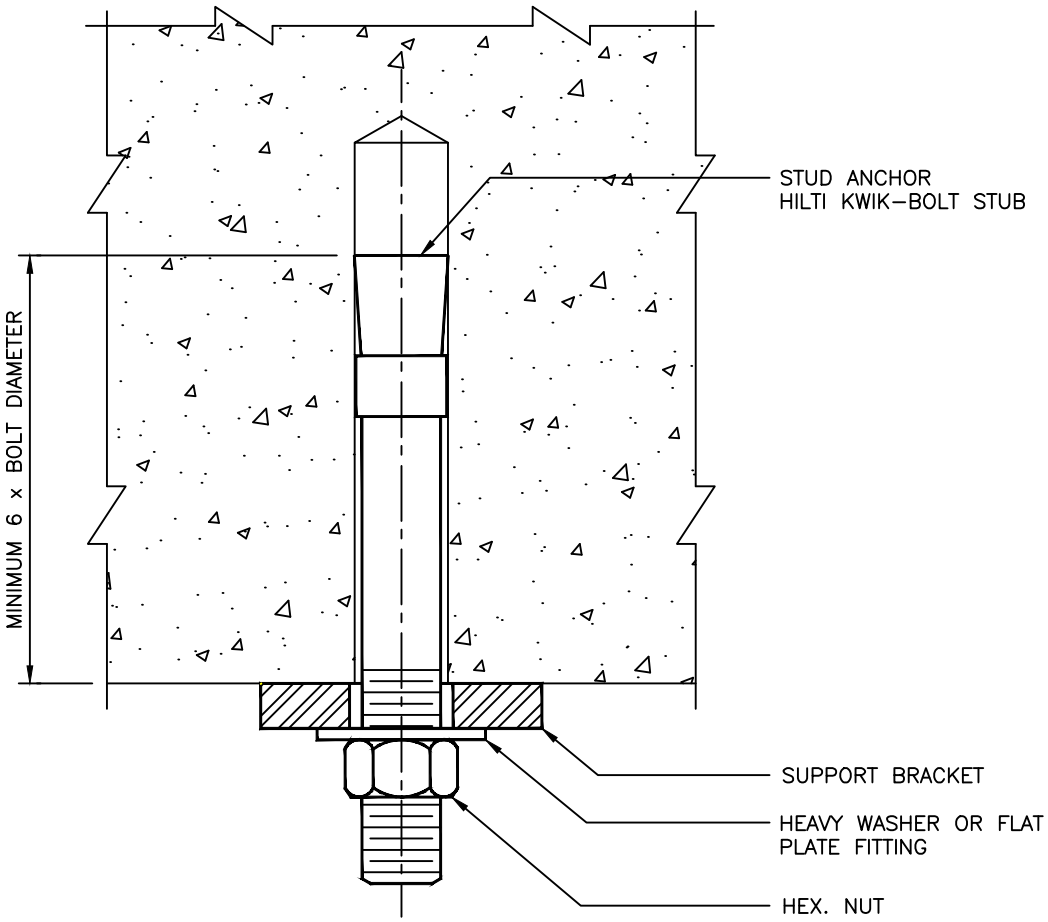
MANITOBA HYDRO

KEEYASK GENERATING STATION

EXPOSED PIPING STANDARDS

STANDARD MECHANICAL DETAILS
EXPANSION ANCHOR

STD–14 – STUD ANCHOR



ATTACHMENT : TYPE G

ALLOWABLE LOAD (kg)					
BOLT SIZE	TENSILE	SHEAR	TORQUE NOM. N–m	SPACING mm	EDGE DIST. mm
M6	50	25	9	115	95
M10	100	150	33	130	130
M15	150	200	85	180	180
M18	250	400	110	205	230
M20	350	600	235	255	255
M24	700	950	450	305	360

BASED ON 21 kPa (3000 PSI) CONCRETE
SAFETY FACTOR = 10 FOR TENSILE, FOR NON REVERSING VIBRATORY LOADS
SAFETY FACTOR = 4 FOR SHEAR

NO.	DATE	BY	CKD	APP	
REVISIONS					
DWG. NO. STD–14					
DRAWN	CHECKED	APPROVED			
DATE	SHEET	REV			
	1 OF 1	00			

HATCH

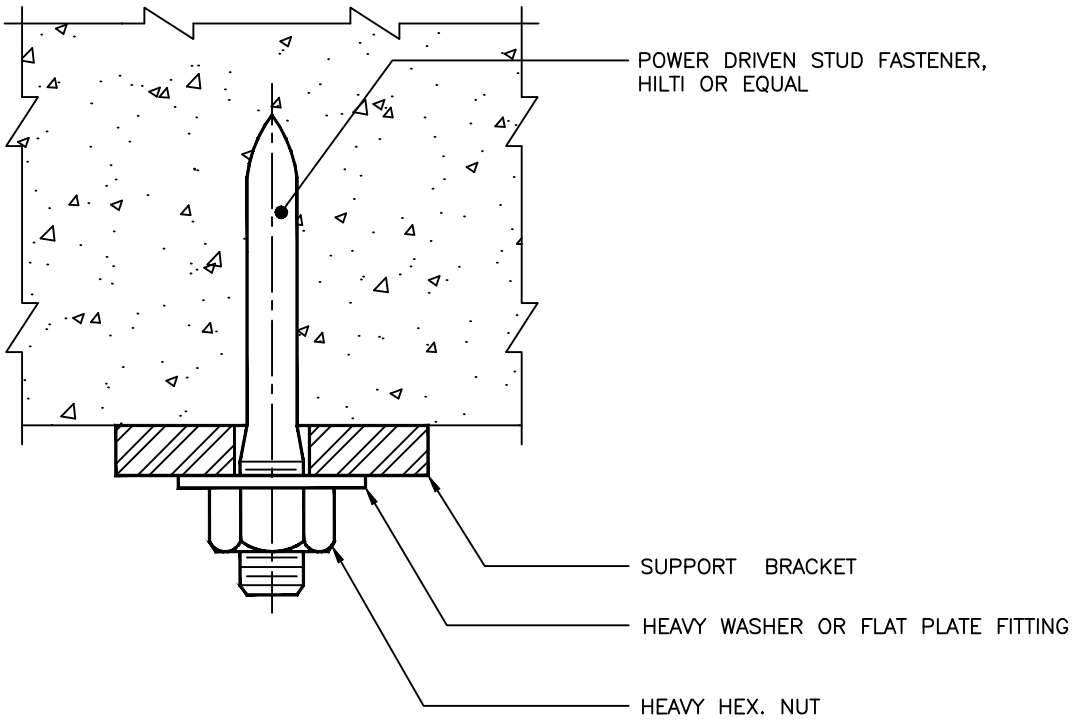
MANITOBA HYDRO

KEEYASK GENERATING STATION

EXPOSED PIPING STANDARDS

STANDARD MECHANICAL DETAILS
STUD ANCHOR

STD–15 – STUD FASTENER



ATTACHMENT : TYPE D

ALLOWABLE LOAD (kg)					
FASTENER SIZE	TENSILE	SHEAR	TORQUE NOM. N–m	SPACING mm	EDGE DIST. mm
W6–20–32	40	50	3.5	75	50
W10–30–42	100	125	7.7	75	50

BASED ON 21 kPa (3000 PSI) CONCRETE
SAFETY FACTOR = 10 FOR TENSILE, FOR NON REVERSING VIBRATORY LOADS
SAFETY FACTOR = 4 FOR SHEAR

NO.	DATE	BY	CKD	APP	
REVISIONS					
DWG. NO. STD–15					
DRAWN	CHECKED	APPROVED			
DATE	SHEET	REV			
	1 OF 1	00			

HATCH

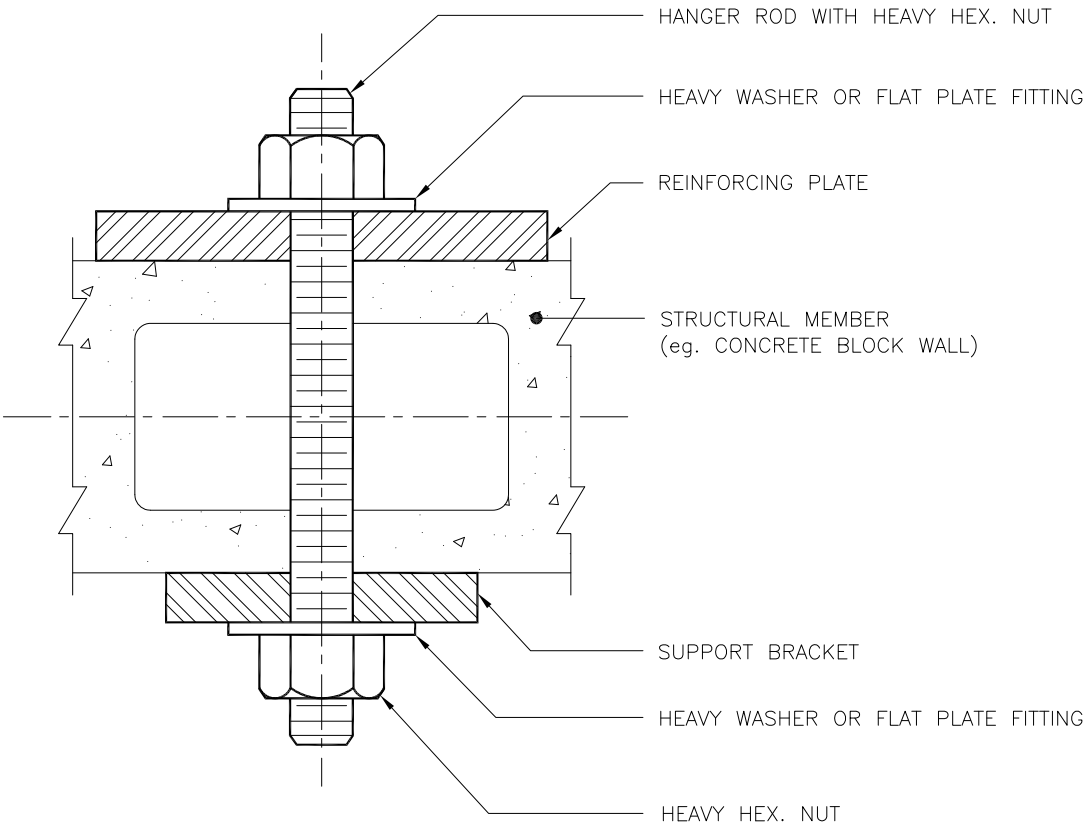
MANITOBA HYDRO

KEEYASK GENERATING STATION

EXPOSED PIPING STANDARDS

STANDARD MECHANICAL DETAILS
STUD FASTENER

STD–16 – SUPPORT FROM CONCRETE BLOCK WALL



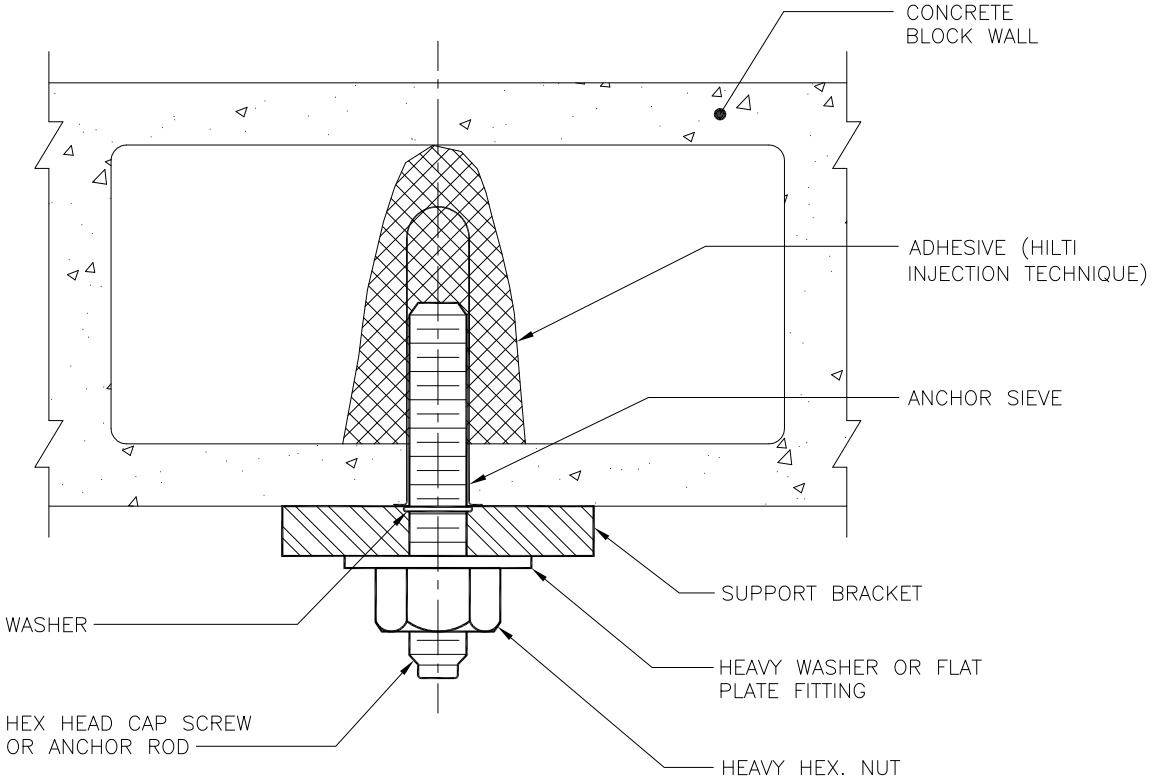
ATTACHMENT : TYPE E

ALLOWABLE LOAD (kg)	
ROD SIZE	BEARING
M10	70
M12	95
M16	120
M20	145
M22	170
M24	195
M30	245

BASED ON CONCRETE BLOCK WITH BEARING STRESS OF 15 MPa.

HATCH	MANITOBA HYDRO				
	KEEYASK GENERATING STATION				
	EXPOSED PIPING STANDARDS	NO.	DATE	BY	CKD	APP
		REVISIONS				
		DWG. NO. STD–16			
	STANDARD MECHANICAL DETAILS SUPPORT FROM CONCRETE BLOCK WALL	DRAWN	CHECKED	APPROVED	
		DATE	SHEET	REV	
			1 OF 1	00	

STD–17 – HOLLOW BLOCK WALL SUPPORT



ATTACHMENT : TYPE F

ALLOWABLE LOAD (KG)	
ROD SIZE	BEARING
10mm	70
12mm	95

BASED ON CONCRETE BLOCK WITH BEARING STRESS OF 15MPa (2175 PSI).

NO.	DATE	BY	CKD	APP	
REVISIONS					
DWG. NO. STD–17					
DRAWN	CHECKED	APPROVED			
DATE	SHEET	REV			
	1 OF 1	00			

HATCH

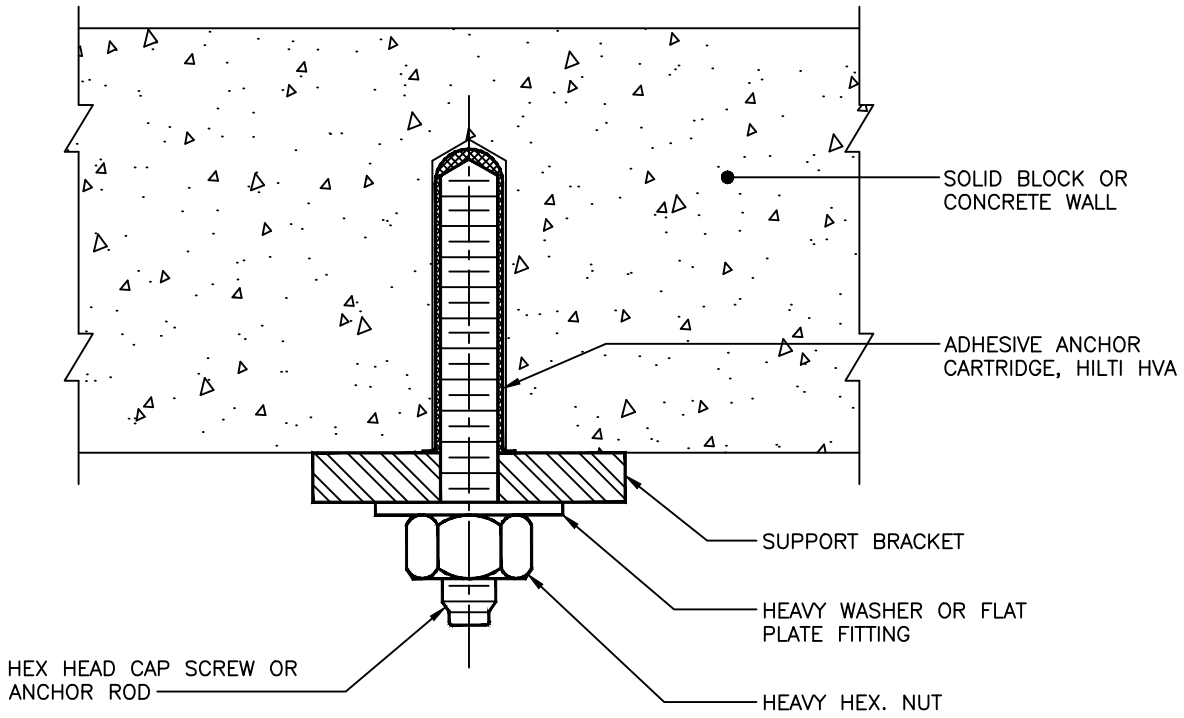
MANITOBA HYDRO

KEEYASK GENERATING STATION

EXPOSED PIPING STANDARDS

STANDARD MECHANICAL DETAILS
HOLLOW BLOCK WALL

STD–18 – SOLID WALL ADHESIVE



ATTACHMENT : TYPE C

ALLOWABLE LOAD (kg)					
BOLT SIZE	TENSILE	SHEAR	TORQUE NOM. N–m	SPACING mm	EDGE DIST. mm
M10	150	150	24	135	135
M12	250	250	40	165	165
M16	500	400	100	190	190
M20	950	700	200	255	255
M22	1400	1000	235	255	255

BASED ON 21 kPa (3000 PSI) CONCRETE
SAFETY FACTOR = 10 FOR TENSILE, FOR NON REVERSING VIBRATORY LOADS
SAFETY FACTOR = 4 FOR SHEAR

NO.	DATE	BY	CKD	APP	
REVISIONS					
DWG. NO. STD–18					
DRAWN	CHECKED	APPROVED			
DATE	SHEET	REV			
	1 OF 1	00			

HATCH

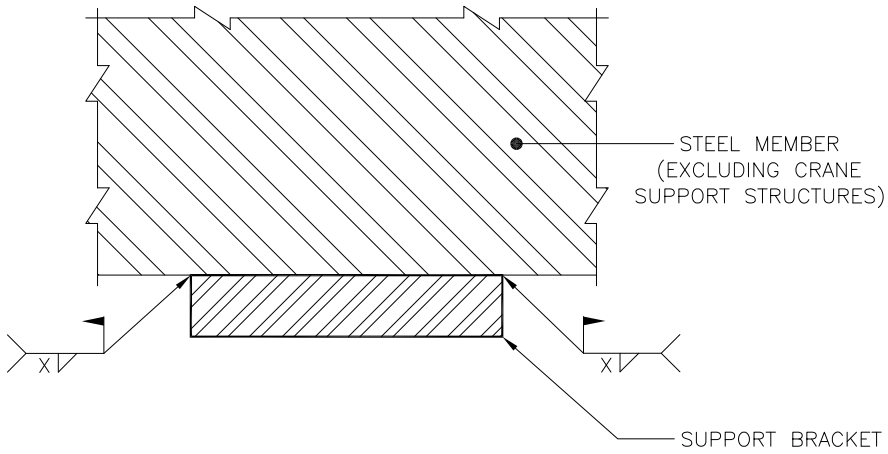
MANITOBA HYDRO

KEEYASK GENERATING STATION

EXPOSED PIPING STANDARDS

STANDARD MECHANICAL DETAILS
SOLID WALL ADHESIVE

STD–19 – WELDED ATTACHMENT



ATTACHMENT : TYPE H

ALLOWABLE LOAD (kg/mm)		
WELD SIZE (X)	TENSILE	SHEAR
4	14	10
6	20	15
8	25	20
10	35	25

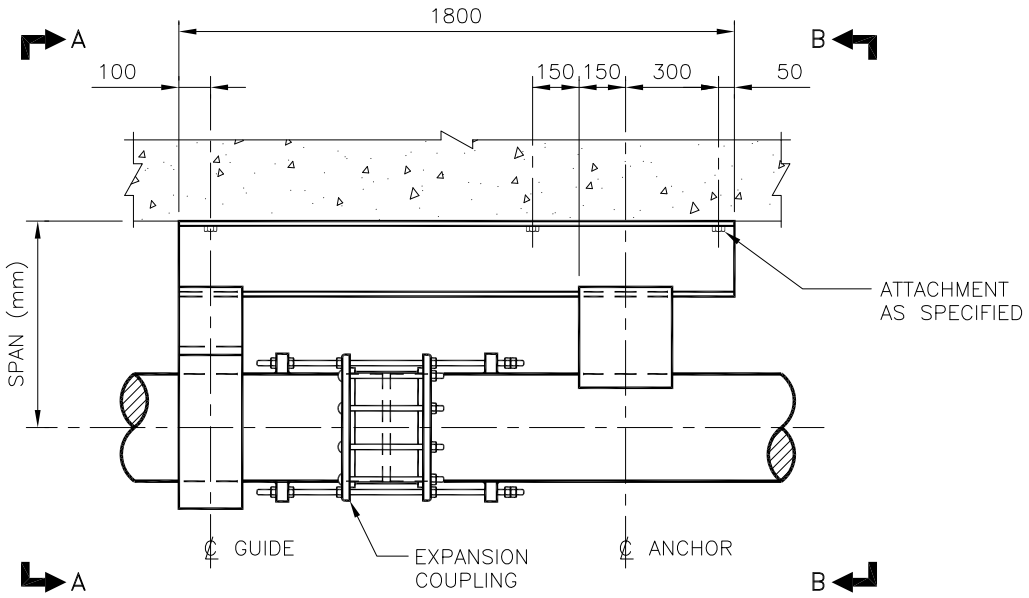
NOTE:

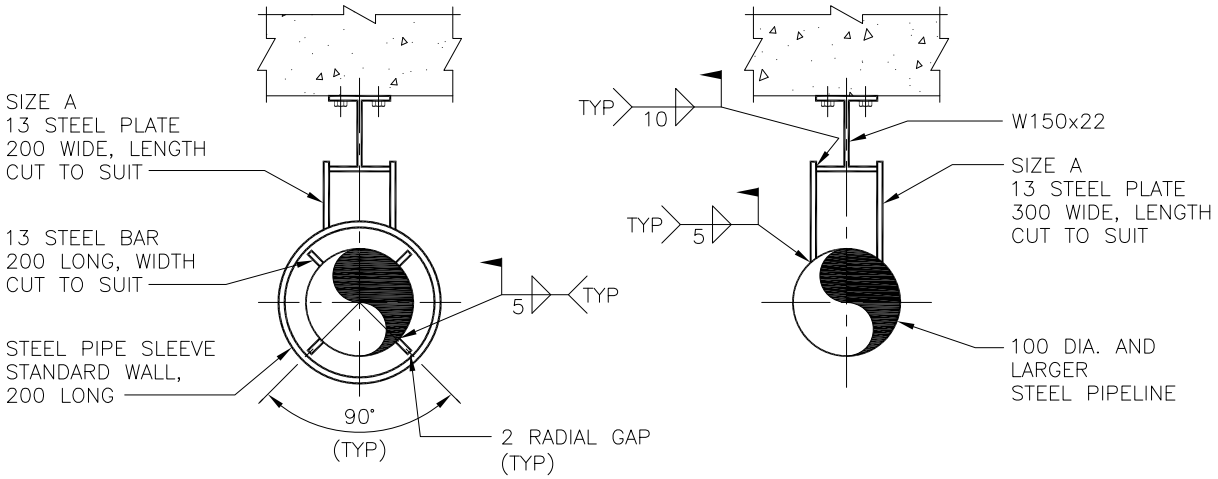
1. MAXIMUM WELD SIZE – BRACKET THICKNESS MINUS 2 mm
2. BASED ON ALLOWABLE TENSILE OF 65 MPa (9500 PSI).

HATCH	MANITOBA HYDRO				
	KEEYASK GENERATING STATION				
	EXPOSED PIPING STANDARDS	NO.	DATE	BY	CKD	APP
		REVISIONS				
		DWG. NO. STD–19				
	STANDARD MECHANICAL DETAILS WELDED ATTACHMENT	DRAWN	CHECKED	APPROVED		
		DATE	SHEET	REV		
			1 OF 1	00		

STD–20 – PIPE EXPANSION JOINT SUPPORT

S6





GUIDE
ELEVATION A–A

ANCHOR
ELEVATION B–B

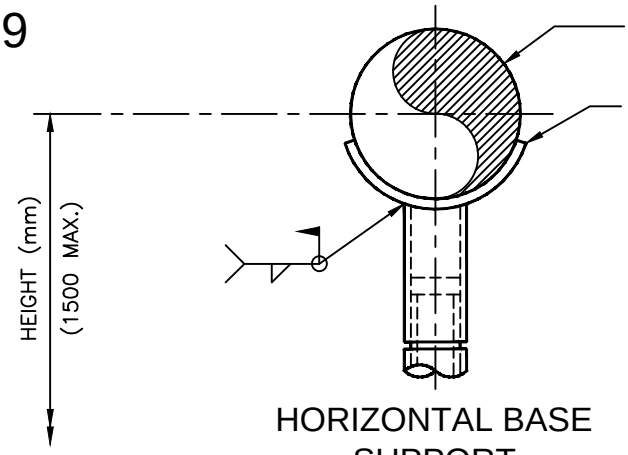
NOTES:

1. ALL DIMENSIONS IN MILLIMETERS UNLESS OTHERWISE NOTED.
2. NOMINAL PIPE SLEEVE SIZE SHALL BE 150mm LARGER THAN NOMINAL PIPE LINE SIZE.

HATCH	MANITOBA HYDRO				
	KEEYASK GENERATING STATION				
	EXPOSED PIPING STANDARDS	NO.	DATE	BY	CKD	APP
		REVISIONS				
	STANDARD MECHANICAL DETAILS PIPE EXPANSION JOINT SUPPORT	DWG. NO. STD–20			
		DRAWN	CHECKED	APPROVED	
		DATE	SHEET	REV	
			1 OF 1	00	

S9

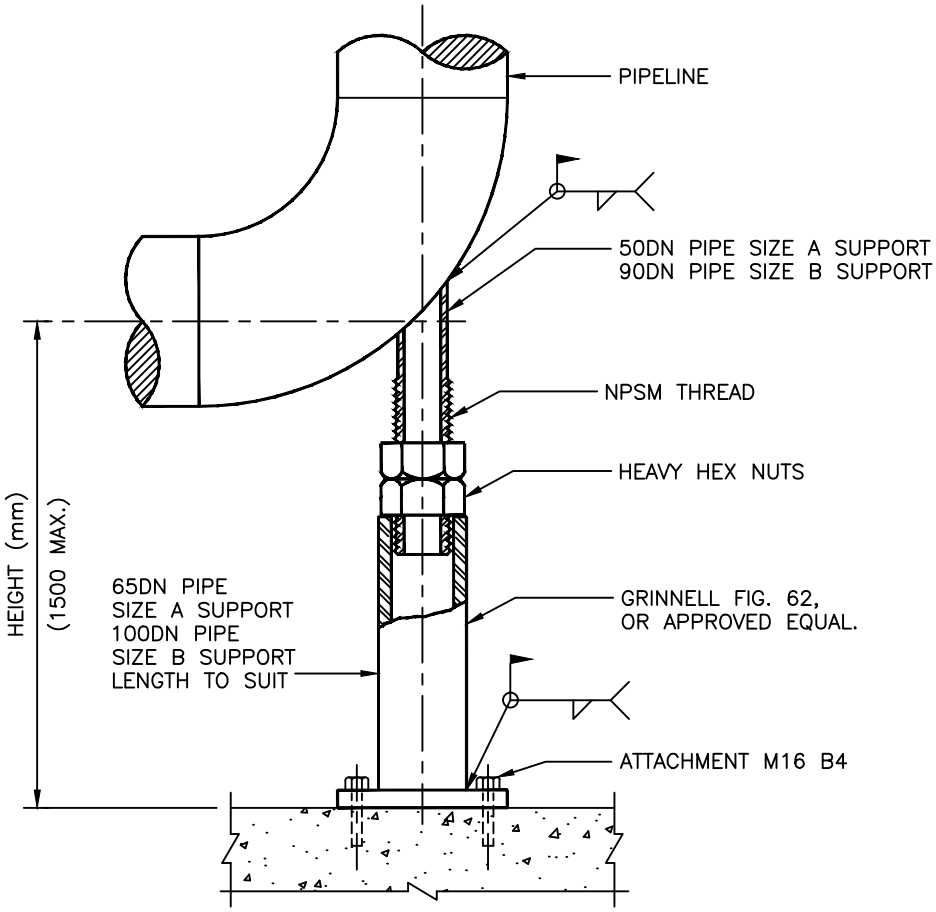
STD–21 – ADJUSTABLE BASE SUPPORT



HORIZONTAL BASE SUPPORT

NOTES:

1. SUPPORT SIZE A IS FOR PIPELINES 150mm AND SMALLER, SUPPORT SIZE B IS FOR PIPELINES 200mm TO 400mm
2. USE FOR VERTICAL SUPPORT ONLY, WHERE LATERAL FORCES ARE PRESENT USE FABRICATED SUPPORT.



ELBOW BASE SUPPORT

HATCH	MANITOBA HYDRO					
	KEEYASK GENERATING STATION					
	EXPOSED PIPING STANDARDS	NO.	DATE	BY	CKD	APP
	STANDARD MECHANICAL DETAILS ADJUSTABLE BASE SUPPORT	REVISIONS				
		DWG. NO. STD–21				
		DRAWN	CHECKED		APPROVED	
		DATE	SHEET		REV	
			1 OF 1		00	

Part 1 General

1.1 SECTION INCLUDES

.1 This Section includes the common general requirements for the Mechanical and Piping systems for the following aspects of the Work:

- .1 Piping and Fittings (both exposed and embedded).
- .2 Pipe Supports, Guides, Hangers and Anchors.
- .3 Mechanical Equipment (including but not limited to: pumps, compressors, strainers, filters, tanks).
- .4 Pressure Testing.
- .5 Flushing and Cleaning.
- .6 Marking.
- .7 Pre-Commissioning.
- .8 Commissioning.

.2 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as determined by the Engineer and as specified herein, including but not limited to the following:

- .1 Pipe Supports, Guides, Hangers and Anchors.

.3 Refer to Purchaser’s Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 07 91 26 - Joint Fillers.

.3 Section 07 92 26 - Joint Sealants.

.4 Section 09 90 00 - Painting and Coating.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

- .1 ANSI Standard B18.2.3.1M.
- .2 ASME B31.1 - Power Piping.
- .3 ASME Boiler and Pressure Vessel Code, Section IX - Welding and Brazing Qualifications.
- .4 CSA B51 - Boilers, Pressure Vessels and Pressure Piping.
- .5 CSA B97.1 - Standard Tolerances for Linear Dimensions, Inch and Metric.
- .6 CSA B97.2 - Interpretation of Limits and Tolerances.

.7 CSA B97.3 - Standard Fits for Mating Parts.

.8 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.9 Manitoba Plumbing Code.

.10 MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection and Installation.

.11 MSS SP-69 - Pipe Hangers and Supports - Selection and Application.

.12 National Plumbing Code of Canada.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 of the General Specification.

.2 Measurement

.1 No separate measurement will be made for the following Items:

.1 40 05 00 (a) - Pipe hangers and supports.

.2 40 05 00 (b) - Fire stops.

.3 Unit Price

.1 The Contractor shall include costs for piping, fittings, valves, equipment, pressure testing, flushing and cleaning, marking, and pre-commissioning associated with a particular system in the Initial Target Price referenced in the Section of the Technical Specification for the associated system.

.2 The Estimated Cost in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for Item 40 05 00 (a) shall be for supply, transporting, unloading, handling, storage, and installation of the Items as specified herein. The supply and installation of anchors are considered incidental to this Work and no separate measurement or payment shall be made. Include the costs for these Items in the Estimated Cost for Item 40 05 00 (a).

.3 The Estimated Cost in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for Item 40 05 00 (b) shall be for supply, transporting, unloading, handling, storage, and installation of the Items as specified herein. The supply and installation of all plates, anchors and associated materials are considered incidental to this Work and no separate measurement or payment shall be made. Include the costs for these Items in the Estimated Cost for Item 40 05 00 (b).

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Prepare an Installation and Test Plan (ITP) for this Work. The ITP shall be reviewed by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification prior to commencement of the Work.

.3 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including material test reports, product data, shop drawings, installation manual including ITPs, testing procedures, flushing procedures, pre-commissioning procedures and operating and maintenance manuals.

.4 Submit testing and pre-commissioning procedures, for all systems, to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification at least 2 months prior to testing/pre-commissioning.

.5 Welding procedure specifications shall be submitted to the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification for review before any welding work is commenced.

.6 Shop and field test results for all systems shall be submitted to the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, including but not limited to: equipment and system performance tests, pressure tests, non-destructive examinations, start-up and pre-commissioning tests.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All pressure containing/retaining components, including pipe fittings, valves, expansion joints, flexible connectors, filters, strainers, measuring devices, capacity rated pressure relief devices, pressure vessels, etc, must be registered through the authorized inspection for Manitoba and shall receive a Canadian Registration Number as set out in the CSA B51 code.

.4 Obtain a registration number for each piping system from the Inspection and Technical Services Manitoba in the Office of the Fire Commissioner. Systems that are vented to atmosphere are exempt from registration, unless they are designed to be able to hold a specific pressure. In that case a registration number should be obtained for the system even if it is vented to atmosphere.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with Section 25 Warranty of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Piping, fittings, flanges and valves shall be as indicated on the Purchaser's Drawings (i.e., included in the piping line numbers) and as specified in the applicable Pipe Class Material Specifications in this section.

.2 Insulation shall comply with the specifications listed in Section 40 42 00 Piping Insulation of the Technical Specification.

.3 Paint shall comply with the specifications listed in Section 09 90 00 Painting and Coating of the Technical Specification.

.4 Firestop material

.1 All firestops to be rated for a minimum of 2 hours and shall provide the same fire resistance rating of the element being penetrated.

.2 Firestops that contain mineral wool or intumescent fire stop sealants are not acceptable.

.3 Use joint filler and/or joint sealant as per Sections 07 91 26 Joint Fillers and 07 92 00 Joint Sealants of the Technical Specification respectively.

.5 No materials patching, plugging, shimming or other such means to overcome defects, discrepancies or errors shall be employed without the prior written approval of the Engineer. Failure to comply with this requirement shall constitute grounds for rejection of the Item in question.

.6 Similar equipment parts shall be made to tolerance where possible, to ensure that such parts are interchangeable one with the other, including all normally supplied spare parts. At a minimum, this Work shall be carried out in accordance with CSA Standards B97.1, Standard Tolerances for Linear Dimensions, Inch and Metric; B97.2, Interpretation of Limits and Tolerances; and B97.3, Standard Fits for Mating Parts.

.7 Screws, bolts, studs, nuts and other fasteners should preferably be of Canadian Standard with Canadian Unified Standard Thread form in accordance with ANSI Standard B18.2.3.1M, and shall be galvanized.

.8 Provide one spare set of seals for each pump and valve included in supply.

.9 All mechanical equipment shall be provided with lifting lugs as required for general handling.

.10 Pipe hangers and supports:

.1 Contractor shall fabricate piping hangers and supports as per the standard support details listed in Appendix A attached to this Section of the Technical Specification, STD-05 to STD-21.

Part 3 Execution

3.1 INSTALLERS

.1 Use only licensed plumbers, pipefitters and welders to perform fabrication and installation of the piping.

.2 Welders to be qualified under ASME Section IX to perform welding on pressurized piping systems.

3.2 EXAMINATION

.1 Carry out all non-destructive examination as per the ITP and applicable code requirements.

3.3 PREPARATION

.1 Prior to fabrication, assembly, or erection of any Items, verify field measurements required for completion of this Work including actual sizes, locations, and details of equipment connections, embedded piping, and embedded sleeves and location of connection points.

.2 Obtain approval of the Work from the authorities having jurisdiction where such approval is required, including registration of systems with the Inspection and Technical Services Manitoba in the Office of the Fire Commissioner.

3.4 INSTALLATION

.1 Fabricate and erect piping as shown on the Purchaser's Drawings. All pipes shall be cut accurately to measurements taken at Site, installed without springing or forcing. All changes in direction of pipe shall be made with manufactured fittings.

.2 Piping 65 mm (2-1/2 in.) nominal diameter and larger may be fabricated prior to shipment to Site at the discretion and risk of the Contractor. Ensure that piping is installed to meet the Contract Schedule . Prior to any fabrication, field check all available terminal points and the proposed route. Any discrepancies between various drawings and/or drawings and as-built terminal points shall be brought to the attention of the Engineer prior to any fabrication. Prefabricated piping must have allowances in all directions for field adjustments to accommodate erection tolerances of equipment, plant and building materials.

.3 Sufficient unions and/or flanged connections shall be installed to permit convenient removal of equipment, valves, and specialty components.

.4 Valves and specialty components shall be installed in accordance with the manufacturer’s recommendations.

.5 In liquid service where dissimilar metals, including stainless steel and carbon steel materials are joined together, insulated connectors shall be used to prevent electrolytic corrosion. Ensure that any other attachments to the piping, such as common pipe supports, do not short circuit the insulation.

.6 Valve working parts shall be removed during installation to prevent damage from heat where brazing, soldering or welding is used.

.7 All elbows shall be long radius, unless otherwise noted.

.8 Install drain valves with hose thread outlet at hot water tanks and in mains where shown and/or necessary for complete drainage.

.9 Install drain valves at low points in piping systems. Install vent valves at high points in piping systems.

.10 Welded Carbon Steel and Stainless Steel Joints

.1 Welding of the steel pipe joints shall conform to the requirements of ANSI Standards B31.1 and the ASME Boiler and Pressure Vessel Code, Section IX, except where these standards conflict with provincial or local regulations. All operators shall hold current Manitoba Pressure Welder certificates and shall have performed similar work within the past 3 months.

.2 Pipe ends shall be bevelled by machine, unless otherwise authorized by the Engineer. Butt-welded joints shall be done without the use of backing rings. The root opening and joint preparation of butt-welded joints shall be conducive to good welding procedure and good weld quality. Excessive penetration or "grapes" will not be permitted. The ends of the pipes at the root of butt-welded joints shall not be closer than 1.5 mm nor more distant than 6 mm. Welded branch connections to any pipe shall be made such that the joint is clear and smooth inside with no intrusion of the branch pipe into the main pipe.

.11 Flanged Pipe Joints

.1 Forged steel flanges and fittings with raised faces shall be matched with flanges of equal rating with raised faces. Flat faced flanges shall be matched with flat faced flanges of equal rating. Flat faced flanged joints shall have full-face gaskets and raised faced flanged joints shall have ring type gaskets.

.2 When galvanic corrosion is possible between two dissimilar materials that are flanged together, the mating surfaces shall be insulated from each other. Where required the flanged joints shall be furnished with insulating washers under the bolt heads through the bolt holes and non-conducting gaskets (laminated Micarta, Nema Gr. 4 or the Purchaser's approved equivalent) between the flange faces.

.3 All flanges shall be installed with the bolt holes straddling the vertical center lines, or center lines normal to walls for vertical pipes, unless otherwise specified. Bolts shall be tightened using the crossover method and the correct torques.

.12 Threaded Pipe Joints

.1 Threaded pipe connections shall conform to ANSI B2.1 for taper pipe threads. All threads shall be cut with clean, sharp dies, accurately set. Threads damaged during handling and storage shall be run over with dies before installation. Pipe ends shall be reamed after threading to remove burrs. The start of each thread shall be chamfered for ease of assembling.

.2 Threads shall be solvent cleaned and wiped dry to remove oil and grease which would prevent adherence of the thread seal.

.3 Acceptable thread sealants are Masters Metallic Compound, and Loctite 592. Teflon ribbon tape is NOT permitted on any system, unless it is required by the equipment manufacturer to maintain warranty.

.13 Tubing

.1 Teflon tape shall not be used when connecting instruments, tubing or pipe fittings, pipe nipples, unions, valves and other fittings.

.2 Tube cutting shall be in the manner shown in the Swagelok Tube Fitter's Manual. Swagelok tube cutter or equivalent tube cutter with sharp cutter wheel shall be used for all cutting.

.3 All tube bends shall be made with the use of proper bending tools. Bending tools, pins and clips shall be kept oiled to ensure smooth bends. The proper bender for each size of tubing shall be used.

.4 Welding or cutting flames shall not be used close to the instruments impulse tubing. Mounting holes in the instruments shall not be enlarged and any damage to paint or other finish of the instruments shall be repaired by the Contractor.

.5 If tubing is straightened by stretching, care shall be taken such that the diameter is not reduced to the extent that a poor seal at the compression fitting results.

.6 Swagelok four-piece compression type tube fittings shall be used on all instrument and control tubing.

.14 Victaulic Pipe Joints

.1 Victaulic pipe joints shall be installed only after pipe ends are properly prepared. Grooved ends of pipes shall be clean, and where necessary all dents, scores or burrs shall be removed. Pipe ends and the lips and backs of the gaskets shall be lubricated with cup grease or graphite paste. For pipes over 10 in. in diameter, gaskets shall be turned inside out, and rolled back into seating position. Assembly in accordance with manufacturer's manual is required.

.15 Brazed Joints

.1 Brazing shall be used for joining threadless copper fittings to copper tube for piezometer piping only.

.2 The qualification of brazers and brazing operators shall be in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Part C, Section IX.

.16 Soldered Joints

.1 Joints in copper drainage and water tube shall be in strict accordance with manufacturer's published recommendations and Manitoba Plumbing Code.

.17 Valves

.1 Valves shall be installed as detailed on the Purchaser's Drawings and with their pressure ratings visible. Screwed hexagon valves shall be installed using a smooth, square-jawed wrench on the hexagon and nearest the joint. Globe valves shall be installed with pressure under the disc, unless otherwise specified on the Purchaser's Drawings. Unless otherwise detailed, all safety and relief valves shall be installed in a vertical position.

.18 Expansion Joints - Exposed Piping

.1 Install Expansion Joints on all piping passing across any Powerhouse contraction joint. Refer to Appendix A attached to this Section of the Technical Specification, STD-02 for details.

.2 Where expansion joints are installed, support the piping as shown in Appendix A attached to this Section of the Technical Specification, STD-20.

.19 Tolerances

.1 Tolerances on linear dimensions shall be as required herein and shall apply to all end to end, end to face, face to face, centre to end, centre to face and centre to centre dimensions. Tolerances shall not be cumulative.

DN (NPS)	Tolerances
25 – 250 mm (1 - 10 in.)	+/- 3 mm (0.118 in.)
300 mm (12 in.) and greater	+/-4.5 mm (0.177 in.)

.2 Flanges and other attachments shall be square with the axis and shall not deviate from the square position by more than 0.75 mm (0.029 in.) up to 300 mm DN (12 in. NPS), or by more than 1.5 mm (0.059 in.) for pipe size above 300 mm DN (12 in.)

.3 Bolt holes on flanges shall be aligned within +/- 1.5 mm (0.059 in.) of the required position.

.4 To achieve accurate pipe alignment, each pipe piece shall be checked for position and any discrepancies shall be corrected by adjustment of the adjoining pipe piece before it is erected. All variations in the erected piping system in excess of the above tolerances shall be reported to the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification for review and acceptance of remedial measures.

.20 Structural Welding

.1 All structural welding shall conform to the requirements of CSA W59 Welded Steel Construction.

.21 Pipe Hangers and Supports

.1 All supports shall be installed in accordance with ASME B31.1. In areas where support information is not shown on the Purchaser's Drawings, the Contractor shall supply and install hangers, supports and anchors in accordance with the following requirements.

.2 Except as shown otherwise on the Purchaser's Drawings, horizontal pipe runs 50 mm DN (2 in. NPS) and smaller shall be supported at intervals not exceeding 2.0 m (79 in.), and 65 mm DN (2-1/2 in. NPS) and larger shall be supported at intervals not exceeding 3.0 m (118 in.).

.3 Vertical piping shall be supported at the base of the riser, at the head of the riser and at intervals not exceeding 3.0 m (118 in.) except as otherwise shown on the Purchaser's Drawings.

.4 Groups of horizontal pipes shall be supported on trapeze type hangers or as specified on the Purchaser's Drawings. Wherever possible, hangers and supports shall be located within 300 mm (11.8 in.) of changes of direction in the pipe, and concentrated heavy loads in the system.

.5 Piping shall be supported to elevation and according to pipe support and expansion anchor bolt installation details as shown on the Purchaser's Drawings. (Note: these Purchaser's Drawings will need to be prepared during the Phase I detailed design phase).

Supports shall be located accurately both horizontally and vertically. Expansion anchors where indicated for hanger rods or bolts shall be to correct depth to prevent pullout. Copper pipe or tubing shall be wrapped with neoprene tape at supports, to prevent electrolysis.

.22 Pipeline Slopes

.1 Horizontal pipe lines shall be installed using the following grade line minimum slope standards, unless otherwise specified on the Purchaser's Drawings. All piping systems shall be arranged to be self-draining.

.1 Plumbing, Drainage and Sewage - the pipe slopes shall be as required by the regulations.

.2 Water and Oil Service - 1 in 200.

.3 Air Service - 1 in 200.

.23 Embedded Piping

.1 Unless noted otherwise, all requirements of this Section Mechanical & Piping General Requirements of the Technical Specification shall also apply to embedded piping and fittings. The requirements listed below apply specifically to embedded piping and fittings.

.2 Embedded piping running across any Powerhouse Complex contraction joint shall have expansion couplings installed as per details in the Purchaser's Drawings. Prior to concreting, the region around the coupling shall be covered with closed cell foam joint filler to the depth indicated on the drawing. Provision shall be made for expansion and contraction of the pipe during the installation of the embedded flexible coupling.

.3 For interface piping (a transition from embedded to exposed piping), install pipe as per details on the Purchaser's Drawings. Details indicate a pipe check. Pipe checks are optional and may be used at any location to simplify formwork construction.

.4 Screened pipe openings shall be installed as per details in the Purchaser's Drawings.

.5 Cleanout fittings shall be installed as per details in the Purchaser's Drawings. Cleanout shall be heavy duty, non-adjustable tuf-top, dura coated cast iron body, with gas tight ABS plug, round secured cover and frame, Neo-Lok type outlet, Zurn Model Z-1402-HD-NL or Purchaser's approved equivalent.

.6 Piezometer plates shall be installed as per details in the Purchaser's Drawings.

.7 Frame openings shall be installed as per details in the Purchaser's Drawings.

.8 Duct transitions on frame openings shall be installed as per details in the Purchaser's Drawings.

.9 Termination points of embedded pipes shall be protected either by flanges or by plates welded to the pipe. The Contractor shall be responsible for removing these closures. Removal shall be delayed until necessary for connection to exposed piping, in order to maintain the cleanliness of the embedded pipe.

.24 Embedded Pipe Supports

.1 Supports for embedded pipe shall be made of material which will not deteriorate, weaken or cause damage to the concrete and the pipe. All methods for supporting shall be subject to the review and authorization of the Engineer. All lugs, brackets and other supports welded directly to the pipes shall be of materials compatible with the material of the pipe.

.2 In general, embedded horizontal pipe runs 50 mm DN (2 in. NPS) and smaller shall be supported at intervals not exceeding 2 m (79 in.). Piping 65 mm to 250 mm DN (2-1/2 in. to 10 in. NPS) shall be supported at intervals not

exceeding 3 m (118 in.). Piping 300 mm DN (12 in. NPS) and over shall be supported at intervals not exceeding 5 m (197 in.), except as otherwise shown on the Purchaser's Drawings.

.3 Embedded vertical piping shall be supported at the base of the riser, at the head of the riser, and at intervals not exceeding 2 m (79 in.), except as otherwise shown on the Purchaser's Drawings.

.25 Protective Coating

.1 Coating requirements for mechanical and piping are specified in Section 09 90 00 Painting and Coating of the Technical Specification.

.26 Insulation

.1 Insulation requirements for mechanical and piping are specified in Section 40 42 00 Piping Insulation of the Technical Specification.

.27 Firestops

.1 The Contractor shall supply and install firestops at all firewalls and fire partitions.

.2 Install firestops in accordance with manufacturer’s installation manual.

.3 Firestops shall provide the same fire resistance rating of the element being penetrated.

.28 If at any time the Contractor receives written manufacturer’s installation or operating instructions for equipment, the Contractor shall comply with such instructions, and shall immediately submit all copies of such instructions to the Engineer.

.29 Installation of Equipment

.1 Check and, if necessary, adjust the factory alignment, after installation, for all machinery consisting of more than one unit connected by a coupling. The coupling shall be left open until the Engineer has inspected the alignment.

.2 Floor-mounted equipment shall be installed in accordance with the supplier’s literature. The Contractor shall design, detail and fabricate bases, stands or supports which are not shown in detail on the Purchaser's Drawings. Equipment base or top of grout shall be to the elevations shown. Shims shall be used at each anchor bolt for levelling. The Contractor shall ensure that the shims are properly deburred and that the bottom shims are resting flat on the top of the foundation. If wedges are used to raise the machinery, such wedges shall be removed before the anchor bolts are tightened. Anchor bolts shall be fully tightened to the correct tension before grouting may proceed.

.3 Under no circumstance shall machinery be started before the approval of the Engineer has been obtained. No machinery shall be allowed to operate, even for a short test run, until it has been properly lubricated and until belt guards, coupling shields, guardrails and other safety devices have been installed.

.4 Design, detail and fabricate stands or brackets required for installation of wall-mounted equipment, where not shown in detail on the Purchaser's Drawings. Brackets to be mounted on concrete walls shall be suitably anchored with Hilti HSL anchor bolts or other methods authorized by the Engineer. Brackets mounted on insulated concrete walls shall be anchored with Hilti HSL anchors with spacer tubes or other methods authorized by the Engineer.

3.5 SITE QUALITY CONTROL

.1 Quality Control Inspectors

.1 Provide certified quality control inspectors with proven industrial construction, fabrication and maintenance experience.

.2 Inspectors shall carry out inspections during the construction and fabrication of facilities and products covered by Section 7.13 Project Quality Management of the General Specification.

.3 Inspections include, but are not limited to the following: witnessing welder testing, materials receiving and handling.

.2 Initial Cleaning

.1 After fabrication and before installation, all loose scale and foreign materials shall be removed from the inside of each pipe piece by means of a mechanical device such as an air driven centrifugal rotary cleaner or by air blowing, depending upon the pipe size.

.2 Open ends of all pipe pieces shall be covered after each cleaning operation to ensure that foreign matter and moisture is excluded.

.3 Pressure Tests

.1 All completed piping systems shall be pressure tested in the presence of the Engineer. The tests shall be in accordance with the applicable ASME Code requirements or the ANSI Code for Pressure Piping B31.1. The test pressure shall be as specified on the Purchaser's Drawings.

.2 The Contractor shall provide the necessary pumping equipment, spool pieces and pressure gauges used for the pressure tests. Permanently installed equipment shall not be used for the tests.

.3 The pressure testing of piping systems shall be performed after the lines have been erected and authorized by the Engineer as being acceptable for testing. A piping system may be tested in sections using suitable blank flanges, pipe caps or closed block valves to protect either equipment or incomplete sections of the piping. Equipment other than piping equipment shall not be subjected to the pressure tests.

.4 Piping shall be pressure tested prior to embedding in concrete.

.5 Embedded heating and ventilating ducts are exempt from pressure testing.

.6 All piping systems shall use filtered water for pressure tests.

.7 Before the piping systems are tested, all pressure relief valves shall be removed and replaced with adequate blank flanges or plugs.

.8 At least 4 hours shall elapse after erection before any line is pressure tested.

.9 In all cases, at least one hour shall elapse after the test pressure has been applied before the joints, valve stem glands, pressure gauges and other components are checked for leaks.

.10 All threaded or flanged joints which leak shall be taken apart, checked, cleaned, re-assembled and retested.

.11 During cold weather, it is important that all lines after being tested with water shall be completely drained to avoid damage due to freezing.

.12 The Contractor shall inform the Engineer of its intention to perform a pressure test at least 24 hours before its commencement. The Contractor shall carry out

repairs and retest until the test is successful. The Contractor shall obtain the Engineer's written acceptance of repair procedures prior to carrying out repairs.

.13 The Purchaser may, at its discretion, carry out such additional tests as may be necessary to determine that every aspect of the Work will perform and operate satisfactorily and efficiently. The Contractor shall assist the Purchaser as required to perform such tests.

.4 Flushing and Final Cleaning

.1 After the piping systems have been installed and successfully pressure tested, but before connection to the pumps or other equipment, check each line thoroughly as indicated below.

.2 Demonstrate by flushing with the appropriate medium as defined below, or by some mechanical device authorized by the Engineer such as an air drive centrifugal rotary cleaner, that the following pipelines are free of obstruction: roof drains, dewatering pump discharge, transformer enclosure drains, sanitary drainage, cooling water lines, fire standpipe lines, drainage pump discharge lines.

.3 The following lines shall be flushed: compressed air lines, shaft seal water lines, domestic water lines, oil handling lines, diesel fuel supply and return lines.

.4 The flushing media shall be water for water lines, diesel fuel for the diesel fuel supply and return lines, dust free air for compressed air lines and clean oil for oil supply and return lines. The Purchaser will supply the oil for flushing. Permanently installed equipment such as the low-pressure compressors and fire pumps may be used for flushing provided the equipment has been adequately commissioned, at the discretion of the Engineer. Any spool pieces required to facilitate flushing shall be provided by the Contractor.

.5 Flushing shall be done using the following, or other approved, procedures:

.1 Fine mesh cloth or screen shall be installed in the pipeline to remove contaminants dislodged by the flushing medium during circulation. The screens shall be frequently inspected and cleaned.

.2 Flushing shall be continued until, in the opinion of Engineer, the required cleanliness is obtained, as determined by the quantity of foreign matter deposited on the filter screens.

.6 Particular attention shall be paid to the cleanliness of the shaft seal water lines, oil handling lines and fuel supply lines.

.7 In service, the oil will be filtered to 5 microns and the flow velocities will be approximately 0.5 m/s. The shaft seal water, in service, will be filtered to 1.5 mm and the flow velocity will be approximately 1 m/s. The Contractor shall flush the lines using at least twice the normal flow velocity and shall achieve at least the cleanliness required for system operation.

3.6 IDENTIFICATION AND MARKING

.1 After installation, painting, and insulating, prepare identification tags for all equipment, valves, instruments and piping systems in accordance with the requirements of Appendix A attached to this Section of the Technical Specification, STD-01.

.2 Tags for valves, instrumentation and control devices shall be made of 19-gauge solid brass, 51 mm (2 in.) round, with black ink. Attach tags to valves using a ball chain.

.3 Equipment nameplates shall be Lamacoid engraved.

.4 The Contractor may, at the Purchaser's option by issuance of an Extra Work Order, be required to identify and mark valves supplied by other contractors.

.5 Identification requirements for HVAC Control Equipment.

.1 Use engraved black and white laminated plastic, 25 mm x 62 mm (1 in.) x (2-1/2 in.), at all thermostats, thermometers, panels, etc, supplied so as to clearly indicate service of particular device. Does not apply to room thermostats. Manual switches, unless they come with standard nameplates, and thermostats, thermometers, switches, etc, installed on local panels to be similarly labelled.

.2 Excluding room thermostats, convector valves, ceiling reheat and radiant panel valves and damper assemblies, provide lamacoid identification plates fastened with rivets or self-tapping screws at all equipment so as to clearly indicate service of particular device. All manual switches, unless they come with standard nameplates, shall be similarly labelled.

.3 Equipment installed on surfaces of local panels shall be similarly labelled. Equipment mounted inside local panels must have permanent plate labels with self-tapping screws. Tape labels are not acceptable.

.4 Identification plates to be white background with minimum 5 mm high black letters, unless specified otherwise.

.5 Information on lamacoid identification plates to be consistent with "as-built" control drawings.

.6 Prior to lamacoid fabrication, submit copies of control drawings and complete list of proposed wording for each lamacoid, for approval by the Purchaser. Include copy of approved lamacoid list in each Operation and Maintenance manual.

3.7 PRE-COMMISSIONING

.1 The Contractor shall give the Engineer 1 week written notice of the date of each testing or pre-commissioning procedure.

.2 Tests and pre-commissioning procedures shall be witnessed and documented by the Contractor and may be witnessed by the Engineer.

.3 Perform all start-up, tests, and pre-commissioning. Provide all devices, materials, supplies, and labour required in connection with the testing and pre-commissioning.

.4 Correct all defects noted during testing and pre-commissioning.

3.8 COMMISSIONING

.1 After the Contractor has completed all testing and pre-commissioning activities and turned over an operational system to the Purchaser, final commissioning will be performed by the Purchaser.

.2 Contractor shall provide commissioning support as requested by the Engineer.

3.9 DEMONSTRATION, OPERATION AND MAINTENANCE

.1 Submit all installation, operation and maintenance manuals to the Purchaser.

.2 Supply all tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operation, control, adjusting, trouble shooting, and servicing of all systems and equipment during regular work hours.

.3 Use operation and maintenance manuals, and as-built drawings as part of the instruction.

.4 Where specified in the Technical Specification, arrange for instruction by the manufacturer's technical representative

.5 Where appropriate, the Purchaser may record these demonstrations for future reference and training.

.6 Provide any special tools required for operation and/or maintenance.

APPENDICES

APPENDIX A – STANDARD MECHANICAL DETAILS

END OF SECTION

Appendix A
Standard Mechanical Details

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, flushing, marking, testing, pre-commissioning and commissioning of the Service Water, Cooling Water and Shaft Seal Water Systems, including but not limited to the following:

.1 Service Water Strainers.

.2 Station Service Water Pumps.

.3 Piping for Station Water, Cooling Water, and Shaft Seal Water Systems.

.2 Refer to Purchaser’s Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 40 42 00 - Piping Insulation.

.5 Section 40 05 00 - Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time this Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ASME B31.1 - Power Piping.

.2 CSA B51 - Boilers, Pressure Vessels and Pressure Piping.

.3 CSA C22.2 No. 14 - Industrial Control Equipment.

.4 NEMA Standard MG1 - Motors and Generators.

.5 NEMA ICS 1- Industrial Control and Systems: General Requirements.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments.

.2 Measurement

.1 Measurement for Equipment Items 40 23 19 (a)i to 40 23 19 (a)ii will be based on the number of Items as shown in the Purchaser's Drawings.

.2 Measurement for the following Piping Items will be based on the length of pipe in metres shown in the Purchaser's Drawings, from fitting to fitting, excluding the fitting(s).

.1 40 23 19 (b)i to 40 23 19 (b)vii - Service Water - Exposed Piping.

.2 40 23 19 (e)i - Shaft Seal - Exposed Piping.

.3 40 23 19 (h)i to (h)ii - Service Water - Embedded Piping.

.3 Measurement for the following Fitting and Valve Items will be based on the number of Items as shown in the Purchaser's Drawings.

.1 40 23 19 (c)i to 40 23 19 (c)xxxi - Station Water - Exposed Fittings.

.2 40 23 19(d)i to 40 23 19 (d)vi - Station Water – Valves.

.3 40 23 19 (f)i to 40 23 19 (f)iii - Shaft Seal Water - Exposed Fittings.

.4 40 23 19 (g)i to 40 23 19 (g)ii - Shaft Seal Water – Valves.

.5 40 23 19 (i)i - Service Water - Embedded Fittings.

.4 No separate measurement will be made for the following Items:

.1 40 23 19 (j) - Insulation.

.2 40 23 19 (k) – Instrumentation.

.3 40 23 19 (l) - Testing, Flushing and Cleaning.

.4 40 23 19 (m) - Pre-commissioning.

.3 Unit Price

.1 The unit prices for Items 40 23 19 (a)i to40 23 19 (a)ii in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein.

.2 The unit prices in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for the following Exposed Piping Items shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein.

.1 40 23 19 (b)i to 40 23 19 (b)vii - Service Water - Exposed Piping.

.2 40 23 19 (c)i to 40 23 19 (c)xxxi - Service Water - Exposed Fittings.

.3 40 23 19 (d)i to 40 23 19 (d)vi - Service Water - Valves.

.4 40 23 19 (e)i Shaft Seal Water - Exposed Piping.

.5 40 23 19 (f)i to 40 23 19 (f)iii - Shaft Seal Water - Exposed Fittings.

.6 40 23 19 (g)i to 40 23 19 (g)ii - Shaft Seal Water – Valves.

.3 The unit prices in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for the following Embedded Piping Items shall be for supply, installation, transporting, unloading, handling, non-destructive testing, examination, pressure testing and flushing of the embedded piping segments to be installed, as specified herein.

.1 40 23 19 (h)i to 40 23 19 (h)ii - Service Water - Embedded Piping.

.2 40 23 19 (i)i - Service Water Embedded Fittings.

.4 The Estimated Cost in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for Insulation Item 40 23 19 Item (j) shall be for supply, installation, transporting, unloading and handling of insulation material as specified herein.

.5 The Estimated Cost in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for Instrumentation Item 40 23 19 (k) shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment manufacturer. Include the costs for manufacturer supplied/installed instrumentation with the Item to which it applies.

.6 The Estimated Cost in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for Testing, Flushing and Cleaning Item 40 23 19 (l) shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system.

.7 The Estimated Cost in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for Pre-Commissioning Item 40 23 19 (m) shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the system(s) as specified herein.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor’s Documents of the General Specification.

.2 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data, shop drawings, installation manuals including installation and test plans, testing procedures, flushing procedures, marking procedures, pre-commissioning procedures and operation and maintenance manuals.

.3 For all pumps, provide shop drawings including pump performance curves showing operating point (capacity/head, efficiency and NPSH) and dimensional drawings of pump and accessories.

.4 Provide list of recommended spare parts.

.5 Submit all test results and reports to the Engineer.

.6 The Contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All fittings require a Canadian Registration Number.

.4 Obtain a registration number for the system from the Province of Manitoba Department of Labour.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site clearly tagged for easy identification.

.3 Materials stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Service Water Strainers

.1 Product Requirements:

.1 Type - motorized automatic self-cleaning type.

.2 Size - 300 mm (12 in.).

.3 Capacity - 164 L/s (2,600 GPM) each.

.4 Rated pressure - 1,000 kPa (145 psi).

.5 Inlet pressure - 1,00 kPa (15 psi) minimum.

.6 Pressure drop - 35 kPa (5 psig); 10 kPa max (1.5 psig) (when clean).

.2 Cast iron inlet and outlet flange connections, 125 lb ANSI flat faced.

.3 Lifting lugs provided on the strainer body, cover, and drive unit.

.4 Provision for bolting the strainer to the floor/pads.

.5 Internal rotating drum equipped with stainless steel straining elements with 1.5 mm perforations.

.6 Backwash operation from flow reversal through the straining elements to NPT inlet and outlet backwash connections.

.7 Backwash activated by either a timer or a pressure differential switch if the pressure drop across the strainer reaches the limit value. This will open motorized ball valves allowing water to flow in and out of the backwash connections and start the motor to rotate the strainer basket.

.8 Valved supply and drain openings.

.9 Connections for inlet and outlet pressure gauges.

.10 Gear reducer, drive motor.

.11 All required instruments and controls.

.12 S.P. Kinney Model AP, or the Purchaser's approved equivalent.

.13 Motor and Drive Assembly:

.1 Flange mounted horizontal regreaseable ball bearing induction motor rated to suit service, totally enclosed fan cooled, for operation on 120 Vac, single-phase, 60 Hz service.

.2 Gear drive coupled to the motor. The combined unit mounted on the strainer. All exposed drive parts adequately shielded, and lubricating fittings readily accessible without removal of drive components or shields.

.14 Instrumentation and Control:

.1 For Instrumentation and Control refer to Section 40 90 25 Instrumentation for Piping Systems of the Technical Specification.

.15 Protective Coating:

.1 Equipment shall be painted green (colour code per Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification) to manufacturer’s factory standard coating system.

.16 Testing:

.1 Shop test the fully assembled strainer and associated equipment to demonstrate that all parts are in satisfactory operating condition.

.2 Station Service Water Pumps: Tag numbers - 5750-PP-1015, 5750-PP-2015, 5750-PP-3015, 5750-PP-4015, 5750-PP-5015, 5750-PP-6015 and 5750-PP-7015.

.1 Requirements:

.1 Capacity - 164 L/s (2,600 USgpm).

.2 Rated Head - 350 kPa(g) (116 ft).

.3 Vertical split case centrifugal pump, flexible-coupled electric motor and accessories.

.4 Aurora Series 413 pump 8 x 10 x 15A 2,600 gpm at 350 kPa (116 psi) max or the Purchaser's approved equivalent.

.2 Pump:

.1 Single Stage Vertical split case centrifugal.

.2 The suction supply to the pump will have a maximum pressure of 150 kPa (22 psi) and a minimum pressure of -21 kPa (-3 psi).

.3 Vertical design.

.4 200 MPa (30,000 psi) Tensile Cast iron casing.

.5 Vacuum Cast Bronze impeller, double suction enclosed type.

.6 1045 Alloy Steel shaft.

.7 Bronze Sleeves keyed to shaft.

.8 125 lbs ANSI flat faced flanges.

.3 Motor:

.1 1750 RPM NEMA motor.

.2 Rated for 575 Vac, 3-phase, 60 Hz service.

.3 Motor speed to not exceed 1750 RPM. The motor to meet the performance and test requirements of NEMA Standard MG1. The motor shall be capable of operating continuously with 15 % overload without injurious stresses or excessive rise in temperature.

.4 Protective Coating:

.1 Equipment shall be painted green (colour code per Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification) to manufacturer’s factory standard coating.

.5 Testing:

.1 Perform hydrostatic and performance test of the pump at the factory.

.6 Noise:

.1 Noise level not exceeding 85 dB(A).

2.2 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc) refer to Purchaser’s Drawings and applicable Pipe Class Material Specification as outlined in Section 40 05 00 Mechanical & Piping General Requirements.

.2 Paint for piping: in accordance with Appendix A of Section 09 90 00 Painting and Coating. Paint colour shall be green, per colour code indicated in Appendix A of Section 09 90 00.

.3 Insulation: refer to Section 40 42 00 Piping Insulation of the Technical Specification.

.4 Refer to Part 2 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification for additional material requirements.

Part 3 Execution

3.1 GENERAL

.1 General execution of this Work, including but not limited to fabrication, installation, examination, preparation, cleaning, testing, flushing, marking, pre-commissioning, commissioning and site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification, in addition to any specific requirements indicated below.

3.2 PREPARATION

.1 Contractor shall field verify all dimensions and details and report any discrepancies.

.2 Supply all materials which are also not specified in material take-offs, and are required to safely and effectively complete this scope of Work.

3.3 INSTALLATION

.1 Paint all pipe, fittings, and valves in accordance with Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification.

.2 Pumps and all equipment shall be installed in accordance with the Purchaser's Drawings, manufacturers' instruction/drawing and in accordance with the Technical Specifications.

.3 Piping installed adjacent to pumps shall be located to allow for the required service clearances.

.4 Water and drain piping shall be installed with downward slope in direction of flow.

.5 Insulation is required on the following (refer to Section 40 42 00 Piping Insulation of the Technical Specification for insulation specifications).

.1 Raw water exposed piping up to and including raw water strainers.

.2 Station service water lines from raw water strainers to pump rooms.

.3 Cooling water lines up to generator enclosure wall.

.4 Shaft seal water lines up to generator enclosure wall.

.6 Electrical and control equipment shall be installed in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, testing, flushing, marking, pre-commissioning, and commissioning of the Dewatering and Filling System, including but not limited to the following:

.1 Dewatering sump pumps, including controllers and level transmitters.

.2 Dewatering and filling system piping, fittings, valves, supports, paint and insulation.

.2 Refer to the Purchaser’s Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 40 05 00 - Mechanical and Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ASME B31.1 - Power Piping.

.2 CSA B51 - Boilers, Pressure Vessels and Pressure Piping.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding

unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments

.2 Measurement

.1 Measurement for Equipment Item 40 23 21 (a)i will be based on the number of Items as shown in the Purchaser's Drawings.

.2 Measurement for the following Piping Items will be based on the length of pipe in metres shown in the Purchaser's Drawings, from fitting to fitting, excluding the fitting(s).

.1 40 23 21 (b)i to 40 23 21 (b)ii - Exposed Piping.

.2 40 23 21 (e)i to 40 23 21 (e)v - Embedded Piping.

.3 Measurement for the following Fitting and Valve Items will be based on the number of Items as shown in the Purchaser's Drawings.

.1 40 23 21 (c)i to 40 23 21 (c)ix - Exposed Fittings.

.2 40 23 21 (d)i to 40 23 21 (d)iv – Valves.

.3 40 23 21 (f)i to 40 23 21 (f)xvi - Embedded Fittings.

.4 No separate measurement will be made for the following Items:

.1 40 23 21(g) – Instrumentation.

.2 40 23 21 (h) - Testing, Flushing and Cleaning.

.3 40 23 21 (i) - Pre-commissioning.

.3 Unit Price

.1 The unit price for Item 40 23 21 (a)i in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein.

.2 The unit prices for the following Exposed Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein.

.1 40 23 21 (b)i to 40 23 21 (b)ii - Exposed Piping.

.2 40 23 21 (c)i to 40 23 21 (c)ix - Exposed Fittings.

.3 40 23 21 (d)i to 40 23 21 (d)iv - Valves.

.3 The unit prices for the following Embedded Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall before supply, installation, transporting, unloading, handling, non-destructive testing, examination, pressure testing and flushing of the embedded piping segments to be installed, as specified herein.

.1 40 23 21 (e)i to 40 23 21 (e)v - Embedded Piping.

.2 40 23 21 (f)i to 40 23 21 (f)xvi - Embedded Fittings.

.4 The estimated cost for Instrumentation Item 40 23 21 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall

be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment manufacturer. Include the costs for manufacturer supplied/installed instrumentation with the equipment Item to which it applies.

.5 The estimated cost for Testing, Flushing and Cleaning Item 40 23 21 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system.

.6 The estimated cost for Pre-Commissioning Item 40 23 21 (i) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the system(s) as specified herein.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 3.8 Submittals of the General Specification.

.2 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification, all applicable Contractor's Documents including product data, shop drawings, installation manuals including installation and test plans, testing procedures, flushing procedures, marking procedures, pre-commissioning procedures and operation and maintenance manuals.

.3 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification drawings, including performance curves showing operating point (capacity/head, horsepower, efficiency and NPSH) and dimensional drawing(s) of pump and accessories.

.4 Provide list of recommended spare parts.

.5 Submit all test results and reports to the Engineer.

.6 The Contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Section 7.13 Project Quality Control of the General Specification.

.2 Follow the Contractor’s Quality Management Plan.

.3 All fittings require a Canadian Registration Number.

.4 Obtain a registration number for the Dewatering and Filling system from the Province of Manitoba Department of Labour.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements of Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Dewatering Sump Pumps - Tag Nos. 5750-PP-2005A, 2005B, 5005A, and 5005B.

.1 Type: Vertical turbine.

.2 Rated Capacity:

.1 Minimum: 113 L/s [1,800 US gpm] @ 36 m [120 ft] head.

.2 Normal: 230 L/s [3,650 US gpm] @ 30 m [98 ft] head.

.3 Maximum: 284 L/s [4,500 US gpm] @ 16 m [55 ft] head.

.3 Drive: Electric motor, 112 kW [150 hp], 575 V, 3-phase, 60 Hz.

.4 Included Items: discharge head with packing gland, open line shaft and bearings, column pipe, bowl assembly, inlet bell and basket strainer.

.5 Pump components shall not exceed 2.0 m in length. The maximum diameter of the bowl and column shall not exceed 475 mm. Each pump shall include a fabricated steel discharge head complete with all necessary fasteners. The discharge head shall be capable of mating to a 150 lb flange.

.6 The exterior of the pump assembly shall be painted to the manufacturer's factory standard paint system.

.7 Each pump shall be hydrostatic and performance tested at the factory. The Purchaser reserves the right to inspect the pumps prior to shipment.

.8 The pump shall be Layne/Verti-line model 19GM, or the Purchaser's approved equivalent.

.9 Pump:

.1 The pump shall consist of the following components: cast iron bowl complete with inlet screen, suction bell, bronze impeller and replaceable bronze bowl and impeller wear rings.

.2 The line shaft shall be 416 stainless steel, with stainless steel journals at the bearings.

.3 Shaft couplings shall accurately align the adjacent line shaft sections. Column sections shall have flanged connections fastened together with stainless steel nuts and studs.

.4 All line shaft connections shall be flanged or keyed, or otherwise locked to prevent torque take-up; no threaded couplings are permitted.

.5 The impeller drive and top shaft shall be made of stainless steel.

.6 Neoprene line shaft bearings shall keep the line shaft centered in the column.

.7 The fabricated steel, above ground, discharge head shall be robustly designed to support the motor and pump column and withstand the hydraulic thrust developed by the pump.

.8 The discharge head shall be mounted on a 20 in. 150 lb ANSI flange and will include a packing gland and an 8 in. 150 lb ANSI discharge flange.

.9 Each pump assembly shall be provided with lifting lugs.

.10 All wetted parts of the pump body shall be epoxy coated as per manufacturer's factory standard coating system and colour.

.10 Motor:

.1 The pump motor shall be a standard totally enclosed, fan cooled vertical squirrel cage induction type with hollow shaft, rated for continuous operation, 575 V, 3-phase, 60 Hz.

.2 The motor shall meet the performance and test requirements of NEMA Standard MG1.

.3 The motor shall be of NEMA B torque design and shall have Class F or Class H insulation made of non-hygroscopic and moisture resistant materials.

.4 The motor shall be equipped with regreaseable anti-friction bearings capable of withstanding the full thrust of the motor and pump in operation.

.5 Each motor shall be provided with a non-reversing ratchet.

.11 Protective Coating:

.1 Equipment shall be painted green (colour code per Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification) to manufacturer's factory standard coating system.

.2 Pump Control

.1 Pump shall be controlled by a level transmitter. See Section 40 90 25 Instrumentation for Piping Systems of the Technical Specification.

2.2 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc) refer to the Purchaser's Drawings and applicable Pipe Class Material as outlined in Section 40 05 00 Mechanical & Piping General Requirements..

.2 Paint for piping: in accordance with Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification. Paint colour shall be green, per colour code indicated in Appendix A of Section 09 90 00 Painting and Coating.

.3 Refer to Part 2 of Section 40 05 00 Mechanical and Piping General Requirements of the Technical Specification for additional material requirements.

Part 3 Execution

3.1 GENERAL

.1 General execution of this Work, including but not limited to fabrication, installation, examination, preparation, cleaning, flushing, marking, testing, pre-commissioning, commissioning, and site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical and Piping General Requirements of the Technical Specification, in addition to any specific requirements indicated below.

3.2 INSTALLATION

.1 Paint all pipe, fittings, and valves in accordance with Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification.

.2 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation of the following:

.1 Insulation for Piping, Valves and Fittings.

.2 Insulation for Mechanical Equipment (as required).

.2 Refer to the Purchaser’s Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 40 05 00 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Applicable sections of ASTM - American Society for Testing and Materials.

.2 National Plumbing Code of Canada.

.3 Manitoba Plumbing Code.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments

.2 Measurement

.1 There will be no separate measurement for items included in this Section of the Technical Specification.

.3 Unit Price

.1 The Contractor shall include costs for insulation with the particular system in the Initial Target Price referenced in the section of the Technical Specification for the associated system.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Section 3.8 Submittals of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data, installation manual including maintenance manuals.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Section 7.13 Project Quality Control of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Section 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements set out in Section 25 Warranty of the General Specification.

Part 2 Products

2.1 MATERIALS

.1 Piping system insulation shall be as indicated on the Purchaser's Drawings and as specified herein.

.2 Insulation shall comply with the specifications listed below:

.1 The following are Anti-Sweat Insulation specifications for general piping, strainers and miscellaneous equipment. Refer to Purchaser's Drawings for system-specific details.

Piping Insulation: rigid fiberglass, 25 mm (1 in.) thick, Johns Manville Micro-Lok,

	Finish: (Exposed Dry Areas) - metal jacket, stucco-embossed aluminum, 0.4 mm (0.016 in.) thick. Finish: (Exposed Wet Areas) - PVC jacket
Valves & Fittings	Insulation: Johns-Manville Microlite, 25 mm (1 in.) thick Finish: metal jacket, stucco-embossed aluminum, 0.4 mm (0.016 in.) thick, tied securely with heavy jute twine.
Equipment	Insulation: expanded closed-cell type, Armacell Armaflex sheet & roll, 19 mm (¾ in.) nominal thickness Adhesive: Armacell Armaflex 520 BLV Finish: metal jacket, stucco-embossed aluminum, 0.4 mm (0.016 in.) thick.

.2 Thermal Insulation for hot water piping

.1 Preformed cylindrical pipe insulation composed of glass fibres bonded together with a thermosetting resin c/w a vapour retarding jacket.

Part 3 Execution

3.1 PREPARATION

.1 Apply insulation on clean, dry surfaces. Wipe, scrape or wire brush all scale, rust, oil, grease or any other foreign matter from piping, equipment and any other surface requiring insulation.

3.2 INSTALLATION

.1 Pipes and fittings shall be insulated where specified on the Purchaser's Drawings and/or in the Section of the Technical Specification for the applicable system after completion of pressure testing, cleaning, and flushing.

.2 Insulation shall be installed in accordance with the instructions issued by the insulation manufacturer. Prior to insulation, all pipes, fittings and adjacent concrete surfaces shall be clean and dry. Sufficient clearance shall be provided for wrenches and bolting as required. Joints in insulation shall be tightly butted.

.3 Identify all piping systems after they are insulated, as per Section 40 05 00 Mechanical and Piping General Requirements of the Technical Specification.

.4 On all piping and equipment provide compensation for contraction and expansion.

.5 Do not insulate vessel nameplates. Seal insulation surrounding these plates to prevent water from entering.

.6 Apply insulation on pipelines with hangers, saddles, etc. after they have been set in their permanent location. If it is necessary to block or shore up pipe to install the insulation or should it be necessary to displace or remove hangers, restore the pipe and hangers to their original location and alignment after the insulation has been completed.

.7 Insulate valve bodies, bonnets, strainers and flanges unless specified otherwise on the project drawings.

3.3 MAINTENANCE

.1 Submit all installation and maintenance manuals to the Engineer.

.2 Where specified, arrange for instruction by the manufacturer's technical representative.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, testing, pre-commissioning and commissioning of the Piezometer Systems and Station Instrumentation, including but not limited to the following:

- .1 Piezometer piping.
- .2 Differential pressure transducers.
- .3 Current alarm monitors.
- .4 Intake and tailwater level transducers.
- .5 Station flood alarm switches.
- .6 Scroll case pressure transmitters.

.2 Refer to the Purchaser’s Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 40 50 01 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 The Works shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

- .1 ASME B31.1 - Power Piping.
- .2 CSA B51 - Boilers, Pressure Vessels and Pressure Piping.

1.4 MEASUREMENT AND PAYMENT PROCEDURES

.1 General

- .1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.
- .2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's

Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments

.2 Measurement

.1 Measurement for the following Piping Items will be based on the length of pipe in metres as shown in the Purchaser's Drawings, from fitting to fitting, excluding the fitting(s).

.1 40 90 00 (a)i to (a)iii - Exposed Piping.

.2 40 90 00 (d)i to (d)iii - Embedded Piping

.2 Measurement for the following Fitting and Valve Items will be based on the number of Items as shown in the Purchaser's Drawings.

.1 40 90 00 (b)i to (b)iii - Exposed Fittings.

.2 40 90 00 (c)i to (c)vi - Valves.

.3 40 90 00 (e)i to (e)ii - Embedded Fittings.

.3 Measurement for Component Items 40 90 00 (f)i to (f)ii will be based on the number of Items as shown in the Purchaser's Drawings.

.4 No separate measurement will be made for the following Items:

.1 40 90 00 (g) - Instrumentation.

.2 40 90 00 (h) - Testing, Flushing and Cleaning.

.3 40 90 00 (i) - Pre-commissioning.

.3 Unit Price

.1 The unit prices for the following Exposed Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein.

.1 40 90 00 (a)i to (a)iii - Exposed Piping.

.2 40 90 00 (b)i to (b)iii - Exposed Fittings.

.3 40 90 00 (c)i to (c)vi - Valves.

.2 The unit prices for the following Embedded Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, non-destructive testing, examination, pressure testing and flushing of the embedded piping segments to be installed, as specified herein.

.1 40 90 00 (d)i to (d)iii - Embedded Piping.

.2 40 90 00 (e)i to (e)ii - Embedded Fittings.

.3 The unit price for Component Items 40 90 00 (f)i to (f)ii in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, final connections of the equipment specified herein.

.4 The Estimated Cost for Instrumentation Item 40 90 00 (g) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's Submission shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein.

.5 The Estimated Cost for Testing, Flushing and Cleaning Item 40 90 00 (h) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's Submission shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system.

.6 The Estimated Cost proposed for Pre-Commissioning Item 40 90 00 (i) in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in the Contractor's Submission shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the system as specified herein.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor’s Documents of the General Specification.

.2 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data, shop drawings, installation manuals including installation and test plans, testing procedures, marking procedures, flushing procedures, pre-commissioning procedures, and operation and maintenance manuals.

.3 Provide list of recommended spare parts.

.4 Submit all test results and reports to the Engineer.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor’s Quality Management Plan.

.3 All fittings require a Canadian Registration Number.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements set out in Section 25 Warranty of the General Specification.

Part 2 Products

2.1 COMPONENTS

.1 Three Valve Manifold

.1 Port Connections: ½ in. NPT.

.2 Material: 316 Stainless Steel.

.3 Port Centreline: 54 mm (2-1/8 in.).

.4 Acceptable Manufacturers and Models: Whitey Part No. SS-M3NBF8, Century Valve Ltd. CM10-3, Alco Valve 3VD4NS, or the Purchaser's approved equivalent.

2.2 INSTRUMENTATION

.1 Trashrack Differential Pressure Transmitter

.1 Shall be capable of measuring differential pressure and transmit a signal to the current alarm.

.2 Output: 4 - 20 mA.

.3 Differential pressure range: 0 to 7500 mm water.

.4 Accuracy: +/- 0.25% of total span.

.5 Body Material: Type 316 Stainless Steel.

.6 Power: 24 Vdc.

.7 Enclosure: gasketed, weather-proof, NEMA 4X.

.8 Diaphragm Material: cobalt-nickel chrome alloy.

.9 Max. Working Pressure: 13,790 kPa(g) (2,000 psig).

.10 Max. Ambient Temperature: 80^{o}C.

.11 Range to be fully adjustable throughout span limit.

.12 Mounting: suitable for direct mounting to bypass manifold.

.13 Includes visual indicator, calibrated in meters.

.14 Manufacturer and Model: ABB 2600T Series, Part No. 264DSHSHA2A1/V1E4L1 or the Purchaser's approved equivalent.

.2 Current Alarm Monitor for Trashrack Differential Pressure Transmitter

.1 Shall be capable of receiving a signal from Differential Pressure transmitter and provide separate dry contact closures at two independent settings.

.2 Module enclosure type: NEMA 4 enclosure for surface mounting.

.3 Input: 4-20 mA.

.4 Output Contact Rating: 3 A.

.5 Operating Power Supply: 120 Vac Input, 24 Vdc/160 mA output.

.6 Include conduit/cable bracket, power supply.

.7 Factory settings: First contact closure at 12 mA, Second contact closure at 15 mA.

.8 Ambient temperature range: 10°C to 35°C.

.9 Manufacturer and Model: Precision Digital Trident Model PD765, or the Purchaser's approved equivalent.

.3 Station Flood Alarm Switch

.1 Factory set point: Trip at 1" water level.

.2 Aluminum body, glass-filled nylon bottom plate.

.3 Nitrile Sensing Diaphragm.

.4 Switch rating: SPDT, 5 A at 120 Vac.

.5 Maximum Pressure Rating 172 kPa(g) (25 psig).

.6 Include: Murphy MAC-1 Volume Air Cell, and MACT-1 Tubing Kit.

.7 Manufacturer and Model: Murphy DF Series Level Switch, Model DM755, or the Purchaser's approved equivalent.

.4 Forebay and Tailrace Water Level Transmitters

.1 Forebay Antenna: 7M1-A410-070 c/w TFE weight.

.2 Tailrace Antenna: 7M1-A410-090 c/w TFE weight.

.3 Manufacturer and Model: Magnetrol Eclipse, Model 705-51AA-110, or the Purchaser's approved equivalent.

.5 Scroll-Case Pressure Transmitters

.1 Range: 25.4 m (1000 in. w.c.).

.2 Display: Local pressure indication (LCD display).

.3 Output: 4 - 20 mA.

.4 Flange and Drain Vent Material: Stainless Steel.

.5 Isolating Diaphragm: 316L Stainless Steel.

.6 O-ring material: Glass-filled PTFE.

.7 Silicone Filled.

.8 Housing Material: Polyurethane-covered aluminum.

.9 Conduit entry size: ½-14 NPT.

.10 Manufacturer and Model: ABB Model 264HS or the Purchaser's approved equivalent.

2.3 MATERIALS

.1 For piping materials (pipe, fittings, flanges, valves, etc) refer to Purchaser's Drawings and applicable Pipe Class Material Specifications as outlined in Section 40 05 00 Mechanical & Piping General Requirements.

.2 Refer to Part 2 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification for additional requirements.

Part 3 Execution

3.1 GENERAL

.1 General execution of this Work, including but not limited to fabrication, installation, examination, preparation, cleaning, testing, flushing, marking, pre-commissioning , commissioning and site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification, in addition to any specific requirements indicated below.

3.2 INSTALLATION

.1 Extreme care shall be exercised when installing the embedded piezometer tubing. Use carbon steel angle iron to protect the piezometer tubing from damage during construction.

.2 Paint all pipe, fittings, and valves in accordance with Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification.

.3 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 This Section includes the general requirements for the piping instrumentation and the Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein for the supply, transportation, handling and installation of instrumentation for piping systems.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 21 12 00 - Fire Protection Standpipe System.

.3 Section 21 13 00 - Fire Suppression Sprinkler System.

.4 Section 22 11 00 - Domestic Water System.

.5 Section 22 13 00 - Sanitary System.

.6 Section 22 14 00 - Clearwater Drainage System.

.7 Section 22 15 00 - Service Air and Brake Air Systems.

.8 Section 26 05 21 - Wire and Cable Systems.

.9 Section 26 32 13 - Standby Diesel Generators.

.10 Section 40 23 19 - Station Water, Cooling Water & Shaft Seal Water Systems.

.11 Section 40 23 21 - Dewatering & Filling System.

.12 Section 40 05 00 - Mechanical & Piping General Requirements.

.13 Section 43 20 00 - Oil Storage & Handling System.

.14 Section 46 07 13 - Domestic Water Treatment Plant.

.15 Section 46 07 53 - Wastewater Treatment Plant.

.16 Section 46 25 00 - Oil Water Separation Facility.

1.3 EXCLUDED SECTIONS

.1 Section 40 90 00 - Piezometer Systems and Station Instrumentation.

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ASME B31.1 - Power Piping.

.2 ASME B31.3 - Process Piping.

.3 ASME Boiler and Pressure Vessel Code (BPVC), Section VIII.

.4 CSA C22.2 No 14 - Industrial Control Equipment.

.5 CSA C22.2 No 142 - Process Control Equipment.

.6 Manitoba Plumbing Code.

.7 National Plumbing Code of Canada.

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments

.2 Measurement

.1 There will be no separate measurement for items included in this Section of the Technical Specification.

.3 Unit Price

.1 The Estimated Cost items for instrumentation are listed under the applicable system in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor’s Documents of the General Specification.

.2 Submit all installation, operation and maintenance manuals to the Engineer.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor’s Quality Management Plan.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.9 WARRANTY

.1 Shall be in accordance with the requirements set out in Section 25 Warranty of the General Specification.

Part 2 Products

2.1 INSTRUMENTATION

.1 General Instrumentation

.1 Instrumentation shall be as follows unless otherwise specified.

.2 Pressure Gauges:

.1 Liquid filled, dual scale in both kPa(g) and psi(g), 12mm (1/2 in.) NPT restricted port, 114mm (4-1/2 in.) dial, white with black and red markings, stainless steel case. Winters PFQ or the Purchaser's approved equivalent.

.2 Size pressure gauge such that the full scale reading is approximately double the maximum operating pressure of the system. Minimum accuracy shall be Grade B +/- 2% in middle half of scale.

.3 Provide gauge cock to isolate pressure gauge for maintenance or replacement. Winters SMV Mini Ball valve or the Purchaser's approved equivalent.

.3 Pressure Switches:

.1 Bourdon Tube type, with external adjustments to set high and low pressure setpoint. Snap action switch, 120 Vac, 5 A. 316 SS body. Adjustable operating range of 70 - 1,000 kPa(g) (10 - 150 psig).

.2 Mercoid D series, Model DA-7041-153-24E, or the Purchaser's approved equivalent.

.2 Fire Protection Standpipe System, Section 21 12 00

.1 Instrumentation and Control of Fire Pumps shall be supplied with pumps as specified in Section 21 12 00.

.2 Diesel Fuel Tank Level Transmitter:

.1 Mercoid Model SBLT2-5-40-ETFE, or the Purchaser's approved equivalent. The level transmitter shall have the remote level indicator installed at the diesel fuel fill inlet. The level indicator shall be precision Digital ProVu Model PD6000-6R0, or the Purchaser's approved equivalent. The level indicator shall be installed, with the Oil Inventory Level Indicators, in the plastic NEMA 4X Field Enclosure.

.3 Fire Suppression Sprinkler System, Section 21 13 00

.1 Pressure Gauges:

.1 Each pressure gauge supplied with the deluge valve trim package shall be FM approved and UL and ULC listed, and equipped with a separate snubber to protect the gauge against the pressure surges of 1,200 kPa(g) (175 psig) when the fire pumps start, or when the deluge valve opens. Each shall be suitable for ambient temperature water, shall have 112 mm (4.4 in.) diameter dial size, dual scales kPa/psi, and pressure range 0 - 1,400 kPa(g) (0 – 200 psig). The gauges shall be come with a tee handle cock and pressure snubber.

.2 Water Flow Detectors:

.1 The water flow alarm switch shall be FM approved and UL and ULC listed, constructed to prevent false alarms due to pipe line pressure surges, and shall have two snap switches with pneumatic timer.

.4 Sanitary System, Section 22 13 00

.1 Instrumentation for Wastewater Treatment Plant (WWTP) Sump Pump shall be supplied with pump as specified in Section 22 13 00.

.5 Clearwater Drainage System, Section 22 14 00

.1 Liquid Level Regulators for Clearwater Drainage Pumps:

.1 Each pair of pumps shall require five liquid level regulators with mechanical switches and 17.0 m (55.8 ft.) of No. 14 AWG Type SOW or the Purchaser's approved equivalent factory sealed submersible control cable on each regulator for pump control.

.2 Rated for both 120 Vac, 60 Hz and 5 A and for 125 Vdc and 1 A.

.3 Ratings shall be clearly marked.

.4 A hanger, which will be mounted at the sump roof, shall be supplied to support the liquid level regulators.

.5 Acceptable material: Flygt Model ENM10 or the Purchaser's approved equivalent.

.2 Instrumentation for Elevator Shaft Drainage Sump Pumps:

.1 Provide piggy-back style float switch to control pump operation.

.2 Shatter proof, mercury-to-mercury contact switch.

.3 Housing: factory-sealed PVC.

.4 120 Vac.

.5 Cord length: 5 m (16.4 ft.).

.6 Acceptable material: Paramatic Industries Limited Model PIL-05-D.

.3 Drainage Sump Level Transmitter:

.1 Supply and install a submersible level transmitter in each clearwater drainage sump:

.1 Transmitter body: 316 SS.

.2 Cable: polyurethane or ETFE, 15 m length (minimum).

.3 Nose: PVC.

.4 Water depth range: 0 to 10 m (0 – 32.8 ft.).

.5 External power supply 120 Vac.

.6 Output signal: 4-20 m A DC, 2-wire.

.7 Acceptable material: Mercoid Series SBLT2-15-60, or the Purchaser's approved equivalent.

.6 Service Air and Brake Air Systems, Section 22 15 00

.1 Instrumentation and Control Panels for all compressors shall be supplied with compressors as specified in Section 22 15 00.

.2 Pressure Transmitters: Pressure transmitters shall be Rosemount Model 3051 complete with integral display and stainless steel block and bleed manifold.

.7 Station Water, Cooling Water & Shaft Seal Water Systems, Section 40 23 19

.1 Service Water Strainer:

.1 Wiring and cabling in accordance with Section 26 05 21 Wire and Cable Systems of the Technical Specification.

.2 Inlet and outlet liquid filled pressure gauges installed on the strainer.

.3 All control devices placed in a NEMA Type 12 panel mounted on or adjacent to the strainer.

.4 All control devices necessary for the safe operation of the unit.

.5 Relay contacts rated for 120 V/1 ph strainer basket motor current.

.6 Flushed automatically for an adjustable 0.5 to 5 minutes preset time at an adjustable 3 to 30 hours preset interval.

.7 An adjustable differential pressure switch, set at 30 kPa, to provide backup by initiating the cleaning cycle on high differential pressure if required.

.8 A manual/off/automatic selector switch to provide manual control.

.9 A control power light to indicate the panel is energized.

.10 Dry contacts for remote alarm of loss of power and backwash cycle.

.11 Electrically operated backwash control valves.

.12 Manual valve provided between the strainer and electrically operated valve to regulate the backwash flow and allow servicing of the control valve.

.13 Control relays, if used, of the type designed for machine tool application featuring contact reliability and convertibility. Time delay relays of the solid-state type and have adjustable timing ranges.

.14 Control conductors with single conductor stranded copper minimum size No. 14 AWG or the Purchaser's approved equivalent.

.15 Screw clamp terminal blocks, Entrelec Type M10/10 or the Purchaser's approved equivalent.

.16 Control fuses with dead front fuse holders, HRC Form II Type C.

.17 All devices clearly identified with lamacoid engraved nameplates.

.18 All wires identified at both ends according to the accepted schematic and wiring diagrams. Any specific wiring designations shall be marked on the supplier’s schematics and wiring diagrams when they are submitted for review by the Engineer in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification.

.19 The control devices and wiring in conformance with the applicable CSA Standards.

.2 Station Service Water Pumps:

.1 Wiring and cabling in accordance with Section 26 05 21 Wire and Cable Systems of the Technical Specification.

.2 Install inlet and outlet liquid filled pressure gauges on the headers.

.3 Electrically controlled. All control devices placed in an NEMA Type 4 panel mounted on the end of the filter.

.4 Factory wired and plumbed to its panel so that only the 120 Vac power supply needs to be connected to the main panel.

.5 Controls include all devices necessary for the operation of the unit. Provide a timer and a differential pressure switch to initiate the backwash. Timer range will allow backwash at least once a day.

.6 Provisions made to manually initiate backwash cycle.

.7 Control power light to indicate the panel is energized.

.8 Individual dry contacts provided for remote alarm of loss of voltage, excess backwash frequency, and high differential pressure. These alarms also annunciated locally.

.9 Timers and time delay relays solid state type with adjustable timing ranges.

.10 Control conductors with single conductor stranded copper, minimum size No. 14 AWG or the Purchaser's approved equivalent.

.11 Sufficient terminal blocks shall be provided for all circuits plus 20% spare, suitably distributed.

.12 Provide control fuses.

.13 All devices clearly identified with lamacoid engraved nameplates, securely fastened with rivets or screws.

.14 All wires identified at both ends according to the accepted schematic and wiring diagrams. Any specific wiring designations required by the Engineer will be marked on the supplier’s schematics and wiring diagrams when they are submitted for review by the Engineer in accordance with Subsection 21.7.9 Engineer’s Review of the General Specification.

.15 The control devices and wiring in conformance with the applicable CSA Standards.

.8 Dewatering & Filling System, Section 40 23 21

.1 Dewatering Sump Level Transmitter:

.1 A submersible level transmitter shall be installed in each dewatering sump, which shall provide a signal to the UCMS.

.2 The transmitter body shall be 316 SS, the cable shall be either polyurethane or ETFE, and the nose shall be made of PVC.

.3 The level transmitter shall be capable of measuring a water depth between 0 and 10 m (0 – 32.8 ft.), but shall be capable of withstanding 46 m (151 ft.)without damage.

.4 The cable shall have a minimum length of 12 m (39.36 ft.).

.5 The output signal shall be 4 - 20 m A DC, 2-wire.

.6 Acceptable material: Mercoid Series SBLT2-15-60, or the Purchaser's approved equivalent.

.9 Oil Storage & Handling System, Section 43 20 00 & Standby Diesel Generators Section, Section 26 32 13.

.1 Oil Inventory/Level Transmitters:

.1 Each oil storage tank shall have a level transmitter, which shall provide a signal to the UCMS.

.2 The level transmitter shall be the radar type.

.3 The level transmitter shall meet all of the requirements listed below:

.1 Suitable for Lubricating Oil & Fuel Oil Service.

.2 Output Signal: 4-20 mA.

.3 Supply voltage 120 Vac.

.4 Material: 316 Stainless Steel.

.5 Connection to Tank: 4 inch Class 150 lb Flange.

.6 Effective Range of Measured Depth: as required by tank.

.7 Accuracy: +/- 10 mm (0.39 in.)

.8 Acceptable material: Level transmitter Rosemount 5400 series or the Purchaser's approved equivalent.

.2 Remote Level Indication:

.1 In accordance with CCME PN 1326, each oil storage tank shall have remote level indication at the oil fill station outside the Service Bay, with audible and visual alarm.

.2 The level indicators shall meet the following requirements:

.1 4-digit display.

.2 Sunlight readable display for outdoor application.

.3 120 Vac power supply.

.4 2 SPDT relays.

.5 NEMA 4X, IP65 front.

.6 Compatible annunciator with audible and visual alarm.

.3 Level indicating meters and annunciator shall all be mounted in a common enclosure.

.4 Acceptable material:

.1 Meters: Precision Digital Model PD765-6X2-00 or the Purchaser's approved equivalent.

.2 Annunciator: Precision Digital Model PD154-6R2-1 or the Purchaser's approved equivalent.

.3 Enclosure: Precision Digital Model PDA2505 or the Purchaser’s approved equivalent.

.3 Pressure Gauges:

.1 Refer to 2.1.1 General Instrumentation of this Section of the Technical Specification.

.4 Local Level Indicators:

.1 Each tank shall be provided with a shielded tubular level gauge (sight glass) to provide local level indication from floor level.

.2 Centre-to-centre: 3848 mm (151.5 in.)

.3 Connection size: 19 mm (3/4 in.) NPT.

.4 Tube: 15.875 mm (5/8 in.) OD acrylic tubing.

.5 Frame: Zinc Plated Carbon Steel.

.6 Wetted Metal: Zinc Plated Carbon Steel.

.7 Seals: Viton O-Rings.

.8 Valves: Integral shutoff valves (offset).

.9 Vent and drain ports: 6.35 mm (1/4 in.)

.10 Pressure rating: 1034 kPa(g) (150 psig).

.11 Acceptable material: John C. Ernst Model 819 or the Purchaser's approved equivalent.

.10 Domestic Water Treatment Plant, Section 46 07 13

.1 For Instrumentation for Packaged Domestic Water Treatment Plant refer to Section 46 07 13 of the Technical Specification.

.11 Wastewater Treatment Plant, Section 46 07 53

.1 Flow meter:

.1 The proposed ultra-sonic flowmeter shall have a range and blanking distance to 3.05 m (10'-0").

.2 Outputs shall consist of three relay-SPDT contacts rated 8A/120Vac; function programmable current isolated 0 to 20 or 4 to 20 mA into 1,000 ohms max.

.3 The display shall be a two line alphanumeric LCD type with LED backlighting.

.4 User interface shall be via detachable IR keypad programmer.

.5 Dual back-up systems memory-super capacitor and Ultralife lithium power cell.

.6 Polycarbonate enclosure: Type 4 IP65 rated.

.12 Oil Water Separation Facility, Section 46 25 00

.1 Oil Recovery Tank Level Switches:

.1 A diaphragm-operated, hydrostatic head level switch shall be installed on each oil recovery tank.

.2 The level switch body shall be aluminum.

.3 The diaphragm shall be nitrile.

.4 The switch shall have a DPDT switch rated for 10A at 12/120/250 Vac.

.5 The level switch shall be explosion-proof.

.6 The level switch shall be capable of measuring a depth from 2 to 110 in. W.G. (50.8 – 2794 mm W.G.), or equivalent head of oil with a specific gravity of 0.87.

.7 Process connection shall be 25.4 mm (1 in.) NPT, and electrical connection shall be 12.7 mm (1/2 in.) NPT.

.8 Acceptable material: Murphy DF757, or the Purchaser's approved equivalent.

Part 3 Execution

3.1 INSTALLERS

.1 Use only licensed installers.

3.2 PREPARATION

.1 Prior to fabrication, assembly, or erection of any items, verify field measurements required for completion of the Work including actual sizes, locations, and details of equipment connections.

3.3 INSTALLATION

.1 Electrical installation in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

.2 Tubing

.1 Teflon tape shall not be used when connecting instruments, tubing or pipe fittings, pipe nipples, unions, valves and other fittings.

.2 Tube cutting shall be in the manner shown in the Swagelok Tube Fitter's Manual. Swagelok tube cutter or equivalent tube cutter with sharp cutter wheel shall be used for all cutting.

.3 All tube bends shall be made with the use of proper bending tools. Bending tools, pins and clips shall be kept oiled to ensure smooth bends. The proper bender for each size of tubing shall be used.

.4 Welding or cutting flames shall not be used close to the instruments impulse tubing. Mounting holes in the instruments shall not be enlarged and any damage to paint or other finish of the instruments shall be repaired by the Contractor.

.5 If tubing is straightened by stretching, care shall be taken such that the diameter is not reduced to the extent that a poor seal at the compression fitting results.

.6 Swagelok four-piece compression type tube fittings shall be used on all instrument and control tubing.

3.4 SITE QUALITY CONTROL

.1 Quality Control Inspectors

.1 Provide certified quality control inspectors with proven industrial construction, fabrication and maintenance experience.

.2 Inspectors shall carry out inspections during the construction and fabrication of facilities and products covered by the Contractor's Quality Management Plan.

.3 Inspections include, but are not limited to the following: witnessing welder testing, materials receiving and handling, supervising and directing service providers.

3.5 IDENTIFICATION AND MARKING

.1 After installation, painting, and insulating, prepare identification tags for all instruments and piping systems in accordance with the requirements of Appendix A, STD-01 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification.

.2 Tags for instrumentation and control devices shall be made of 19-gauge solid brass, 2 in. round, with black ink.

3.6 DEMONSTRATION, OPERATION AND MAINTENANCE

.1 Supply all tools, equipment and personnel to demonstrate and instruct operating and maintenance personnel in operation, control, adjusting, trouble shooting, and servicing of all instruments during regular work hours, prior to acceptance by the Engineer.

.2 Provide any special tools required for operation and/or maintenance.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein to complete the installation of the following Items:

.1 Machine Shop Bridge Crane.

.2 Machine Shop Floor Crane.

.3 Oil/Water Separator Bridge Crane.

.4 Waste Water Treatment Plant Monorail Crane.

.5 Intake Hoist Housing Monorail Crane.

.2 Work by others

.1 Periodic inspections per Manitoba Workplace Safety and Health after completion of commissioning.

1.2 RELATED SECTIONS

.1 Those Sections and Subsections of the General Specification as set out below.

.2 Section 26 05 00 - Electrical General Requirements.

.3 Section 41 22 13 - Crane Rails.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 CSA B167-08 - Overhead Travelling Cranes - Design, inspection, testing, maintenance, and safe operation.

.2 CMAA No. 70 - Specification for Top Running Bridge and Gantry Type Multiple Girder Electrical Overhead Traveling Cranes.

.3 CMAA No. 74 - Specifications for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist.

.4 CSA C22.2 No. 33 - Construction and Test of Electric Cranes.

.5 CSA Z460-05 - Control of Hazardous Energy.

.6 ASME PALD - Safety Standard for Portable Automotive Lifting Devices.

.7 Manitoba Workplace Safety and Health Act and Regulations.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and any change identified through Section 27 Clarifications and Changes to the Work and Adjustments.

.2 Measurement

.1 Measurement for Items 41 22 00 (a) to (e) will be based on the quantity shown in the Purchaser's Drawings.

.3 Unit Price

.1 The unit prices for Item 41 22 00 (a) to (e) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for receiving at Site, unloading, examination, site storage, handling, installation, touch-up painting, site testing and pre-commissioning of the equipment specified herein.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7of the General Specification.

.2 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including product data, shop drawings, installation manuals including installation and test plans, critical components list with inspection criteria and procedures, testing procedures, commissioning procedures and operation and maintenance manuals.

.3 Product Data

.1 Provide manufacturer's printed product literature, specifications and data sheets for the cranes and their components as applicable and include product characteristics, performance criteria, physical size, finish and limitations in sufficient detail to demonstrate compliance with this Section of the Technical Specification.

.4 General Arrangement Drawings

.1 Submit arrangement drawings showing:

.1 Dimensions.

.2 Rail/beam requirements.

.3 Wheel loads.

.4 Mechanical and electrical connection details.

.5 Shop drawings.

.5 Source Quality Control

.1 Test certificate.

.6 Site Quality Control

.1 Inspection and Test Report.

.7 Regulatory Requirements

.1 Verification documents as required by Manitoba Workplace Safety and Health and CSA B167, i.e. on supporting structure, test reports, etc.

.2 The manufacturer(s) for each of the cranes listed herein shall supply a critical components list and inspection criteria and procedures in accordance with CSA B167, Paragraph 5.3.

.3 Supply an up to date log book for cranes with a capacity over 907 kg in accordance with Manitoba Workplace Safety and Health Act and Regulations.

.8 Provide manufacturer's standard operation and maintenance manuals/data for each crane.

.9 The Contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All furnished equipment shall be of the latest commercial design.

.4 The manufacturer/assembler shall have a minimum of 10 years experience with the manufacture, assembly and sale of cranes for similar industrial use.

.5 Compliance with CSA Z460-05 Control of Hazardous Energy - Lockout and Other Methods.

.1 Read, understand and apply all of CSA Z460-05 Lockout and other methods:

.1 Contractor must have a lockout program that complies completely with the lockout program stipulated in MR 217,
Part 16.14 -17, Part 38.9 (b) and Part 38.14. The Contractor is required to apply its lockout program when controlling hazardous energy for worker protection.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspection and Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 The Contractor shall be responsible for receiving, offloading and handling the cranes.

.5 The Contractor shall be responsible for storage. Preference is to store crane indoors. If stored outdoors, determine storage requirements based on winter/summer conditions and suitably protect crane and its components from damage (provide coverage, heating, etc as required). Contractor will replace crane components not suitably protected in storage.

.6 All items shall be handled with care to avoid damage prior to installation and in accordance with manufacturer's recommendations.

1.8 WARRANTY

.1 Shall be in accordance with the requirements set out in Section 25 Warranty of the General Specification.

1.9 SITE CONDITIONS

.1 Shall be in accordance with Section 4 Site Location and Access of the General Specification.

Part 2 Products

2.1 SYSTEM DESCRIPTION

.1 General

.1 Bridge cranes: Motorized bridge crane with electric chain hoist.

.2 Monorail cranes: Manual trolley.

.3 Cranes are for an indoor environment.

.4 Cranes to meet Canadian Electrical Code requirements.

.5 Cranes to be designed per CSA B167.

.6 Crane hoist and bridge classification to be CSA B167.

.7 Crane rail/monorail beam systems to be as specified in Section 41 22 13 Crane Rails of the Technical Specification.

.2 Machine Shop Bridge Crane

.1 Capacity: 3 Tonne.

.2 Lift: 4 m.

.3 Span: 7.2 m, to be confirmed.

.4 Max Width: 2 m, to be confirmed.

.5 Runway Length: ~25 m, to be confirmed.

.6 Speeds:

.1 Hoist: less than 10 m/min.

.2 Bridge: less than 15 m/min.

.3 Trolley: less 15 m/min.

.7 Power Supply: 600 V, 3-Phase, 60 Hz, 3-wire.

.8 Pendant control.

.9 Minimum 2 speed points, Maximum 5.

.10 Motors: TENV or TEFC, Inverter duty, Class F insulation with Class B rise.

.11 Runway conductors may be cable reel or rigid conductor bars.

.12 Accessories:

.1 Over-hoist limit switch.

.2 Shock absorbing bumpers and end-stops.

.3 Hook safety latch.

.4 Transformers, as required.

.13 Bridge rail elevation: To be determined.

.14 Material: Carbon steel.

.15 Bridge rail support, mounted from roof at elevation: To be determined.

.16 Crane hoist, trolley and bridge classification per CSA B167: A3.

.3 Machine Shop Floor Crane

.1 Capacity: 2 Tonne.

.2 Lift: 3 m.

.3 Manual push, portable frame with steel caster wheels with roller bearings. Front swivel wheels for easy positioning.

.4 Hand actuated hydraulic lift control, with needle valve for lowering and holding control.

.5 Hook safety latch.

.6 Material: Carbon steel.

.7 Meet minimum requirements for Manitoba Workplace Safety and Health Act and Regulations and ASME PALD-2009, Part 9 Shop Cranes.

.4 Oil/Water Separator Bridge Crane: The bridge crane shall be located in the electrical gallery above the oil separator. Requirements are:

.1 Capacity: 0.5 Tonne.

.2 Lift: 7 m.

.3 Span: 9.2 m, to be confirmed.

.4 Max Width: 2 m, to be confirmed.

.5 Runway Length: ~24 m, to be confirmed.
.6 Speeds:
.1 Hoist: 10 m/min.
.2 Bridge: 15 m/min.
.3 Trolley: 15 m/min.
.7 Power Supply: 120 V, 1 Phase, 60 Hz.
.8 Pendant control.
.9 Minimum 2 speed points, Maximum 5.
.10 Motors: TENV or TEFC, Inverter duty, Class F insulation with Class B rise.
.11 Runway conductors may be cable reel or rigid conductor bars.
.12 Accessories:
.1 Over-hoist limit switch.
.2 Shock absorbing bumpers and end-stops.
.3 Hook safety latch.
.4 Transformers, as required.
.13 Bridge rail elevation: To be determined.
.14 Material: Carbon Steel.
.15 Bridge rail support, mounted from roof at elevation: To be determined.
.16 Crane hoist, trolley and bridge classification per CSA B167: A1.

.5 Waste Water Treatment Plant Monorail Crane

.1 Capacity: 1 Tonne.
.2 Lift: 4 m.
.3 Max Length: 2 m, to be confirmed.
.4 Runway Length: ~14 m, to be confirmed.
.5 Electric chain hoist:
.1 Speeds:
.1 Hoist: less than 10 m/min.
.2 Power Supply: 120 Vac, 1 Phase, 60 Hz.
.3 Pendant control.
.4 Minimum 2 speed points, Maximum 5.
.5 Motors: TENV or TEFC, Class F insulation with Class B rise.
.6 Runway conductors may be cable reel or rigid conductor bars.
.7 Accessories:
.1 Over-hoist limit switch.
.2 End-stops.
.3 Hook safety latch.
.4 Transformers, as required.
.8 Material: Carbon steel.
.9 Beam support, mounted from roof at elevation: to be determined.
.10 Crane hoist, trolley and bridge classification per CSA B167: A1.

.6 Intake Hoist Housing Monorail Crane

.1 Capacity: 2 Tonne.
.2 Lift: 3 m.
.3 Max Length: 2 m, to be confirmed.
.4 Runway Length: ~190 m, to be confirmed.
.5 Manual hand chain hoist.
.6 Accessories:
  .1 End-stops.
  .2 Upper limit device (not braking device).
  .3 Hook safety latch.
.7 Material: Carbon steel.
.8 Beam support, mounted from roof at elevation: to be determined.
.9 Crane hoist and trolley classification per CSA B167: A1.

2.2 MANUFACTURERS

.1 Bridge Crane Kit Gorbel Ceiling Mounted Crane System or Purchaser's approved equivalent.

.2 Hoist KITO EFS or Purchaser's approved equivalent.

2.3 EQUIPMENT

.1 The Contractor shall be responsible for the selection, supply, installation and testing of the cranes, complete with all necessary hardware.

2.4 MATERIALS

.1 Crane’s mechanical and structural components to be carbon steel as per manufacturer standard design.

2.5 FINISHES

.1 Cranes shall be protected with the manufacturer's standard heavy duty industrial epoxy primer and topcoat coatings.

2.6 SOURCE QUALITY CONTROL

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Cranes to be functionally tested at the factory and a test certificate provided.

Part 3 Execution

3.1 EXAMINATION

.1 Perform initial visual inspection to verify as received condition of cranes prior to installation.

3.2 INSTALLATION

.1 Crane rails and monorail beams shall be installed and aligned in accordance with Section 41 22 13 Crane Rails of the Technical Specification.

.2 Cranes shall be installed in accordance with manufacturer's requirements.

.3 Perform electrical installation in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

3.3 SITE QUALITY CONTROL

.1 Prepare initial crane inspection and testing reports as required by CSA B167.

.2 Non-Conforming Work

.1 Contractor is responsible for all labour, materials and any other costs associated required for rectifying any defect found during testing to bring the cranes into proper working order in compliance with CSA B167 and in accordance with the requirements of this Section.

3.4 PRE-COMMISSIONING

.1 Cranes shall be inspected and tested as per the requirements of CSA-B167 under the direction of an authorized representative of the crane manufacturer.

3.5 COMMISSIONING

.1 The Purchaser shall perform its own commissioning tests on the small cranes in accordance with the requirements of CSA B167 as part of the station commissioning.

.2 Contractor shall provide commissioning support as requested in accordance with the requirements of Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein to complete the following:

- .1 Supply and installation of cranes rails and end-stops for:
  - .1 Draft tube gate crane.
  - .2 Powerhouse overhead cranes.
- .2 Design, supply and installation of crane rails/monorail beam systems for:
  - .1 Small cranes.

.2 Work by others

- .1 Supply and installation of powerhouse overhead cranes and draft tube gate crane.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 41 22 00 - Small Cranes.

.3 Section 05 12 23 - Structural Steel.

.4 Section 03 15 19 - Embedded Anchors.

.5 Section 03 60 00 - Equipment Grouting

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

- .1 CSA B167-08 - Overhead Travelling Cranes - Design, inspection, testing, maintenance, and safe operation.
- .2 CSA S16-09 - Design of Steel Structures.
- .3 CMAA No. 70 - Specification for Top Running Bridge and Gantry Type Multiple Girder Electrical Overhead Traveling Cranes.
- .4 CMAA No. 74 - Specifications for Top Running and Under Running Single Girder Electric Overhead Cranes Utilizing Under Running Trolley Hoist.
- .5 ASTM A759 - Carbon Steel Crane Rails.
- .6 Manitoba Workplace Safety and Health Act and Regulations.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes as identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.2 Measurement

.1 Measurement for Item 41 22 13 (a) shall be in metres and shall be based on the straight line length of rails as detailed on the Purchaser's Drawings and as directed by the Engineer.

.2 No separate measurement will be made for supplying, transporting, handling and installing the crane rail work complete with splices and clamps for the powerhouse overhead crane.

.3 No separate measurement will be made for supplying, transporting, handling and installing any crane rail/monorail beam systems work complete with splices and clamps for the small cranes required as per Section 41 22 00 Small Cranes of the Technical Specification.

.3 Unit Price

.1 The unit prices for Item 41 22 13 (a) in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission shall be for supplying, storage, loading, transporting, unloading, storing, handling and installation of crane rails complete with plates, anchors, splices, rail clamps and grouting works and as specified herein and as follows:

.1 Item 41 22 13 (a) shall cover draft tube gate crane rails.

.2 The supply and installation of the powerhouse overhead crane rail work complete with splices and clamps shall be considered incidental to the Work set out in Section 05 12 13 Structural Steel of the Technical Specification. Include costs for such Work in the unit prices set out for the Crane Runway Beam specified in Section 05 12 13 Structural Steel of the Technical Specification to which this Work applies.

.3 The supply and installation of the small crane rail/monorail beams systems work complete with splices and clamps shall be considered incidental to the Work set out in Section 41 22 00 Small Cranes of the Techncial Specification. Include costs for such Work in the unit prices set out for small cranes specified in Section 41 22 00 Small Cranes of the Technical Specification to which this Work applies.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including shop drawings, installation manual including installation and test plans, and testing procedures.

.3 Crane rail alignment records.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 DESCRIPTION

.1 Crane rail systems for the draft tube gate crane and the powerhouse cranes to be as indicated on Purchaser's Drawings and as specified herein. Preliminary description of each rail system is as follows:

.1 Draft tube crane rails: ASCE 85 lb rail, Gantrex crane rail clips Weldlok 15/85G with upper and lower components, Grade 5 heavy hex cap screw, hex nut and hardened washer with polysar nose, spaced equally between embedded anchor bolts. At rail splices, install clips close to each end of splice bars. Weld clips according to manufacturer's specifications. After welding, lower clips to be painted for galvanic protection with paint as determined by the Engineer. Final design shall be in accordance with the Purchaser's Drawings.

.2 Powerhouse crane rails: BETH 175 lb rail complete with rail splices, Gantrex crane rail clips Weldlok 43/ 175 with upper and lower components, Grade 5 heavy hex cap screw, hex nut and hardened washer with polysar nose, spaced equally between embedded anchor bolts. At rail splices, install clips close to each end of splice bars. Weld clips according to manufacturer's specifications. After welding, lower clips to be painted for galvanic protection with paint

accepted by the Engineer. Final design shall be in accordance with the Purchaser's Drawings.

.2 Crane rail/monorail beam systems for small cranes to be as designed by the Contractor's engineer, who shall be a licensed Professional Engineer in the Province of Manitoba.

2.2 DESIGN CRITERIA

.1 Crane rail/monorail beam systems designed for small cranes listed in Section 41 22 00 Small Cranes of the Technical Specification shall be in accordance with CSA B167.

2.3 MATERIALS

.1 Contractor shall supply all materials necessary to install the crane rails, as specified herein.

.1 Crane Rails – ASTM A759.

.2 Crane rails for the draft tube gate and the powerhouse overhead crane shall not be galvanized.

Part 3 Execution

3.1 INSTALLATION

.1 Contractor to supply all labour, Materials, Plant, Tools and equipment necessary to install the crane rails, as specified herein.

.2 Crane rails/beams to be installed and aligned as per the requirements of CSA B167 and as indicated on the Purchaser's Drawing for the draft tube and powerhouse cranes. Crane manufacturer's representative shall supervise installation of rails, connecting plates and all associated appurtenances for the crane runway beam for cranes supplied by the Purchaser.

.3 Contractor to install crane endstops as per crane manufacturer's requirements as shown on the Purchaser's Drawings and/or manufacturer's instructions. Crane manufacturer's representative shall supervise installation of end-stops for cranes supplied by the Purchaser.

.4 Contractor shall record crane runway final alignment for review by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. Any corrections required shall be undertaken to the satisfaction of the Engineer.

.5 Grouting shall be in accordance to Section 03 60 00 Equipment Grouting of the Technical Specification.

3.2 SITE QUALITY CONTROL

.1 Crane rails for cranes supplied and installed by others shall be inspected and reviewed by the manufacturer's representative prior to installation of the cranes.

.2 Crane rails for the draft tube gate and powerhouse cranes shall be rechecked for alignment once/year after initial alignment or upon completion of the intake gate housing concrete works, whichever is sooner, and thereafter once/year. Splice plate bolts on crane rails shall be loosened and retightened prior to alignment check.

.3 Crane rails for small cranes shall have their alignment rechecked one year after initial installation or as a close-out activity prior to job completion if less than one year. In the latter case, timing is to be negotiated with the Purchaser.

.4 As part of the recheck of alignment as required in the above sections, all crane rail clip bolts, splice plate bolts, crane rail beam bolts, and end-stop bolts shall be checked for tightness in accordance with the torque specified on the assembly drawings (Purchaser's or Contractor's as applicable).

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, testing, flushing, marking, pre-commissioning and commissioning of the Oil Storage and Handling System, including but not limited to the following:

.1 Oil Storage Tanks (New Oil, Clean Oil, Used Oil, and Waste Oil).

.2 Oil Handling Pumps.

.3 Oil Filters.

.4 Oil Transfer Piping.

.5 Mobile Pump/Filter Skid.

.6 Instrumentation.

.2 Refer to the Purchaser’s Drawings for additional scope details.

1.2 WORK EXCLUDED

.1 Fuel systems (diesel storage tanks and fuel piping) for Standby Diesel Generators (see Section 26 32 13 Standby Diesel Generators of the Technical Specification).

.2 Fuel system (diesel storage tank and fuel piping) for diesel-driven fire pump (see Section 21 12 00 Fire Protection Standpipe System of the Technical Specification).

1.3 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 21 12 00 - Fire Protection Standpipe System.

.4 Section 26 05 00 - Electrical General Requirements.

.5 Section 26 32 13 - Standby Diesel Generators.

.6 Section 40 05 00 - Mechanical and Piping General Requirements.

1.4 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 ASME B31.1 - Power Piping.

.2 CSA W47.1 - Certification of Companies for Fusion Welding of Steel Structures.

.3 CSA W59 - Welded Steel Construction (Metal Arc Welding).

.4 CCME PN 1326 - Environmental Code of Practice for Aboveground and Underground Storage Tank Systems for Petroleum Products and Allied Petroleum Products.

.5 NFPA-30 - Flammable and Combustible Liquids Code.

.6 API 650 - Welded Tanks for Oil Storage

1.5 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 General

.1 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

.2 The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

.3 The Final Target Price for Items of Work set out in this Section shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes identified through Section 27 Clarifications and Changesto the Work and Adjustements of the General Specification.

.2 Measurement

.1 Measurement for Equipment Item 43 20 00 (a)i to 43 20 00 (a)ix will be based on the quantities shown in the Purchaser's Drawings.

.2 Measurement for the following Piping Items will be based on the length of pipe in metres shown in the Purchaser's Drawings, from fitting to fitting, excluding the fitting(s).

.1 43 20 00 (b)i - Lubricating Oil and Governor Oil - Exposed Piping.

.2 43 20 00 (e)i to (e)ii - Waste Oil - Exposed Piping.

.3 Measurement for the following Fitting and Valve Items will be based on the quantities shown in the Purchaser's Drawings.

.1 43 20 00 (c)i to 43 20 00 (c)iii - Lubricating and Governor Oil - Exposed Fittings.

.2 43 20 00 (d)i to 43 20 00 (d)iii - Lubricating and Governor Oil - Valves.

.3 43 20 00 (f)i to 43 20 00 (f)vii - Waste Oil - Exposed Fittings.

.4 43 20 00 (g)i to 43 20 00 (g)v - Waste Oil - Valves.

.4 No separate measurement will be made for the following Items:

.1 43 20 00 (h) - Instrumentation.

.2 43 20 00 (i) - Testing, Flushing and Cleaning.

.3 43 20 00 (j) - Pre-commissioning.

.3 Unit Price

.1 The unit prices for Equipment Items 43 20 00 (a)i to 43 20 00 (a)ix in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in Contractor's

Submission shall be for supply, installation, transporting, unloading, handling, touch-up painting, identification, and final connections of the equipment specified herein.

.2 The unit prices for the following Exposed Piping Items in the Bill of Quantities, Unit Prices and Target Price Estimate as set out in Contractor's Proposal shall be for supply, installation, transporting, unloading, handling, painting and marking of the Items specified herein.

.1 43 20 00 (b)i - Lubricating and Governor Oil - Exposed Piping.

.2 43 20 00 (c)i to 43 20 00 (c)iii - Lubricating and Governor Oil - Exposed Fittings.

.3 43 20 00 (d)i to43 20 00 (d)iii - Lubricating and Governor Oil - Valves.

.4 43 20 00 (e)i to 43 20 00 (e)ii - Waste Oil - Exposed Piping.

.5 43 20 00 (f)i to 43 20 00 (f)vii - Waste Oil - Exposed Fittings.

.6 43 20 00 (g)i to 43 20 00 (g)v - Waste Oil - Valves.

.3 The Estimated Cost for Instrumentation Item 43 20 00 (h) shall be for supply, installation, transporting, unloading, handling, identification, and final connections of the instrumentation specified herein. Instrumentation shall include, but not be limited to, Items such as pressure gauges, temperature gauges, level gauges, differential pressure gauges and switches, supplied by the Contractor, but shall not include instrumentation supplied and installed by an equipment manufacturer. Include the costs for equipment manufacturer supplied/installed instrumentation with the Equipment Item to which it applies.

.4 The Estimated Cost for Testing, Flushing and Cleaning Item 43 20 00 (i) shall be for all non-destructive testing, examination, pressure testing, flushing, and all materials, supplies and equipment necessary to complete the specified activities for the complete system.

.5 The Estimated Cost for Pre-Commissioning Item 43 20 00 (j) shall be for start-up, pre-commissioning tests, repairs, trouble-shooting and all materials, supplies and equipment necessary for pre-commissioning and putting into service of the system as specified herein.

1.6 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor’s Documents of the General Specification.

.2 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification of all applicable Contractor's Document including product data, shop drawings, installation manuals including installation and test plans, testing procedures, flushing procedures, marking procedures, pre-commissioning procedures, and operation and maintenance manuals.

.3 Provide list of recommended spare parts.

.4 Submit all test results and reports to the Engineer.

.5 The Contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.7 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All fittings require a Canadian Registration Number.

.4 Obtain a registration number for the Oil Storage and Handling system from the Province of Manitoba Department of Labour.

1.8 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.9 WARRANTY

.1 Shall be in accordance with the requirements set out in Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Oil Storage Tanks - Tag Nos. 5750-TK-0001 to 0004

.1 Oil storage tanks shall be of the vertical above ground type, of welded steel construction, complete with appurtenances and hold down lugs.

.2 The tanks shall be located in a contained area to prevent oil leakage.

.3 Each tank shall be constructed to the following specification:

.1 Diameter (internal): 1,700 mm.

.2 Height: 4,000 mm.

.3 Capacity: 9000 L.

.4 Design and Fabrication:

.1 Tanks shall be designed and fabricated in accordance with ULC CAN/ULC-S601 Standard for Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids and NFPA-30 Flammable and Combustible Liquids Code.

.2 Tanks shall be suitable for storing Class IIIB liquids inside a building.

.3 Fill and vent lines will terminate outside building approximately 15 m above base of tanks.

.5 Lifting Lugs:

.1 Each tank shall be provided with lifting lugs of adequate size and strength, properly located for lifting the tanks during shipping and installation.

.6 Connections:

.1 Pipe connections shall be accurately aligned. Connections on the top shall be parallel to vertical axis of tank.

.7 Manholes:

.1 Each tank shall have a manhole.

.2 Manholes shall be of the bolted and gasketted type, at least 762 mm (30 in.) in diameter, fabricated in accordance with Underwriters Laboratories of Canada Standards.

.8 Emergency Vents:

.1 An emergency vent shall be installed on each tank.

.2 400 mm (16 in.) diameter, Class 125 flat face flange (undrilled), pressure setting 16 oz/square inch, hinged type, carbon steel, with stainless steel seat, guide stem and hinge pin.

.3 FEP Teflon diaphragm.

.4 Suitable for use on a lubricating oil storage tank.

.5 Acceptable material: Shand and Jars Model 94210, or the Purchaser's approved equivalent.

.9 Welding:

.1 All welding shall conform to the requirements of CSA Standard W59 and shall be undertaken by fabricators and operators who are qualified under CSA Standard W47 and are approved by the Canadian Welding Bureau.

.10 Inspection and Testing:

.1 Factory inspection and testing of the storage tanks shall be in accordance with the Underwriters Laboratories of Canada.

.2 Tanks shall be factory-tested in the vertical position, to a test pressure meeting the requirements of ULC-S601.

.11 Protective Coatings:

.1 Surface preparation, primer and finish shall be applied to the oil storage tanks as follows:

.1 Exterior - As per System S-1 set out in Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification.

.2 Interior - As per System S-3 set out in Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification.

.2 Instrumentation

.1 For required instrumentation refer to Section 40 90 25 Instrumentation for Piping Systems of the Technical Specification.

.3 Pumps - Tag Nos. 5750-PP-0005 to 0010

.1 The type, capacity and discharge pressure for each pump is listed in the table below:

Pump Name	Type	Flow Capacity L/s (GPM)	Discharge Pressure kPa (psi)
Waste Oil Pump (fixed) 5750-PP-0005	Rotary Gear	3.5 (55)	350 (51)
Used Oil Pump (fixed) 5750-PP-0006	Rotary Gear	3.5 (55)	350 (51)
New/Clean Oil Pump (fixed) 5750-PP-0007	Rotary Gear	3.5 (55)	350 (51)
Clean Oil Pump (portable) 5750-PP-0008	Diaphragm	3.0 (48)	350 (51)
Dirty Oil Pump (portable) 5750-PP-0009	Diaphragm	3.0 (48)	350 (51)
Used Oil Pump (mobile) 5750-PP-0010	Rotary Gear	3.5 (55)	350 (51)

.2 All pumps shall be factory-tested.

.3 Rotary Gear Pumps:

.1 Each unit shall consist of a horizontal pump, electric motor driver, manual starter, and accessories.

.2 Suitable for transferring lubricating oil having a viscosity of approximately 1250 SSU at 15^{o}C and a specific gravity of approximately 0.87.

.3 Pump:

.1 The pump shall be of the positive displacement rotary gear type.

.2 The pump shall operate at a maximum synchronous speed of 1,800 RPM.

.3 The body and rotors shall be cast iron and the shafts carbon steel.

.4 The pump shall be provided with mechanical seals and the bearings shall be sleeve type lubricated by the pumped fluid.

.5 The pump shall have a built-in emergency bypass relief valve set at 500 kPa (72 psi).

.4 Motor:

.1 The motor shall be a horizontal foot mounted regreaseable ball bearing induction motor with a totally enclosed fan cooled NEMA enclosure.

.2 Pump motor shall be rated for 575 Vac, 3-phase, 60 Hz service.

.3 The motor shall meet the performance and test requirements of NEMA Standard MG 1.

.4 The motor shall be capable of operating continuously with a 15% overload without injurious stresses or excessive rise in temperature.

.5 The motor shall be mounted on a steel base common to the pump and shall be connected to the pump with a flexible coupling protected by a suitable guard.

.6 The pump and motor shall be accurately aligned.

.5 Acceptable material: Viking Pump Model KK-124, 5 HP, or the Purchaser's approved equivalent.

.4 Diaphragm Pumps

.1 Air-operated double diaphragm design.

.2 Heavy duty ball valve.

.3 The pump shall come with an air filter/regulator assembly (FR-3 recommended) to ensure clean air is supplied to the pump at the correct pressure.

.4 The diaphragm shall be made of BUNA-N (Nitrile).

.5 The body shall be grade 316 stainless steel.

.6 Acceptable material: Warren Rupp, Sandpiper Model HDB2-A or the Purchaser's approved equivalent.

.4 Filters

.1 Mobile Oil Purifier - Tag No. 5750-SP-0200:

.1 The Mobile Oil Purifier shall comply with the following specifications:

.1 Type - vacuum filter.

.2 Flow capacity - 0.95 L/s (15 GPM).

.3 Moisture removal - 100% of free, / 80% dissolved.

.4 Air/gas removal - 100% of free, / 80% of dissolved.

.5 Particle size removal - 3 microns with β_3 /200.

.6 Discharge pressure - 350 kPa (51 psi).

.2 The Mobile Oil Purifier shall remove entrained hydrogen and moisture in the lubricating oil.

.3 Acceptable material: Pritchard Hydra-motion Part No. VDOPS-15VFD-840X-32kW-575-N4-V or the Purchaser's approved equivalent.

.2 Oil Filter Units:

.1 Each Oil Filter Unit shall be arranged as a set, consisting of two edge filters in series with two cartridge filters.

.2 Each filter unit shall be capable of handling a minimum of 3.5 L/s (55 GPM) of lubricating governor oil having a viscosity of approximately 1,250 SSU at 15^{o}C and a specific gravity of 0.87.

.3 There are three oil filter units required in total:

.1 One unit downstream of the New/Clean Oil Pump (fixed).

.2 One unit on the line between the Used Oil Tank/Clean Oil Tank and Oil Trough.

.3 One unit on the Mobile Pump/Filter Skid (Note: this unit may be deleted during detailed design - to be discussed with the Purchaser).

.3 Edge Filter:

.1 The edge filter shall be capable of handling the quantity and type of fluid specified above with a maximum clean pressure drop of 35 kPa (5 psi).

.2 The filter shall be an all metal type rated for at least 850 kPa (123 psi).

.3 The filter shall provide a nominal 40 micron filtration.

.4 A top-mounted handle shall rotate the cartridge past cleaning blades.

.5 A total of six edge filters are required.

.6 Acceptable material: CUNO Auto-Klean Model EGS, or the Purchaser's approved equivalent.

.4 Cartridge Filter:

.1 The cartridge filter shall be capable of handling the quantity and type of fluid specified above with a maximum initial pressure drop of 65 kPa (9.4 psi).

.2 The filter shall consist of a filter vessel, support, and replaceable elements.

.3 The industrial style filter housing shall be rated for 690 kPa (100 psi) working pressure.

.4 The inlet and outlet shall be 1-1/2 in. NPT.

.5 The filter media shall be a pleated cellulose and glass with a steel casing.

.6 The element shall have a nominal rating of 5 microns.

.7 The element shall be capable of withstanding a 240 kPa (35 psi) differential pressure without failure.

.8 A total of six cartridge filters are required.

.9 Acceptable material: Weir Model PP2 with Filtration Systems Model PP-618-C-5-B-SC Filter Elements, or the Purchaser's approved equivalent.

.5 Mobile Pump/Filter Skid

.1 The Mobile Pump/Filter Skid shall include the Used Oil Pump (mobile), two edge filters, and two cartridge filters.

.2 The equipment shall be mounted on a dolly.

.3 The Mobile Pump/Filter Skid unit shall be designed to handle a minimum of 3.5 L/s (55 psi) of lubricating oil having a viscosity of approximately 1250 SSU at 15^{o}C and a specific gravity of 0.87.

.4 The Mobile Pump/Filter skid shall be complete with manual starter and be completely wired and plumbed.

.6 Cable for Mobile/Portable Equipment

.1 The cable for all mobile equipment shall be 15 m long flexible type suitable for extra hard usage complete with ground wire and oil resistant neoprene jacket.

.2 One end shall terminate at the manual starter and the other end shall be equipped with a Crouse-Hinds Model APJ 6465 plug.

.7 Protective Coatings

.1 All structural portions of the dolly frame, filters, piping, and associated devices shall be painted purple as per system S-1 (colour code as set out in Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification) to manufacturer’s factory standard coating.

.8 Testing

.1 Pumps and pre-assembled units shall be hydrostatic and performance tested at the factory prior to shipment.

2.2 MATERIALS

.1 For piping materials (pipes, fittings, flanges, valves, etc) refer the Purchaser's Drawings and applicable Pipe Class Material Specification in Section 40 05 00 Mechanical and Piping General Requirements of the Technical Specification.

.2 Paint for piping: in accordance with Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification. Paint colour shall be purple, per colour code indicated in such Appendix A of Section 09 90 00.

.3 Refer to Part 2 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification for additional material requirements.

Part 3 Execution

3.1 GENERAL

.1 General execution of this aspect of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, testing, flushing, marking, pre-commissioning and commissioning and site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification, in addition to any specific requirements indicated below.

.2 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

END OF SECTION

Part 1 General

1.1. SECTION INCLUDES

1.1.1. The Work to be performed under this Section shall consist of supplying all labour, Materials, equipment, components, piping, instrumentation, devices and ancillary systems as necessary to supply a fully functional, regulatory compliant, Packaged Domestic Water Treatment Plant. The Contractor will perform all Work necessary as shown on the Purchaser's Drawings, as determined by the Engineer and as specified herein for the design, manufacture, supply, transportation, handling, installation, testing, flushing, marking, pre-commissioning and commissioning of the Packaged Domestic Water Treatment Plant.

1.1.2. Refer to this Technical Specification and the Purchaser's Drawings for additional scope details.

1.2. RELATED SECTIONS

1.2.1. Those Sections or Subsections of the General Specification as set out below.

1.2.2. Section 22 11 00 - Domestic Water System.

1.2.3. Section 26 05 00 - Electrical General Requirements.

1.2.4. Section 40 05 00 - Mechanical & Piping General Requirements.

1.2.5. Section 09 90 00 - Painting and Coating.

1.3. REFERENCES

1.3.1. This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

1.3.2. This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

1.3.3. At a minimum, this Work shall be performed in accordance with:

1.3.3.1. Manitoba Building Code:

1.3.3.1.1. Manitoba Plumbing Code.

1.3.3.1.2. National Building Code of Canada.

1.3.3.1.3. Local Regulations and By-Laws.

1.3.3.2. Manitoba Drinking Water Safety Act (C.C.S.M. c. D101):

1.3.3.2.1. Drinking Water Quality Standards Regulation 41/2007.

1.3.3.2.2. Drinking Water Safety Regulation 40/2007.

1.3.3.3. Manitoba Environment Act (C.C.S.M. c. E125):

1.3.3.3.1. Water and Wastewater Facility Operators Regulation 77/2003.

1.3.3.4. Manitoba Public Health Act (C.C.S.M. c. W65):

1.3.3.4.1. Water Supplies Regulation 330/88 R (Amendment 37/2007).

1.3.3.4.2.

1.3.3.4.3.

1.3.3.5. CSA Standards:

1.3.3.5.1. CSA Standard B51-09 - Boiler, pressure vessel, and pressure piping code.

1.3.3.5.2. CSA Standard C22.1 - Safety Standard for Electrical Installations.

1.3.3.5.3. CSA Standard C22.2 - Safety Standard for Electrical Equipment.

1.3.3.5.4. CSA Z432 - Safeguarding of Machinery.

1.3.3.5.5. CSA Z460 - Control of Hazardous Energy - Lockout and Other Methods.

1.3.3.5.6. Manitoba Hydro - Isolation, Lock & Tag Procedure.

1.3.3.6. NEMA Standard MG1 - Motors and Generators.

1.3.3.7. Society for Protective Coatings.

1.3.3.8. National Sanitation Foundation:

1.3.3.8.1. NSF/ANSI Standard 61 (NSF 61) Drinking Water System Components - Health Effects

1.3.3.9. National Fire Protection Association

1.3.3.9.1. NFPA 70 - National Electric Code

1.3.3.9.2. NFPA 79 – Electrical Standard for Industrial Machinery

1.4. MEASUREMENT AND TARGET PRICE PROCEDURES

1.4.1. General

1.4.1.1. The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be determined in accordance with the General Specification, the Terms and Conditions of Payment and as specified herein.

1.4.1.2. The Initial Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the estimated quantity of the Item in the Bill of Quantities, Unit Prices, and Target Price Estimate set out in the Contractor's Submission multiplied by the corresponding unit price set out therein for each Item as specified.

1.4.1.3. The Final Target Price for Items of Work set out in this Section of the Technical Specification shall be calculated as the measured quantity of the Item multiplied by the corresponding unit price in the Bill of Quantities, Unit Prices and Target Price Estimate set out in the Contractor's Submission for each Item as specified and incorporating any changes identified through Section 27 Clarifications and Changes to the Work and Adjustments of the General Specification.

.1 The Contractor shall include the cost of the Domestic Water Treatment Plant in the Target Prices referenced in Section 22 11 00 Domestic Water System of the Technical Specification.

1.5. SUBMITTALS

.2 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

1.5.1. The equipment manufacturer's factory Inspection and Test Plan (ITP) shall be submitted for review by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification prior to commencement of the manufacture of equipment. ITP's shall be provided for key activities and tasks.

1.5.2. Vendor shall maintain a field ITP and quality assurance manual, which shall be submitted to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. The plans shall specify each characteristic to be verified: the requirements, the amount of inspection or testing, and the organizational element responsible for performing the inspections.

1.5.3. Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including material test reports, shop drawings, installation manual, testing procedures, flushing procedures, marking procedures, pre-commissioning procedures and operation and maintenance manuals.

1.5.4. Provide a detailed pre-commissioning program for field-testing. Develop the pre-commissioning program to test that designed capacity is achieved, as indicated in this Section of the Technical Specification, as well as for acceptable controllability and smoothness of operation.

1.5.5. Submit all test results and reports to the Engineer.

1.5.6. The Contractor shall provide a simplified 3D-model of the equipment in accordance with Subsection 21.7.7 3D Model Standards of the General Specification. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6. QUALITY MANAGEMENT

1.6.1. Shall be in accordance with the requirements of Subsection 7.13 Project Quality Management of the General Specification.

1.6.2. Follow the Contractor's Quality Management Plan.

1.6.3. All pressure containing/retaining components, including pipe fittings, valves, expansion joints, flexible connectors, filters, strainers, measuring devices, capacity rated pressure relief devices, overall piping systems, pressure vessels, etc, must be registered through the Authorized Inspector for the Office of the Fire Commissioner Inspections and Technical Standards of Manitoba and shall receive a Canadian Registration Number as per the CSA B51 code.

1.6.4. Obtain permits as required from the Office of the Fire Commissioner Inspections and Technical Standards of Manitoba.

1.6.5. The Contractor shall possess a current and valid Quality Control Program Certificate of Authorization for pressure piping in accordance with CSA B51, applicable for the intended work and endorsed by the authority having jurisdiction in the Province of Manitoba. The Contractor shall submit to the Purchaser the Pressure Systems Quality control Manual prior to performing the Work.

1.7. DELIVERY, STORAGE AND HANDLING

1.7.1. Shall be in accordance with the requirements set out in Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

1.7.2. General

1.7.2.1. Materials delivered to the Site shall be clearly tagged for easy identification.

1.7.2.2. Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

1.7.2.3. All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.7.3. Assembly, Packaging and Shipping Instructions

1.7.3.1. All components shall be assembled to the maximum extent possible prior to shipment. Match mark and tag all assemblies, as required, at the equipment manufacturer's assembly area prior to shipment.

1.7.3.2. Identify individual pieces in accordance with the identification schedule used on the shop drawings and bill of materials to clearly indicate their location in the work for installation.

1.7.3.3. The equipment manufacturer shall provide adequate packing and crating to prevent damage to the parts in transit. Ensure all assemblies and components are suitably protected, loaded and anchored in preparation for shipment.

1.7.3.4. Preparation for Shipment

1.7.3.4.1. Upon completion of manufacture, ensure that all equipment is thoroughly cleaned prior to shipping.

1.7.3.4.2. Surfaces requiring protection shall be coated with a suitable rust preventive material. After coating, spare parts shall be wrapped in heavy moisture-proof paper.

1.7.3.4.3. All flanges shall be coated with a suitable rust preventive and covered with a full-size steel cover, ¼ in. (6 mm) minimum thickness, with rubber gasket and bolted in place by a minimum of four full size bolts. All drilled and tapped holes shall be plugged with steel bar stock plugs. All other exposed pipe ends shall be capped. Plastic plugs are not allowed.

1.7.3.4.4. Miscellaneous parts shall be tagged or marked with the item numbers for which they are intended. All such parts shall be suitably boxed and shipped with the unit.

1.7.3.4.5. One complete set of printed installation, operation and maintenance instructions shall be packaged with the crates and shipped to the Site.

1.7.3.5. Shipping Instructions and Special Requirements

1.7.3.5.1. No shipment of equipment shall be initiated until final release has been received from per Subsection 21.7.9 Engineer's Review of the General Specification.

1.7.3.5.2. The Contractor shall be responsible for coordination of shipment and arrival of all equipment components, accessories, special tools (as required) and drivers at the pre-agreed to delivery point. Drivers and drive components shall be clearly identified and shipped assembled with equipment.

1.7.3.5.3. Rectify any damage to equipment incurred in transit.

1.8. WARRANTY

1.8.1. Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

1.8.2. The membranes shall have a guaranteed lifetime of at least 10 years. Copies of manufacturer's guarantee for the membranes shall be submitted with the Shop Drawings.

Part 2 Products

2.1. PACKAGED DOMESTIC WATER TREATMENT PLANT

2.1.1. Acceptable material: Pall AP-2 Membrane Microfiltration (MF) System or the Purchaser's approved equivalent..

2.1.2. The Packaged Domestic Water Treatment Plant shall be designed a flow rate of 3.0 L/s (48 USgpm) river water; regardless of the preceding and following the effluent water quality must meet the requirements of the Manitoba Drinking Water Safety Act and its Regulations. Additional pre-treatment settling and post treatment disinfection measures may be proposed, only if required, to meet drinking water quality standards. The complete system shall include all necessary equipment, devices, controls, and ancillary system for continuous efficient plant operation. System and components shall be constructed in accordance with CSA and / or ULC standards. Plant shall be designed for treating the following:

Parameter	Unit	Raw Water Quality	Treatment Objectives
Alkalinity	mg/L	59 - 66	N/A
Colour	TCU	30 – 60	≤ 5
Harness	mg/L	77.7 – 199.5	< 200
Iron	mg/L	0.7 – 1.9	0.3
Manganese	mg/L	< 0.05	≤ 0.05
pH	pH units	7.27 – 8.10	6.5 – 8.5
Total Organic Carbon	mg/L	7 – 22	< 3.5
Aluminum	mg/L	0.9 – 2.5	< 0.1
Total Suspended Solids	mg/L	< 2 - 45	
Turbidity	NTU	1.7 - 46	
Total Residual Chlorine	mg/L	1.5	< 0.02
Detectable E. Coli	MPN per 100 ml		0
Total Detectable Coliform	MPN per 100 ml		0
Virus reduction	log reduction		4
Giardia and Cryptosporidium	log reduction		3

2.1.2.1. The microfiltration membrane system described in this section will be the end product of one (1) microfiltration membrane system supplier (MFSS) equipment manufacturer. The equipment manufacturer must be regularly engaged in the application, design and supply of the specified equipment for use in water treatment facilities. In order to demonstrate capability, the equipment supplier shall submit documentation that demonstrates production and supply of the specified equipment for at least ten (10) years, and a minimum of ten (10) similarly sized (or larger) and designed successfully operating units in service. Additionally, the equipment supplier will be required to demonstrate by successful testing (a 1 week demonstration period at site prior to final handover) on the source water intended for use by the equipment that the system can achieve the desired water treatment objectives.

2.1.2.2. Like items of equipment shall be the product of one (1) manufacturer to facilitate standardization of performance, operation, spare parts, maintenance and manufacturer's service. The omission of any items from these specifications shall not relieve the Contractor and microfiltration system equipment manufacturer of the responsibility for providing a complete and operable membrane system.

2.1.2.3. The microfiltration system shall include all hardware, pressure vessels, support structures, membrane elements, valves, interconnecting piping and wiring, control panel, sampling panel, conduit, tubing, fasteners, and instrumentation. The system shall be sized for orientation and function as indicated on the design drawings and as further defined in the follow-on sections below.

2.1.2.4. The acceptable equipment supplier shall have achieved certification and listing by the National Sanitation Foundation (NSF) standard NSF 61 for a complete system.

2.1.2.5. The acceptable manufacturer shall be currently certified as a supplier to meet quality standards as defined by International Standards Organization (ISO) standard 9001 or provide sufficient documentation to demonstrate equivalent Quality Control.

2.1.3. Microfiltration System Functionality

2.1.3.1. The MF system shall be a complete package that is primarily skid mounted and contains all pumps, manual and automated valves, tanks, instruments, pre-filters, membranes, membrane cleaning systems, control system, on-skid piping, wiring, conduit, and tubing to make up a fully operational system. To accommodate shipping, unloading, and layout flexibility, the system shall be provided in one or more pieces to be mounted at the site for installation. If it is necessary to separate the system into two or more assemblies, such as when an off-skid module rack is provided, all the necessary interconnecting piping, tubing, wiring, etc. shall provided for the system to operate as a unit. It is the responsibility of the installation Contractor to install the interconnect piping, wiring, tubing, etc.

2.1.3.2. The MF system shall include the following features as a minimum:

1.1.1.1.1. RF (Reverse Flush) tanks with associated level instrumentation

2.1.3.2.1. Feed tank with associated level instrumentation

2.1.3.2.2. Feed pumps

2.1.3.2.3. Recirculation tank associated pump skid

2.1.3.2.4. Reserve Flush (RF) pumps

2.1.3.2.5. On-skid VFD for control of Feed and RF pumps

2.1.3.2.6. On-skid automatic backwashing pre-filter

2.1.3.2.7. Pressure transmitters for pre-filter and membrane pressure differential measurement

2.1.3.2.8. Temperature transmitter

2.1.3.2.9. Filtrate/backwash flow transmitter

2.1.3.2.10. Module rack and associated piping

2.1.3.2.11. Fully wired control panel with HMI and PLC to provide automation

2.1.3.2.12. Fully automated Integrity Test

2.1.3.2.13. Fully automated air scrub/backwash system

2.1.3.2.14. Ability to provide excess-recirculation or additional cross-flow across the membranes to minimize solids build-up within the modules.

2.1.3.2.15. Semi-automatic CIP (Clean In Place) system utilizing heated cleaning solution, including cleaning tanks and associated pump skids

2.1.3.2.16. All piping, valves, wiring, supports, and associated equipment to provide a fully functional system

2.1.3.2.17. Air compressor system

2.1.3.2.18. Turbidimeters (on-skid)

2.1.3.2.19. EFM (Enhanced Flux Maintenance) tanks and associated pump skids

2.1.3.2.20. Automated CIP Chemical Transfer

2.1.3.2.21. Uninterruptible Power Supply (UPS)

2.1.3.2.22. Alarm Dialer

2.1.3.2.23. Modem for remote access and data trending

2.1.3.2.24. A hypochlorinator with 12% solution at 0.5 ml/s dosing rate (assumed in lieu of water samples).

2.1.3.2.25. Chlorine analyzer

2.1.3.3. Membranes

2.1.3.3.1. Microfiltration modules shall be of hollow fibre construction and configured for a normal filtration flow direction from outside the fibre through to the inside (lumen) of the fibre. They shall be 0.1 micron rated, high-crystalline (PVDF (Polyvinylidenefluoride)) that support high and stable flux rates and constructed with advanced bonding techniques for an exceptionally strong module design.

2.1.3.3.2. Membranes and module shall be compatible with the following cleaning and treatment chemicals at the levels indicated in the following table:

Chemical	**Maximum Concentration**
NaOCl	< 5000 ppm
NaOH	< 4%
HNO3, HCl, H2SO4	< 10%
Citric Acid	< 20%
Oxalic Acid	< 2%
EDTA	< 0.4%
Hydrogen Peroxide	< 2%
Na/KMnO4	< 5000ppm
Chlorine dioxide, ClO2	< 0.2 ppm

2.1.3.3.3. Membrane Modules

2.1.3.3.3.1. The membrane fibers shall be encased in an ABS (Acrylonitrile-Butadiene-Styrene copolymer) housing that is suitable for operating pressures up to 310 kPa (45 psig) and up to 40°C. The membrane fibers together with the housing shall be referred to as a membrane module.

2.1.3.3.3.2. The modules shall be constructed as an integral unit, without mechanical seals such as o-rings and gaskets, to eliminate the risk of raw water bypass to the filtrate side of the membrane.

2.1.3.3.3.3. The modules shall not require special lifting mechanisms for handling and must be able to be individually removed from the membrane rack.

2.1.3.4. Pre-Filter Assembly

2.1.3.4.1. MF system shall include an on-skid automatic self-cleaning strainer to protect the membranes from particles that may cause damage. The strainer backwash shall be initiated by meeting a differential pressure setpoint, or by a specified time interval, whichever comes first.

2.1.3.5. Face-piping

2.1.3.5.1. Face-piping shall be factory installed.

2.1.3.6. Feed / CIP tank

2.1.3.6.1. The MF system shall include a feed tank as a buffer to the raw water supply. This tank allows for a discreet cut-off point between the boundary of the MF system and the water supply system by others. Another purpose of this tank is to allow easy integration of the raw water supply, typically a raw water pump.

2.1.3.6.2. The feed tank shall also serve the purpose of a recycle tank for chemical clean in place (CIP) solutions. The tank shall be equipped with a removable or hinged cover so that manual addition of CIP chemicals can occur if an automated system is not purchased. A 6 mm (1/4 inch) removable perforated screen constructed of PVC shall be installed on the tank outlet to prevent items that may be inadvertently dropped into the tank from damaging the feed/re-circulation pump, or membranes.

2.1.3.6.3. The feed tank shall be equipped with level instrumentation and a modulating control valve sized to operate in the range of 35 to 210 kPa (5-30 PSIG) upstream pressure to control tank level.

2.1.3.6.4. The feed tank shall be constructed of HDPE and be compatible with CIP/water treatment chemicals such as sodium hypochlorite, organic acids, potassium permanganate, chlorine dioxide, and sodium hydroxide. Tank capacity shall be 260 L (70 USgal).

2.1.3.7. Reverse Filtration (RF) Tank and Pump Assembly

2.1.3.7.1. A closed tank shall be included on the MF skid to collect clean permeate to be used for backwash of the membranes.

2.1.3.7.2. The RF tank shall be equipped with level instrumentation and an on-off valve to prevent overflow in normal operation.

2.1.3.7.3. The RF Tank shall be fully enclosed to prevent contamination. It shall be vented through a filter assembly with removable cartridges rated at 10 microns absolute.

2.1.3.7.4. The feed tank shall be constructed of HDPE and be compatible with CIP/water treatment chemicals such as sodium hypochlorite, organic acids, potassium permanganate, chlorine dioxide, and sodium hydroxide. Tank capacity shall be 435 L (115 USgal).

2.1.3.7.5. For backwash of the membranes, the system shall include an on-skid centrifugal pump assembly to deliver filtrate from the RF tank in the reverse direction to the membrane modules.

2.1.3.7.5.1. The RF pump assembly shall be driven by the variable frequency drive (VFD) so that the proper flow to backwash the membranes can be maintained, even if the number of modules changes. The VFD shall be mounted on the MF skid in a NEMA 4 enclosure.

2.1.3.8. Optional functionality

2.1.3.8.1. High efficiency, high output, low pressure amalgam ultraviolet disinfection system (690 kPa design pressure, 40 DVGW (mJ/cm^2) dose range).

2.1.3.9. Instrumentation

2.1.3.9.1. The MF unit shall include at a minimum the following instruments to monitor and report to the control system:

2.1.3.9.1.1. Raw water and treated water turbidity

2.1.3.9.1.2. Raw water flow

2.1.3.9.1.3. Feed tank level

2.1.3.9.1.4. Reverse filtration tank level

2.1.3.9.1.5. Pre-filter inlet pressure

2.1.3.9.1.6. Pre-filter outlet/module feed pressure

2.1.3.9.1.7. Filtrate outlet pressure

2.1.3.9.1.8. Water temperature near the module

2.1.3.9.1.9. Filtrate flow rate exiting the membrane modules

2.1.3.9.1.10. Throttling valve position

2.1.3.9.1.11. Pressure switch for low-air pressure

2.1.3.9.2. All analog instrumentation shall use 24VDC, 4-20 mA output. An alarm will sound if the system detects a transmitter failure.

2.1.3.9.3. Local display of the following shall be included, either as integrated into the transmitter, or as individual indicators for the following:

2.1.3.9.3.1. Turbidity

2.1.3.9.3.2. Raw water flow

2.1.3.9.3.3. Feed tank level

2.1.3.9.3.4. Reverse filtration tank level

2.1.3.9.3.5. Pre-filter inlet pressure

2.1.3.9.3.6. Pre-filter outlet/module feed pressure

2.1.3.9.3.7. Filtrate outlet pressure

2.1.3.9.3.8. Filtrate flow rate

2.1.3.9.3.9. Instrument air pressure for valve actuation

2.1.3.9.3.10. Instrument air pressure for module regeneration

2.1.3.9.3.11. Module regeneration air low rate

2.1.3.9.4. Instrumentation to be provided on-skid, as specified:

2.1.3.9.4.1. Laser Nephelometers

2.1.3.9.5. Instrumentation that may be provided for installation off-skid include (but are not limited to):

2.1.3.9.5.1. pH meter

2.1.3.9.5.2. Particle counters

2.1.3.9.5.3. Raw water flow measurement

2.1.3.10. Automatic PLC control panel

2.1.3.10.1. The MF system shall have a main control panel mounted on the support skid. In addition to the necessary CSA standards, the control panel shall designed and constructed per the National Electrical Code (NFPA 70) and Electrical Standard for Industrial Machinery (NFPA 79). The enclosure shall be NEMA 4 rated stainless steel enclosure with mounting hardware, complete with PLC, power supply, I/O racks, terminal blocks, relays, timers, switches, indication, etc., as required for a complete operating system.

2.1.3.10.2. Allen Bradley Series PLC, complete with necessary digital and analog I/O modules for a complete operating system. BCE includes an operator interface terminal Series 1,000 Panelview Plus color touch screen and necessary programming to indicate system status, backwash, alarms, exterior signals, wells, and other functions as required for complete system operation.

2.1.3.10.3. Includes the following control components: One uninterruptible power supply, software, communication ports, etc., as required for a complete installation.

2.1.3.10.4. Hand/Off/Auto (HOA) switches shall be provided for each piece of equipment to facilitate maintenance activities and to allow manual control in the event of control system failure.

2.1.3.10.5. Control panel will be shop tested prior to shipment, subject to witnessing by Engineer or delegate if required.

2.1.3.10.6. PLC shall be mounted within the enclosure shall be the system's main controller. This shall be a commercially available programmable logic controller with sufficient I/O to automatically control the system's valves, send signals to operate the system's pumps, and receive input from the instruments included with the system. A block of terminals shall be provided within the control panel; specifically designated to receive input from customer's instruments. There will be wired into the PLC's I/O to allow the system to accept signals from customer's upstream or downstream equipment so that the system can be automatically stopped, started, or production rate changed based on the availability of feed water or filtrate storage space.

2.1.3.10.7. Wiring to/from PLC input/output modules shall run through a properly sized fuse to protect the instrument or PLC module.

2.1.3.10.8. All distribution and instrumentation systems are to be grounded/bonded in accordance with Section 26 05 28 Surface Grounding of the Technical Specification.

2.1.3.10.9. The MF system shall include an Ethernet connection port for connecting the system to a Local Area Network and/or an existing SCADA system if properly configured.

2.1.3.10.10. Alarms

2.1.3.10.10.1. Alarm conditions shall be displayed and acknowledged at the main operator interface terminal (OIT). An alarm condition shall also cause the alarm pilot light to be lit, and an audible horn mounted on the control panel shall sound. Controls shall be included to allow the operator to silence the horn, but the alarm will continue to be visually displayed until the alarm is corrected/acknowledged.

2.1.3.10.10.2. The following alarm conditions are included as a minimum:

2.1.3.10.10.2.1. Q-stop

2.1.3.10.10.2.2. Feed Pump Fault

2.1.3.10.10.2.3. RF Pump Fault

2.1.3.10.10.2.4. Lack of feed fluid/filtrate storage

2.1.3.10.10.2.5. Low Air Pressure

2.1.3.10.10.2.1. Integrity Test Failure

2.1.3.10.10.2.2. Low/high RF tank level

2.1.3.10.10.2.3. High/Low feed tank level

2.1.3.10.10.2.4. CIP required (high TMP)

2.1.3.10.10.2.5. High turbidity (optional)

2.1.3.10.10.2.6. High/low water temperature

2.1.3.10.10.2.7. Level, pressure, flow, temperature transmitter failure

2.1.3.10.11. Once the Quick-stop pushbutton is pressed (located on the control panel door), all pumps on the MF skid shall stop, and the system's inlet, outlet, and drain valves shall close. The system will not be able to operate again until the operator disengages the Q-stop button.

2.1.3.10.12. Chemical, Hot Water, Neutralization (CH) Skid

2.1.3.10.12.1. A CHN (Chemical, Hot Water, Neutralization) system shall be provided. This system generally includes: a tank with an immersion heater, level control and temperature transmitter, a supply pump to transfer the water to the AP system feed/recirculation tank, air driven diaphragm chemical pump, solenoids, control panel to control the operation and communicate with the AP or master control system, and the various valves, injection ports, piping, and wiring required. The supply pump, valving, injection ports, control panel, etc. are skid mounted, with interconnect piping included to connect to the free-standing warm water tank. The chemical pump is mounted on a plate and shipped loose so that it can be located directly on a chemical drum or tote. This system provides the following:

2.1.3.10.12.1.1. Warm Water for CIP (Clean In Place) operations.

2.1.3.10.12.1.2. Provides EFM (Enhanced Flux Maintenance) capability.

2.1.3.10.12.1.3. Provides capability for automatic injection of CIP chemicals, if an automated CIP injection option is purchased.

2.1.3.10.12.1.4. Provides capability for automatic injection of chemicals to neutralize the CIP waste if an optional Neutralization System is purchased.

2.1.3.10.13. CIP Transfer/Injection

2.1.3.10.13.1. This allows automatic transfer of the CIP (Clean In Place) chemicals into the Recirculation Tank, eliminating the need for manual addition by the operator. The CHN skid is required to use the CIP transfer system. The CIP transfer system includes two additional chemical pumps (mounted on plates) that may be mounted directly on chemical drums or totes, along with the associated solenoid valves, injectors/check valves, foot valves, and programming.

2.1.3.10.14. Air Compressor System

2.1.3.10.14.1. An air compressor system shall be supplied to meet the air requirements of the MF system and associated components. The system shall consist of two (2) rotary screw compressors (one duty, one standby) and a receiver tank, along with associated filters, gauges, relief valves, drains, etc. required for a complete air supply system. The MFSS will determine the compressor and receiver tank best suited for the application.

2.1.3.10.15. Turbidimeters

2.1.3.10.15.1. Turbidimeters shall be provided to measure and report the turbidity (in NTU) of the feed and/or filtrate. Two turbidimeters may be mounted on the skid, with feed and filtrate ports already installed, or shipped loose for installation by Contractor. Turbidimeters shall be as follows:

2.1.3.10.15.1.1. Common Feedwater Piping – 1 HACH Model 1720 turbidity meter,

2.1.3.10.15.1.2. Filtrate Piping – 1 HACH Model 660 laser turb supplied on filtrate piping from each MF train.

2.1.3.10.16. Chlorine Analyzer

2.1.3.10.16.1. A chlorine analyzer may be purchased to monitor the free or total residual chlorine level using a colorimetric DPD chemistry technique. This avoids the need for probes or manual procedures. A sample line is connected to the analyzer, and an analysis is run every 2 ½ minutes. The analyzer may be used for pre-treatment processes (such as NaOCI addition for Fe or Mn removal), or for controlling the chlorine residual in the filtrate water to distribution.

2.1.3.10.17. Chemical Injection Pumps

2.1.3.10.17.1. If chemical injection is required, a diaphragm metering pump with controls to vary the flow rate is used. The pump

may be mounted on the AP frame if applicable, or may be installed (by others) at a nearby chemical drum. The pump will be controlled by the system's operating system.

2.1.3.10.18. Protective Coating

2.1.3.10.18.1. Vessel Paint/Coating:

2.1.3.10.18.1.1. Interior - Coating System S-2 as set out in Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification.

2.1.3.10.18.1.2. Exterior - Coating System S-1 as set out in Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification.

2.1.3.10.18.2. Other exterior surfaces normally painted shall be cleaned and finished with Coating System S-1 as set out in Appendix A, Section 09 90 00 Painting and Coating of the Technical Specification.

2.1.3.10.18.3. Other surfaces subject to corrosion shall be coated with a corrosion preventative that is readily removable with a commercial solvent.

2.1.4. Hydropneumatic Tank

2.1.4.1. One (1) 1067 mm (3'-6") diameter X 1524 mm (5'-0") side shell horizontal hydropneumatic tank, carbon steel construction, rated for a total capacity of 1,685 l (445USgal), designed in accordance with ASME and bearing the ASME stamp. Tank to weigh approximately 454 kg (1,000 pounds). Including:

2.1.4.1.1. Structural support saddle

2.1.4.1.2. Two (2) cast iron centrifugal pumps, 7.5 HP, 3600 RPM, 575V; 4.1 l/s (65gpm) @ 551 kPa (80 psi), as specified.

2.1.4.1.3. Duplex compressed air system will consist of two (2) compressor pumps with (2) 2 hp, 575V, 3 phase motors, mounted on a 227 l (60 USgal.) ASME code horizontal receiver tank. System requires a 115-volt receptacle

2.1.5. All equipment shall be provided with lifting lugs as required for general handling.

2.1.6. Provide any special tools required for operation and/or maintenance.

2.2. SOURCE QUALITY CONTROL

2.2.1. Equipment is subject to inspection at the following stages of manufacture.

2.2.1.1. Prior to shop testing.

2.2.1.2. Prior to packaging for shipment.

2.2.2. Test equipment to ensure satisfactory operation prior to shipping. Provide certification of satisfactory performance.

2.2.3. Inspect all shop welds prior to shipment. Ensure the welds comply with applicable codes and standards as noted previously in this Section of the Technical Specification.

2.2.4. Inspect and calibrate all installed instrumentation.

2.2.5. Confirm all system wiring.

2.2.6. Submit a written statement that materials and operation conform to the Purchaser's Drawings and the Technical Specification.

2.2.7. Provide the Engineer with all reasonable access to this aspect of the Work whether it is in preparation or progress. Provide proper facilities for such access and for inspection.

2.2.8. Perform factory tests with the understanding that such tests do not constitute a waiver of field commissioning requirements and the requirement to pass field tests under the specified operating conditions.

Part 3 Execution

3.1. INSTALLATION

3.1.1. Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

3.1.1.1. All equipment and material shall be installed plumb and/or horizontal within one-quarter inch in ten feet and conform to the reviewed shop drawings.

3.1.1.2. Membrane rack support structures shall be anchored to the equipment pad, and grouted in place with non-shrink grout after final alignment.

3.1.1.3. A competent and experienced representative of the MF manufacturer shall be on-site during the entire installation, testing, start-up full time at such time as the installation of the microfiltration membrane system package beings. The representative of the MF manufacturer shall remain on-site to observe the installation and connection of the instrumentation and control system.

3.1.1.4. Control system testing and acceptance, final documentation and training shall be the responsibility of the Contractor and MF manufacturer.

3.1.2. Provide a certificate signed by the manufacturer stating that the piping system has been installed in accordance with manufacturer's recommendations.

3.1.3. System to be completely accessible for removal, modification and cleaning.

3.1.4. Piping

3.1.4.1. Pitch 1:100 in direction of flow, without pockets, to low points.

3.1.4.2. Install valved drains at bottom of risers and at low points in system.

3.1.4.3. Minimize contamination by leaving pipe valves and fittings in sealed cartons until prior to their use and seal openings in piping system after installation.

3.1.4.4. Use of thread lubricants shall comply with manufacturer’s recommendations.

3.1.5. Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

3.2. PRE-COMMISSIONING

3.2.1. The Contractor shall demonstrate (with the help of the equipment manufacturer), in the presence of the Engineer, all mechanical and electrical equipment.

3.2.1.1. Factory Acceptance Testing (FAT)

3.2.1.1.1. MF system shall be fully tested prior to shipment. The purpose of the testing is to assure that the system components will be fully functional when properly installed at the site. The testing shall include:

3.2.1.1.1.1. Instrument operation and calibration verification of on-skid equipment.

3.2.1.1.1.2. Check operation of all on-skid pumps, valves, strainer, etc.

3.2.1.1.1.3. Process testing, including running water through the system to verify the various operations and check for leaks.

3.2.1.1.1.4. Verify that equipment supplied matches approved P&ID and electrical drawing.

3.2.1.1.1.5. Verify alarms and alarm display.

3.2.1.1.1.6. Verify that the system programming follows the System Functional Description.

3.2.2. After installation perform pre-commissioning testing to establish the integrity of the system with respect to:

3.2.2.1. Control system operation.

3.2.2.2. Alignment of all mechanical components.

3.2.2.3. Performance of safety and protection devices.

3.2.2.4. Excess vibration.

3.2.2.5. Noise levels.

3.2.2.6. Clearances

3.2.3. Submit relevant equipment repair procedures to the Engineer if repairable defects are identified during testing. Do not repair or use defective parts without prior approval from the Engineer.Commissioning

3.2.4. The equipment manufacturer's representative shall be present to direct the pre-commissioning and to make control system adjustments required during pre-commissioning.

3.2.5. Final system performance testing shall be undertaken by the equipment manufacturer at the Site. Influent and effluent samples shall be collected and tested to verify performance during pre-commissioning. The equipment manufacturer's proposed acceptance criteria shall be included in its bid submission to the Contractor for review by the Purchaser or Purchaser’s representative.

3.3. COMMISSIONING

3.3.1. The Purchaser will commission the Packaged Domestic Water Treatment Plant only after the satisfactory completion of the pre-commissioning tests by the Contractor.

3.3.2. The Contractor shall provide support during commissioning as requested by the Engineer.

3.3.2.1. Provide manufacturer’s services, not including travel time, as follows:

3.3.2.1.1. Minimum of fifteen (15) labour days to check the installation and advise during start-up, testing, and adjustment of each system.

3.3.2.1.2. Minimum of five (5) labour days to instruct the Owner’s personnel in the operation and maintenance of the systems.

3.3.3. Test report.

3.3.3.1. In order to meet the water treatment objectives necessary for this process, the Contractor shall provide proof of performance suitable for system registration with the appropriate regulatory authorities. A written report resulting from successful testing (a 1 week demonstration period at site prior to final handover)

on the source water proposed for use by the facility will constitute satisfactory proof of operational performance with regard to the specified performance and water quality parameters. The test report must be submitted and approved by the Engineer and Owner before final acceptance is granted.

3.4. IDENTIFICATION

3.4.1. Nameplates and Identification Tags.

3.4.1.1. In accordance with Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification.

3.4.1.2. All equipment shall have a standard nameplate securely affixed in a conspicuous place, showing the following information.

3.4.1.2.1. Equipment manufacturer's name and address.

3.4.1.2.2. Purchaser’s equipment number.

3.4.1.2.3. Equipment capacity.

3.4.1.2.4. Equipment serial number.

3.4.1.2.5. Equipment model number.

3.4.1.2.6. Total weight of equipment.

3.4.1.2.7. Year of manufacture.

3.4.1.2.8. Shipping date.

3.4.1.2.9. Other information the equipment manufacturer may consider necessary to complete identification of the equipment.

3.5. SITE QUALITY CONTROL

3.5.1. Inspection and testing, unless stipulated below, shall be carried out at the equipment manufacturer's facilities and shall be available for witnessing and acceptance by the Engineer. A minimum of 15 working days notice to the Engineer shall be provided of all test points.

3.5.2. The equipment manufacturer shall include in its scope of work, items, accessories and services that are usual or necessary to complete the work set out in this Section of the Technical Specification, but which may not have been specifically mentioned herein.

3.5.3. The equipment manufacturer shall include sufficient commissioning services and performance testing to demonstrate regulatory compliance and satisfaction of performance guarantee parameters.

3.5.4. The equipment manufacturer shall provide on-site training sufficient to satisfy the Purchaser's and regulatory requirements, complete with manuals, for all Purchaser’s operating personnel.

3.6. CLEANING

3.6.1. The requirements shall be in accordance with Subsection 7.40 Clean-up and Removal of Plant, Surplus Materials and Debris of the General Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein for the design, supply, transportation, handling, installation, testing, flushing, marking, pre-commissioning and commissioning of the Packaged Wastewater Treatment Plant.

.2 Refer to Purchaser's Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 22 13 00 - Sanitary System.

.4 Section 23 30 00 - Heating Ventilation and Air Conditioning System.

.5 Section 26 05 00 - Electrical General Requirements.

.6 Section 40 05 00 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time the Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

.1 Standards:

.1 CAN/CSA S16.1 Limit States Design of Steel Structures.

.2 Laws:

.1 Manitoba Building Code.

.2 Manitoba Plumbing Code.

.3 National Building Code of Canada.

.4 Local Regulations and By-Laws.

.5 Manitoba Environment Act (C.C.S.M. c. E125):

.1 Onsite Wastewater Management Systems Regulation 83/2003 (Amendments 64/2008, 156/2009 and 60/6010).

.2 Water and Wastewater Facility Operators Regulation 77/2003 (Amendments 162/2005 and 52/2007).

.6 Manitoba Public Health Act (C.C.S.M. c. W65):

.1 Protection of Water Sources Regulation 326/88 R.

.2 Water Works, Sewerage and Sewage Disposal Regulation 331/88 R (Amendment 38/2007).

.3 Manitoba Water Protection Act (C.C.S.M. c. W65):

.1 Manitoba Water Quality Standards, Objectives and Guidelines Regulation 196/2011.

.4 Manitoba Apprenticeship and Certification Act (C.C.S.M. c. A110):

.1 Trade of Water and Wastewater Technician Regulation 4/2011.

.2 Wastewater System Effluent Regulations (SOR/2012-139).

.5 Environmental Protection Plan.

.4 Electrical Design Standards

.1 CSA Standard C22.1 - Safety Standard for Electrical Installations.

.2 CSA Standard C22.2 - Safety Standard for Electrical Equipment.

.3 NEMA Standard MG1 - Motors and Generators.

.4 CSA Z432 - Safeguarding of Machinery.

.5 CSA Z460 - Control of Hazardous Energy - Lockout and Other Methods.

.6 Manitoba Hydro - Isolation, Lock & Tag Procedure.

.5 Other Guidelines

.1 Ontario Design Guidelines for Sewage Works.

.2 NFPA 820 - Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

.3 Manitoba Hydro - Fire Protection & Prevention Standards

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 The Contractor shall include the costs of the Packaged Wastewater Treatment Plant in the Target Prices set out in Section 22 13 00 Sanitary System of the Technical Specification.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor’s Documents of the General Specification.

.2 Equipment manufacturer's factory Inspection and Test Plan (ITP) shall be submitted for review by the Engineer in accordance with Subsection 21.7.9 Engineer's Review of the General Specification prior to commencement of the manufacture of equipment. ITP’s shall be provided for key activities and tasks.

.3 Equipment manufacturer shall maintain a field ITP and quality assurance manual, which shall be submitted to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification. The plans shall specify each characteristic to be verified: the requirements, the amount of inspection or testing, and the organizational element responsible for performing the inspections.

.4 Submit for Engineer’s review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including factory and onsite commissioning test reports, shop drawings, installation manual including installation and test plans, testing procedures, flushing procedures, marking procedures, pre-commissioning procedures and operation and maintenance manuals.

.5 Provide a detailed pre-commissioning program for field testing. Develop the pre-commissioning program to test that designed capacity is achieved, as indicated in the specification as well as for acceptable controllability and smoothness of operation.

.6 Submit all test results and reports to the Engineer.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All pressure containing/retaining components, including pipe fittings, valves, expansion joints, flexible connectors, filters, strainers, measuring devices, capacity rated pressure relief devices, overall piping systems, pressure vessels, etc, must be registered through the Authorized Inspector for the Office of the Fire Commissioner Inspection and Technicial Services of Manitoba and shall receive a Canadian Registration Number as per the CSA B51 code.

.4 Obtain permits as required from the the Office of the Fire Commissioner Inspection and Techncial Services of Manitoba.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspection of Deliveries to Site and Storage of the General Specification.

.2 General

.1 Materials delivered to the Site shall be clearly tagged for easy identification.

.2 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.3 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

.3 Assembly, Packaging and Shipping Instructions

.1 All components shall be assembled to the maximum extent possible prior to shipment. Match mark and tag all assemblies, as required, at the manufacturer's assembly area prior to shipment.

.2 Identify individual pieces in accordance with the identification schedule used on the shop drawings and bill of materials to clearly indicate their location in the Work for installation.

.3 The manufacturer shall provide adequate packing and crating to prevent damage to the parts in transit. Ensure all assemblies and components are suitably protected, loaded and anchored in preparation for shipment.

.4 Preparation for Shipment:

.1 Upon completion of manufacture, ensure that all equipment is thoroughly cleaned prior to shipping.

.2 Surfaces requiring protection shall be coated with a suitable rust preventive material. After coating, spare parts shall be wrapped in heavy moisture-proof paper.

.3 All flanges shall be coated with a suitable rust preventive and covered with a full-size steel cover, ¼ in. (6 mm) minimum thickness, with rubber gasket and bolted in place by a minimum of four full size bolts. All drilled and tapped holes shall be plugged with steel bar stock plugs.

All other exposed pipe ends shall be capped. Plastic plugs are not allowed.

.4 Miscellaneous parts shall be tagged or marked with the item numbers for which they are intended. All such parts shall be suitably boxed and shipped with the unit.

.5 One complete set of printed installation, operation and maintenance instructions shall be packaged with the crates and shipped to the Site.

.5 Shipping Instructions and Special Requirements:

.1 No shipment of equipment shall be initiated until final release has been received from the Engineer.

.2 The Contractor shall be responsible for coordination of shipment and arrival of all equipment components, accessories, special tools (as required) and drivers at the pre-agreed to delivery point. Drivers and drive components shall be clearly identified and shipped assembled with equipment.

.3 Rectify any damage to equipment incurred in transit.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 GENERAL

.1 The Contractor shall furnish and install one factory-built Packaged Wastewater Treatment Plant, complete and ready for operation in accordance with the plans and specifications stated herein.

.2 The Packaged Wastewater Treatment Plant shall be a Model A-4M24-SHUV prefabricated steel package as manufactured by AEROMIX Systems, Inc., Minneapolis, Minnesota, or the Purchaser's approved equivalent.

.3 The Packaged Wastewater Treatment Plant shall be of the activated sludge type, specifically known as "Complete Mix/Extended Aeration Activated Sludge ".

.4 The Packaged Wastewater Treatment Plant shall be designed for treating a total of 2,500 litres per day of 314 mg/l-BOD5 (Biochemical Oxygen Demand); 240 mg/l TSS (Total Suspended Sediments) domestic sewage based on composite sewage samples of the average daily flow.

.5 No substances shall be introduced in quantities which are toxic to biological organisms.

.6 The Packaged Wastewater Treatment Plant shall be designed to handle average daily flows fluctuating over the range of 60% to 100% of design flow and peak hourly flow rates not to exceed 200% of design flow, with an effluent quality of less than or equal to 200 fecal coliform organisms/ 100 mL for fecal coliform; 25 mg/lBOD5; 25 mg/l TSS.

.7 The Packaged Wastewater Treatment Plant shall include all necessary equipment for efficient plant operation.

.8 The Packaged Wastewater Treatment Plant shall be factory assembled, so far as possible, with all piping and controls. All surfaces shall be factory painted.

.9 Provide equipment with lifting lugs as required for general handling.

.10 Provide any special tools required for operation and/or maintenance.

.11 Indicate confined spaces and biohazard areas on applicable parts of the equipment.

2.2 TANK CONSTRUCTION

.1 Tank shall be constructed to Canadian Welding Bureau Standards.

.2 All structural plates associated with the outer and inner vertical tanks walls and all partition walls shall be structural grade carbon steel plate, Grade 300, not less than 6 mm minimum thickness joined by arc welding with fillets of adequate section for the joint involved.

.3 All walls shall be continuous and watertight and shall be supported by structural reinforcing members where required.

.4 Fabrication and erection shall conform to the appropriate requirements of CAN/CSA S16.1.

.5 Connection shall conform to the requirements of the Canadian Welding Bureau Standards and shall develop the full strength of the member.

.6 Aeration tank shall have reinforcing members on 1,800 mm maximum spacing and H-frame reinforcing shall be provided on end walls and partition walls.

.7 All tank piping shall be schedule 40 PVC unless specified otherwise.

.8 The Packaged Wastewater Treatment Plant shall be transported to the Site in section(s). The Contractor shall be responsible for field assembly, including bolting or welding when required.

2.3 COATING AND CORROSION CONTROL

.1 All vessel surfaces to be painted shall be properly prepared in a workmanlike manner to obtain a smooth, clean and dry surface.

.2 All rust, dust, and mill scale as well as other extraneous matter shall be removed by means sandblast, interior (immersion) surfaces shall receive near white blast cleaning SSPC-SP10.

.3 All interior vessel surfaces shall be painted with one coat of Tnemec series 46H-413 Coal Tar Epoxy, 8-10 mils total dry film thickness, or Purchaser's approved equivalent.

.4 All exterior (non-immersion) vessel surfaces shall receive commercial blast cleaning SSPC-SP6, and shall be painted with one coat of Tnemec series 46H-413 Coal Tar Epoxy, 8-10 mils total dry film thickness, or Purchaser's approved equivalent.

2.4 FOUNDATION

.1 A poured concrete foundation pad shall be constructed and provided by the Contractor as foundation for the steel tanks.

.2 The pad shall be level within tolerances of 12 mm per each 3,000 mm of width and within 6 mm per each 3,000 mm of length.

2.5 INLET CONNECTION

.1 The influent connection shall be one, 100 mm diameter 150# standard flange.

.2 The inlet shall be located at the flow equalization end-wall of the Packaged Wastewater Treatment Plant.

2.6 INLET BAR SCREEN

.1 A bar screen shall be provided at the influent port, to remove any unusually large solids from the incoming raw sewage.

.2 The bar screen shall be fabricated from one-half inch diameter bars spaced 1 inch apart and arranged as shown on the Purchaser's Drawings.

.3 The bars shall be sloped to permit easy cleaning of accumulating debris.

.4 A drying deck shall be furnished for drying this debris.

2.7 AEROBIC DIGESTER/SLUDGE HOLDING CHAMBER

.1 An aerated aerobic digester chamber shall be provided as specified and shown on the Purchaser's Drawings and Contractor's Documents. It shall be designed to hold a minimum of 1,135 litres of sludge.

.2 The digester chamber shall be constructed as an integral part of the Packaged Wastewater Treatment Plant and fabricated out of 1/4 in. steel plate. The chamber shall have the same protective coating as specified for the Packaged Wastewater Treatment Plant. It shall also have the same structural requirements as the Packaged Wastewater Treatment Plant.

.3 The chamber shall be of the aerated type with diffusers placed longitudinally along one side of the chamber so as to, in conjunction with the flow control baffles, enhance the spiral rotation of the chamber contents to maintain solids suspension. All piping and valves within the chamber shall be factory installed.

.4 Diffused air shall be supplied by the main treatment plant blower of sufficient size to provide a minimum of 2,100 cubic feet of air per pound of B.O.D. (5-day, 20°C) applied and an airflow of two CFM (minimum) spaced evenly the entire length of the aeration tank. The diffuser spacing and air velocity shall assure that adequate mixing velocities are maintained within the aeration tank to prevent dead spots and maintain cleansing velocities. The diffusers shall be parallel to the fillet and at an elevation which provides optimum diffusion and mixing of the tank contents. The diffuser assembly shall be easily removable from the tank and shall be equipped with an air regulating valve to permit either adjustment of the air flow or complete shut off. The oxygen transfer capacity of each diffuser shall be such that an adequate supply of oxygen will be maintained in the aeration chamber to meet treatment requirements of the design sewage load.

.5 The diffusers shall be a Model CYCLONE™ as manufactured by AEROMIX Systems, Inc., Minneapolis, Minnesota, or Purchaser approved equivalent. The diffusers shall be manufactured to produce a double shear when air is released. The air is sheared as it discharges the air orifice of the air diffuser body and again as it crosses over the diaphragm baffle. The air check diaphragm located on top of the diffuser is molded directly to the diffuser body, preventing the cap from blowing off when excess CFM is delivered to the diffuser. The diffuser shall be supplied with standard male pipe thread connections.

.6 An airlift pump with vertically adjustable intake and air control valve shall be provided for the purpose of decanting supernatant from the aerobic digester. The airlift piping shall be schedule 40 painted steel piping, and neoprene bands shall isolate the piping from all steel surfaces. The pipe shall pivot on a swivel joint. The intake elevation

adjustment shall allow the water level in the digester to be lowered a minimum of 48 inches.

.7 The digester chamber shall be set on the same concrete foundation pad as the Packaged Wastewater Treatment Plant and set at the location as shown on the Purchaser's Drawings.

2.8 AERATION CHAMBER

.1 There shall be supplied, an aeration chamber to work in conjunction with the clarifier chamber. The aeration chamber shall conform to the following specifications.

.2 The aeration chamber shall be of sufficient capacity to provide a minimum of 24 hours retention of the average daily flow, and/or a minimum chamber volume of 1,500 litres. The vessel shall be so shaped on each side to prevent sludge accumulation, to enhance rotation of the vessel contents, and to prevent scum and froth accumulation. To insure maximum retention and eliminate short circuiting of raw sewage particles, the aeration chamber shall be constructed with air diffusers, placed longitudinally along one side of the chamber so as to, in conjunction with the flow control baffles, enhance the spiral rotation of the chamber contents. To ensure adequate circulation velocity, the proportion of the chamber width to depth, in the direction of rotation, shall not exceed 1.33 to 1. The velocity of rotation shall be sufficient to scour the bottom and prevent sludge filleting as well as to prevent the escape to the surface of minuscule air diffusion bubbles and by so causing their entrapment to provide maximum oxygenation efficiency.

.3 An air distribution manifold shall be installed longitudinally on one side of the tank with diffuser drop assemblies connected thereto.

.4 Each diffuser drop assembly shall be equipped with an air regulating and/or shutoff valve, a disconnecting union and a diffuser bar with non-clog air diffuser nozzles mounted thereon. The airflow per diffuser shall range from 1 to 30 SCFM. This minimum air velocity shall be maintained to insure sufficient velocity for self-cleaning. The diffusers shall be parallel to and near the base of the vessel sidewall and at an elevation, which shall provide the optimum diffusion and mixing of the vessel contents. The oxygen transfer capacity of each diffuser shall be such that an adequate supply of oxygen will be maintained in the aeration chamber to meet treatment requirements of the design sewage load.

.5 The diffusers shall be a Model CYCLONE™ as manufactured by AEROMIX Systems, Inc., Minneapolis, Minnesota, or the Purchaser's approved equivalent. The diffusers shall be manufactured to produce a double shear when air is released. The air is sheared as it discharges the air orifice of the air diffuser body and again as it crosses over the diaphragm baffle. The air check diaphragm located on top of the diffuser is molded directly to the diffuser body, preventing the cap from blowing off when excess CFM is delivered to the diffuser. The diffuser shall be supplied with standard male pipe thread connections.

2.9 CLARIFIER CHAMBER

.1 There shall be furnished a clarifier chamber to work in conjunction with the aeration chamber of that system. The clarifier shall conform to the following specifications.

.2 The clarifier chamber shall be of such size as to provide a minimum of four hours retention, based upon the same design flow rate governing the aeration chamber, and shall have proper baffling to prevent short circuiting and to provide maximum uniform retention. The clarifier inlet shall be baffled to prevent short-circuiting and provide

maximum uniform solids settling area. The bottom of the chamber shall be formed into an inverted pyramidal hopper or hoppers. The flat bottom area of each hopper shall not exceed 1 square foot. The slope of the hopper walls shall not be less than 1.7 vertical to 1.0 horizontal. Settled sludge shall be returned from the clarifier sludge hopper to the aeration chamber by the positive sludge return system, consisting of an airlift pump. The clarifier effluent shall pass over the edge of the baffled adjustable effluent weir into the effluent trough and then out of the chamber. The weir plate shall be constructed of 1/8 in. galvanized steel and shall be gasketed with ¼ in. neoprene.

2.10 SLUDGE RECIRCULATION SYSTEM

.1 There shall be installed within the clarifier chamber, a positive sludge recirculation system, consisting of 65 mm diameter airlift sludge return assembly, meeting the following specifications: The airlift pump system shall have the recirculation capacity ranging from 0% to 150% of the design flow. The airline supplying air to the pump shall be equipped with a needle valve varying the capacity of the pump. The airlift pump shall be firmly supported and shall be equipped with a clean-out plug to allow for easy cleaning and maintenance.

2.11 SCUM RECIRCULATION SYSTEM

.1 There shall be installed within the clarifier chamber a positive scum and skimming recirculation system consisting of 50 mm diameter airlift skimming device(s) meeting the following specifications: The skimming device shall be of the positive airlift pump type, located in a position to skim and return floating material to the aeration chamber. The airline supplying air to the skimming device shall be equipped with a needle valve to regulate the rate of return.

.2 The scum intake shall be equipped with an adjustable assembly, which shall enable exact positioning of the skimmer at water level without placing a hand under the water.

2.12 INLET CONNECTION

.1 The 150 mm diameter clarifier loading pipe shall be installed from a point near the bottom of the loading well in the center of the clarifier. It shall be designed to minimize deposition of solids and slow down the flow to improve settlements of solids.

2.13 EFFLUENT WEIR ASSEMBLY

.1 Furnish a steel weir trough with serrated weir plates fabricated from 10 gauge galvanized steel plate allowing up to an including 2 in. of adjustment. The weir trough shall be firmly fastened to the clarifier wall.

2.14 AERATION AIR SUPPLY BLOWER MOTOR UNITS

.1 For supplying the air requirement of the main treatment process, two blower motor units shall be furnished and installed at the location shown on the Purchaser's Drawings. The units shall be completely factory built and tested before shipping to the Site. The blower shall be of the two-lobe involute type design complete with the accessories described below.

.2 The blower motor unit, FPZ, Inc. Model SCL20DH-1.5-3, or the Purchaser's approved equivalent, shall be furnished for supplying the air requirements of the aeration chamber, each with the capacity of 20 scfm at 4 psig, powered by a 1.5 hp, 575 volt, 60 Hz, 3

phase TEFC motor, mounted on a steel base plate with inlet filter/silencer, discharge silencer, check-valve, pressure relief valve, and pressure gauge.

2.15 AERATION ELECTRICAL CONTROL CONSOLE

.1 An electrical control panel shall be installed within a NEMA 4X fiberglass weatherproof enclosure with a locking hasp and free standing leg kit. The control console shall be provided for mounting as indicated on the Contractor's Documents. Any exterior mounting hardware shall be stainless steel or other corrosion resistant material.

.2 The control console shall be completely factory assembled and tested prior to shipment. The control console shall be furnished with all necessary controls for each blower motor unit and associated plant equipment. Control voltage shall be 120 Vac, 1-Phase.

.3 Controls shall be mounted to a removable sub-panel within the enclosure and shall be wired and spaced in accordance with the latest Canadian Electrical Code. The control console shall be supplied with a properly sized magnetic-circuit breaker to act as the main disconnects for the control console with interlocking door handle. Magnetic starters with 3 leg overload protection shall be supplied for all blower motor units. To vary the air supply, a program timer shall be supplied. An electrical alternator shall be furnished to alternate the operation of each blower motor unit. An electrical alternator shall be provided with a manual selector switch to allow manual selection of the lead blower if desired. Provide individual, IEC rated circuit breakers. Provide blower running indicating lights, door mounted, Hand-Off-Auto selector switches, door mounted, elapsed time meters, door mounted. Panel shall be UL 508 Listed with terminals for field connections.

.4 The 24-hour, 7-day time clock shall be capable of being programmed to control the blower run cycle and to adjust both the start set point and the blower run time. The clock shall also include a skip-a day feature which allows for a separate program for weekends (when required).

.5 All wiring conductors within the control console shall be U.L. type THHN, stranded #14 AWG minimum, rated at 600 Volts. Control wiring shall be numbered on each end.

.6 All wire and conduit required between the control panel and the electrical power service shall be furnished and installed by the Contractor. Wiring and conduit between the control panel and plant equipment shall be furnished by the manufacturer of the Packaged Wastewater Treatment Plant. The panel may be detached for shipping. The main power supply shall be 575 Volt, 3-Phase, 60 Cycle. The control voltage shall be 120 Volt, 1-Phase with 120 Volt control transformer, circuit breaker protected.

2.16 ULTRA-VIOLET DISINFECTION UNIT

.1 Disinfection will meet or exceed Manitoba's standard of 200 fecal coliform organisms/ 100 mL for fecal coliform.

.2 A baffle type disinfection chamber shall be provided, constructed as an integral part of the Packaged Wastewater Treatment System. The chamber shall be installed immediately following the clarifier. Baffles shall be provided to eliminate short-circuiting and shall be designed to keep floating material from leaving the chamber.

.3 The chamber shall have the same protective coating as specified for the Packaged Wastewater Treatment System. The chamber shall have the same structural requirements as the Packaged Wastewater Treatment Plant.

.4 An ultra-violet type disinfection chamber shall be provided, constructed as an integral part of the tertiary treatment system. The contact chamber shall be installed immediately following the clarifier.

.5 The disinfection chamber shall have the same protective coating as specified for the tertiary treatment system. The tank shall have the same structural requirements as the tertiary treatment plant.

.6 Ultraviolet Disinfection Unit, Trojan Technologies model UV3025K-PTP, or Purchaser's approved equivalent, shall consist of two UV lamps per module with their corresponding electronic ballast in an aluminum enclosure mounted on a stainless steel type 316 frame. Each UV module shall be provided with a standard 120 volt plug and weatherproof cable for connection to a receptacle. The cable shall be no longer than 10 ft. A total of one UV modules (2 UV lamps) shall be supplied. Materials of construction shall be stainless steel type 316, anodized aluminum, quartz 214, and Teflon.

.7 Effluent channel stainless steel type 304, 14 gauge effluent channel complete with UV module support rack and downstream serpentine weir.

.8 Operators kit, each system shall be supplied with one pair of rubber gloves, one face shield.

.9 UV light intensity monitor, to be mounted by the Contractor within 20 ft of UV unit, NEMA 4X wall mounted panel, elapsed time in hours shall be indicated on 5 character display. Both displays shall utilize seven segment LED’s and shall be visible through the panel door.

.10 Cleaning rack, Type 304 stainless steel. The rack shall be designed to facilitate the servicing operation of the UV modules.

2.17 SERVICE WALKWAY

.1 A service walkway shall be provided for the service area only (or all tank openings) to service the Packaged Wastewater Treatment Plant equipment. Grating panels shall each consist of galvanized Shurgrip safety grating.

.2 Hand railing shall be provided along all open sides of the walkway.

.3 A 45°-access stairway shall be provided leading to the service walkway for the service area only to service the Packaged Wastewater Treatment Plant equipment.

.4 Hand railing and stairway shall satisfy the requirements of the National Building Code of Canada, Manitoba Workplace Safety and Health Guidelines, and the Purchaser’s standard handrail drawings set out in the Purchaser's Drawings.

2.18 FLOW MEASUREMENTS

.1 For measuring the flow rate through the Packaged Wastewater Treatment Plant, a flow-measuring weir shall be supplied. The weir shall be an adjustable "V" notch weir located at the outlet end of the disinfection tank.

.2 For measuring the flow rate, an ultrasonic flowmeter with a circular chart recorder shall be installed. The unit shall record, indicate, and totalize the flow through the Packaged Wastewater Treatment Plant.

2.19 FLOWMETER

.1 Refer to Section 40 90 25 Instrumentation for Piping Systems of the Technical Specification.

2.20 EFFLUENT CONNECTION

.1 The effluent connection of the Packaged Wastewater Treatment Plant shall be located as shown on the Purchaser's Drawings and Contractor's Documents and shall consist of one, 150 mm diameter 150# standard flange.

2.21 SOURCE QUALITY CONTROL

.1 Equipment is subject to inspection at the following stages of manufacture.

.1 Prior to shop testing.

.2 Prior to packaging for shipment.

.2 Test equipment to ensure satisfactory operation prior to shipping. Provide certification of satisfactory performance.

.3 Inspect all shop welds prior to shipment. Ensure the welds comply with applicable codes and standards as noted previously in this specification.

.4 Inspect and calibrate all installed instrumentation.

.5 Confirm all system wiring.

.6 Submit a written statement that materials and operation conform to the Purchaser's Drawings, Contractor's Docucments and this Section of the Technical Specification.

.7 Provide the Engineer with all reasonable access to this part of the Work whether it is in preparation or progress. Provide proper facilities for such access and for inspection.

.8 Perform factory tests with the understanding that such tests do not constitute a waiver of field commissioning requirements and the requirement to pass field tests under the specified operating conditions.

2.22 SLUDGE DEWATERING

.1 Provide the following with rotary press sludge dewatering system

.1 Skid system rotary press sludge dewatering equipment and appurtenances.

.2 Rotary press sludge feed pump and associated VFDs.

.3 Two chemical blend/feed systems.

.4 PLC process controls, control panels.

.5 pH meter and controller.

.6 All necessary bolts, anchor bolts and hardware.

.2 Equipment Performance

.1 Equipment Description:

.1 Rotary press sludge dewatering shall be constructed for continuous operation in humid and corrosive environment.

.2 Chemical feed systems, and sludge pumps shall be monitored and controlled from a rotary press sludge dewatering control panel.

.3 Provide all appurtenant equipment and piping normally furnished as an integral component of rotary press sludge dewatering, whether or not specifically required in this Section of the Technical Specification.

.4 Design and performance criteria of unit specified establish minimum requirements. When installed and operating, equipment shall meet or exceed specified minimum performance requirements.

.5 Equipment shall be completely factory assembled and tested, unless otherwise specified in this Section. Equipment main frame assembly shall require only bolting to floor at the Site and connection of external piping and electrical wiring.

.6 Conditioning with inorganic chemicals such as lime or ferric chloride is unacceptable.

.7 Compliance with the performance section of this Section of the Technical Specification shall not relieve the Contractor of the responsibility to provide equipment which is mechanically and structurally equal to the specified equipment.

.8 The dewatering system shall be capable of operating both continuously and intermittently.

.2 Design Criteria:

.1 Sludge Characteristics:

.1 Type of Sludge: Aerobically Digested Sludge.

.2 Sludge Production:

.1 Design Daily Sludge Production: 1.0 dry lb of solids per day.

.2 Wastewater treatment plant manufacturer to confirm sludge dewatering capacity is sufficient to support the overall wastewater treatment capacity.

.3 Sludge Consistency:

.1 Digested Sludge: 1.0 to 3.0%.

.2 Equipment:

.1 No. of rotary press unit: One.

.2 No. of dewatering channels: One.

.3 Main drive motor size: 3 hp, 575 v, 60 hz., 3 phase, totally enclosed.

.3 Performance Criteria:

.1 Rotary Press Parameters:

.1 Minimum Required Cake Dry Solids at Average Percent Feed Sludge Dry Solids: 18%.

.2 Minimum Solids Capture: 90% (filtrate solids plus wash water solids).

.3 Maximum Polymer Usage at Average Percent Feed Sludge Dry Solids: 20 dry lbs active polymer per ton of feed sludge dry solids.

.3 Manufacturers

.1 The Contractor's Packaged Wastewater Treatment Plant manufacturer shall: Provide equipment of one of the following:

.1 The basis of design (including but not limited to Site, process, mechanical, structural, HVAC, instrumentation, electrical, etc.) for this system has been based upon Model RFP-18Q Single Channel 18" Rotary Fan Press manufactured by Prime Solutions, Inc. of Allegan, MI; or equal.

.4 Details of Construction

.1 Rotary Press Sludge Dewatering Equipment:

.1 The rotary press shall consist of one dewatering channel with a minimum diameter of 450 mm. The rotary press shall utilize the combination of controlled sludge feed along with chemical conditioning of the sludge, drainage of free water (filtrate) within the channel(s) of the rotary press, controlled pneumatic adjustable restrictor gate as the filter plates slowly continuously rotate, producing a sludge cake with the minimum dry weight percent solids as listed in the performance criteria.

.2 The Contractor's manufacturer shall provide one totally self-contained, factory assembled 450 mm diameter rotary press, single channel designed to extract water from the type sludge/slurry specified herein to meet the performance requirements listed.

.3 All equipment supplied shall be mounted on welded, powder coated carbon steel, self supporting skids with all equipment pre-wired and plumbed.

.4 The rotary press shall be comprised of at least the following components:

.1 Main drive system.

.2 Dewatering channel mounted on opposing side of drive.

.3 304 stainless steel filter wheels and slotted elements.

.4 Easily accessible inspection windows.

.5 HD support base.

.6 Pneumatic controlled restriction gates.

.7 Internal channel wash.

.8 304 stainless steel cake discharge chutes.

.5 The main drive system shall be low speed high torque helical/bevel foot mounted to the HD epoxy coated steel base. It shall be fabricated according to ANSI/AGMA 6010 standards with a minimum AGMA standard of 9. The output shaft shall be made of ANSI 17-4 stainless steel or better for maximum service life. The incorporated design of the main drive to the channel housing shall not allow direct contact with the sludge, filtrate or cake at anytime. The robust construction of the main drive shall be used to mount and support the inner channel house by bolting to manufacturer's engineered mounting holes, preventing leakage or gear-misalignment caused by shaft mounting. Flanged mounted electric drive motor shall be as per 2.22.2.2, "C" face, washdown/ VFD rated, high efficiency motor with a minimum service factor 1.15.

.6 Each rotary press dewatering channel shall consist of an epoxy coated inner housing, epoxy coated outer housing, center seal, 304 stainless steel filtration support wheels, block divider, external filtration wash

bars, and large hinged viewing/inspection window. Any channels requiring channel bearings of any kind within the dewatering channel assembly shall not be acceptable for this application.

.7 Both inner and outer housing shall be of a one piece constructed of a combination 1" thick steel ring and heavy plate, which shall be blasted, primed and powder coated to a minimum of 8 mils. The inner housing shall be mounted by bolting to manufacturer's engineered mounting holes provided by the gearbox manufacturer, allowing for proper support without causing overhung load stress of shaft mounted dewatering channels. The outer housing shall have a clear and sealed hinged window for viewing and access to the filter screen outer support for all dewatering channels. The channel housings shall contain all liquids within themselves and have a 6 inch filtrate discharge located in the bottom of each side of the housings. Shaft mounted dewatering channels, bearings and seals within the dewatering channel and/or dewatering channels requiring a separate gland cover shall not be acceptable for this application.

.8 The dewatering channel shall have pneumatically adjusted radial seals to maintain the seal for the outer filter support wheel. Any equipment requiring any manual adjustment for the radial seal shall not be considered acceptable for this application.

.9 Each channel shall have an inner and outer filtration element and filter element support made of 304 stainless steel. The filter element supports shall be mounted and attached to the common drive shaft that is directly attached to the gear reduction drive of the rotary press. Under maximum loading conditions the element supports shall not have a deflection greater than 0.005 over the entire surface area or require internal bearings for support of the element support wheels.

.10 The dewatering channel filtration elements shall be constructed of two slotted non-clogging filter plates with supports constructed of 304 stainless steel or better, separated and sealed by a polyglass filled channel center seal. Various openings shall be available to match the sludge to be dewater maximizing performance of the rotary press. The channel width dimension shall be set according to the sludge characteristics and the performance specified.

.11 Each of the rotary press dewatering channels shall have both internal and external filter wash options. The wash water time internals shall be operator directed through the main operator panel. Washing of the filter elements shall be capable of being done without interrupting the dewatering process at anytime. The wash water requirement for internal filter screen wash and external filter screen shall be as per 2.22.2.2. The incoming water connection shall be 25 mm FNPT to the distribution manifold with the 110 V solenoid valves for controlling the water flow.

.12 Each dewatering channel shall have a tapered pneumatic adjustable self compensating glass filled poly sludge cake restrictor gate. With the restrictor gate in its fully open position it shall not restrict the sludge cake opening in any way.

.13 Individual 304 stainless steel cake discharge chutes shall be provided for each dewatering channel. Each cake discharge chute shall have an easy

to remove inspection cover to gain access to the cake discharge area of the rotary press.

.14 Structural Main Skid Frame

.1 All equipment associated with the rotary press and ancillary equipment listed within this Section of the Technical Specification shall be mounted on welded skid assemblies, allowing space and access for any routine maintenance. Any ancillary equipment listed but to be mounted separately shall be noted as "Remote" mounted. All discharge conveyors listed shall not be included as an integral part of the skid assembly.

.2 The skid base framework shall be of all welded carbon steel construction blasted, epoxy primed and powder coated. All welding shall conform to the American Welding Society Structural Welding Code. Bolted construction of any main supporting frame member of systems requiring additional space is not acceptable.

.3 The frame design construction shall be of an open, compact design allowing for easy maintenance, cleaning and simplicity. The structural frame shall be provided with lifting eyes designed to lift the fully assembled skid system.

.15 Sludge Retention Manifold and Piping

.1 After the polymer and sludge have been mixed in the sludge conditioning system, it shall enter the sludge retention manifold. This sludge retention manifold shall also provide for the sludge feed connection to the rotary press. A minimum of 15 seconds shall be allowed for the polymer and sludge to form and adequate floc before entering the rotary press.

.2 The sludge retention manifold shall be rigidly mounted to the skid platform using schedule 80 PVC piping in a gentle winding "C" formation to minimize space requirements and provide the required retention time as specified. Use of tanks to provide retention time of the sludge/polymer is not acceptable.

.3 The sludge retention manifold shall have operator controlled sludge divert (bypass) option, where the operator can choose to send the sludge back to the source of supply and not to the rotary press should it be so desired. The bypass also will automatically open should operational feed pressures exceed the operator control set point.

.4 The retention manifold shall also include one clear see-through section for visual purposes as well as one sampling port for drawing samples of the flocculated sludge during operation.

.5 Within the sludge retention manifold, a pneumatic sludge bypass valve shall be furnished to divert sludge back to the head of the plant for recycle back into the system.

.16 Air Compressor

.1 System air shall be provided by an oil-lubricated single stage air compressor. Compressor and motor shall be mounted on an air receiver tank with adequate capacity for operation of the entire

system. Compressor system shall include a pressure gauge and adjustable pressure regulator.

.2 A water separator shall be installed within the pneumatic system. In addition an automatic condensate drain valve is provided that is factory pre-wired into the control system of the unit.

.17 Cationic Polymer Feed/Blend System Located on Rotary Press Skid:

.1 Each rotary press skid system shall be provided with a sludge conditioning system, designed to make down the proper polymer solution, efficiently mix polymer with the sludge and to adequately flocculate the sludge, for optimum dewatering.

.2 The emulsion polyer dilution/feed system shall consist of the integrated equipment package capable of metering neat polymer, adjusting dilution water rate, activating and metered feeding of the activated polymer solution.

.3 The system shall include the following components:

.1 Mechanical liquid polymer activation/high shear mixer.

.2 Neat polymer metering pump.

.3 Neat polymer check valve.

.4 Dilution water inlet manifold with flow control.

.5 Low water pressure switch and solenoid valve.

.6 Miscellaneous equipment.

.7 NEMA 4X electrical enclosures.

.4 The mechanical hydrodynamic blending device specifically designed to dilute and activate emulsion, dispersion and solution type polymer with viscosities ranging from 200 to 3,000cps and active contents up to 50% shall be provided.

.5 The liquid polymer activation mixing energy shall be staged such that it provides for high, non-damaging mixing energy over the full operating range of the system. The system shall be designed for use with either potable or non-potable dilution water.

.6 System's which are "retention time dependent" - a system which is prone to induce insufficient or excessive mixing energy depending of flow rate and the subsequent retention time in the mixing chamber, or which utilize conventional static mixers shall not be considered. All components which require periodic maintenance shall be readily accessible.

.7 Provide a diaphragm type or peristaltic neat polymer metering pump capable of viscous liquid. The pump shall have an output range of up to 30 L/hr and mounted within the frame of polymer system.

.8 Provide a neat polymer check valve specifically designed to isolate neat polymer from dilution water. The valve shall be constructed of stainless steel, PVC and viton. The valve shall be readily accessible for cleaning. Valves with are installed inside the mixing chamber or which require mixing chamber disassembly for servicing will not be accepted.

.9 The dilution water inlet assembly shall be connected to the skid water supply manifold, NEMA 4X dilution water solenoid valve, rota-meter type flow meter, stainless steel liquid filled dilution water inlet pressure gauge and bronze PRV water supply regulating valve. Post dilution shall not be required to meet total specified flow range.

.10 The solution discharge assembly shall be plumbed into the polymer injection system, including a stainless steel liquid filled pressure gauge to monitor polymer injection pressure.

.11 Provide an industrial duty differential pressure switch sensing loss of dilution water pressure rated NEMA 4. Pressure switches with plastic construction and/or fittings or mechanically actuated switches shall not be acceptable.

.12 An enclosed polymer aging tank shall be mounted within the skid frame allowing additional time for the polymer to activate.

.13 The skid system shall have a magnetic type sludge flow meter mounted in the main feed piping to the sludge retention piping. The flow meter shall be connected to the PLC in the main control panel for sludge readouts, and process totalizer calculations.

.18 Pressure transducers shall be provided to read and control water pressure, air pressure, polymer flow, main sludge feed pressure, channel sludge feed pressure and cake discharge restrictor. All pressure transducers used for sludge applications shall be mounted on an isolation ring to prevent damage to the transducer itself.

.5 Additional Equipment of the System

.1 The Contractor's rotary press system shall provide the following additional equipment and associated accessories as a part of the rotary press system.

.1 Chemical Metering System: Chemical conditioning of the waste stream will be accomplished with the following chemical metering injection system:

.1 Polymer Feed System for Sludge:

.1 The sludge shall be conditioned utilizing a neat emulsion anionic polymer which shall be injected into the waste stream.

.2 pH Sensor and Transmitter:

.1 Retractable ORP Sensors/pH Sensors:

.1 Rosemount model 396R by Rosemount or Purchaser's approved equivalent.

.2 The sensors shall be retractable under pressure so that maintenance and inspection can be conducted without shutdown of the process.

.3 A 316 stainless steel process connector (Rosemount CN 23166-00) and a 316 SST ball valve kit (Rosemount PN 23240-00) shall be included with each sensor.

.4 The sensors shall be 21” titanium tubes.

.5 The ORP sensors shall provide a measurement range of -1200 to 1,200 mV with a temperature range of 0˚-100˚C.

.6 The sensors shall be installed in the sludge pipe downstream of pinch valve at the location recommended by rotary press dewatering system manufacturer.

.7 The Contractor shall supply a 25 mm NPT threaded pipe connection for each unit.

.8 The sensor shall be provided with a local read out that consists of one Solu Comp II analyzer.

.9 The analyzer shall be wall mounted within 4.5 m of cable length from the insertion probes.

.10 The analyzers shall each have a NEMA 4X enclosure.

.11 The power supply shall be 115 VAC, 60 Hz.

.12 Each sensor shall be connected to the analyzer with a flexible cable to permit removal of the sensor from the pipeline.

.13 The display shall be a pH.

.14 The pH transmitter shall measure over the range of 0 to 14.

.6 Finishing

.1 All materials used in the construction of the sludge dewatering equipment shall be of the best quality and entirely suitable in every respect for the service required. All structural steel shall conform to the ASTM Standard Specification for Structural Steel. All iron castings shall conform to the ASTM Standard Specifications for Gray Iron Castings and shall be of a class suitable for the purpose intended. Other materials shall conform to the ASTM Specifications where such specifications exist and the use of such materials shall be based on continuous and successful use under similar conditions of service.

.2 The following materials and coatings shall be provided for the rotary press and related components unless specified otherwise herein:

Housings	Cleaned/Blasted/Primed and Powder Coated 8 mils
Frame	Cleaned/Blasted/Primed and Powder Coated 8 mils
Skid	Cleaned/Blasted/Primed and Powder Coated 8 mils
Filter Plate Supports	316 Stainless Steel or better
Filter Plates	316 Stainless Steel or better
Center Seal	Glass Filled Poly
Piping	Schedule 80 PVC or better
Tubing	Nylon/Poly
Discharge Chutes	304 Stainless Steel
Hardware, Fasteners, Springs, Clips, etc.	18-8, 304 & 316 Stainless Steel

.3 All items listed as stainless steel shall not be coated. Zinc flame spray, epoxy painted, nylon coated and/or hot dip galvanizing of any material that is not authentic alloy stainless steel shall not be considered an acceptable substitute to this specification.

.7 Controls

.1 Electrical Components and Instrumentation:

.1 The operation of the rotary press dewatering system shall be able to be operated in either manual or automatic mode. The system shall be able to control flow, pressure, conditioning mixing and ancillary equipment listed in this Section of the Technical Specification. All control functions shall be easily readable and adjusted from the touch screen operator control panel.

.2 The rotary press shall be supplied with the following NEMA 4X rated components: including but not limited to; operator control panel, touch screen, low water pressure switch, pressure transducers, flow meter, pneumatic controls and water solenoids. All skid mounted components shall be wired to the operator supplied control panel. All wire runs carrying more than 24 VDC shall be in water tight pvc or pvc coated conduit, or cabling securely mounted to the skid. All controls and communication wiring 24 VDC or less shall be jacketed cable rated for intended use, securely mounted to the skid.

.3 The skid system shall have a magnetic type sludge flow meter mounted in the main feed piping to the sludge retention piping. The flow meter shall be a “Foxboro 2000 Series” or the Purchaser's approved equivalent with hard rubber liner, hastelloy c electrodes, ANSI flange connections, 316 stainless steel grounding rings and a IP67 enclosure. The flow meter shall be connected to the PLC in the main control panel for sludge readouts, and process totalizer calculations.

.4 Pressure transducers shall be used to read and control water pressure, air pressure, polymer flow, main sludge feed pressure, channel sludge feed pressure and cake discharge restrictor. All pressure transducers used for sludge applications will be mounted on an isolation ring to prevent damage to the transducer itself.

.2 Electrical Control Panel (General):

.1 An electrical control panel shall be furnished with the rotary press skid system to control the rotary press functions and related ancillary equipment. The panel shall be preassembled and pre-wired and shall include all controls necessary for automatic and manual system operations. The panel shall be suitably wired for connection to a 575 V, 3 phase, 60 Hz power source.

.2 The enclosures shall be NEMA 4X.

.3 Control devices mounted on the enclosures door shall be rated for and installed to maintain the NEMA 4X rating. All components mounted on the panels shall be clearly labeled to properly identify the function of each device.

.4 Controls for remote, electrically-operated or motor-driven equipment shall be complete, including all necessary auxiliary relays. The Contractor shall provide required wiring and connection to equipment’s control circuit.

.5 All electrical components shall be ULC or CSA recognized and all wiring shall comply with the Canadian Electrical Code.

.6 The main control enclosure shall house a panel mounted main disconnect with a through the door handle, all motor starters, variable frequency controls, a programmable logic controller, interlocks, alarms, indicating

lights and touch screen display required for operation of the rotary press and ancillary equipment.

.7 All equipment shall be completely checked out and hot tested prior to shipment. This shall include a test of all switches, lights, relays, and other components. All safety devices shall be rechecked completely for operation, function and control prior to final clean up and packaging for shipment.

.3 Main Control Panel:

.1 The main control panel shall be wired 575 volts 3-phase 60 Hz. Cycle, unless otherwise noted. A step down transformer shall provide 120 V AC control power and the DC voltage shall be 24 V.

.2 The panel shall contain a master panel mounted fused disconnect with a through the door handle, rated 125% of full load current.

.3 The panel shall contain:

.1 A red mushroom EMERGENCY STOP button that provides a means of quickly stopping all equipment controlled from this panel. This shall be accomplished by tripping the master control relay to turn off all outgoing control power which has to be manually reset.

.2 A green power indicator pilot lamp. This indicates MCR/ CONTROL MCR.

.3 An illuminated flush green master START button. This activates the MCR.

.4 All operators and pilot lamps shall be as per Division 26 - Electrical of the Technical Specification.

.5 Motor control shall be provided by properly sized IEC starters, overloads, VFD’s, and individual breakers per each device required.

.6 Control and monitoring shall be provided by a through Program Logic Controller (PLC) in conjunction with a touch screen display.

.7 The PLC shall be an industrial grade programmable logic controller, capable of controlling the required functions of the entire rotary press system and ancillary equipment. The PLC shall be manufactured by Automation Direct or the Purchaser's approved equivalent.

.8 All fault and alarms shall be displayed and logged by the touch screen. The following alarms at a minimum shall be required:

.1 Low polymer Water Pressure.

.2 Press Drive Fault.

.3 Sludge Drive Fault.

.4 Low Air Pressure.

.5 Analog Signal Loss.

.4 Variable Frequency Drives:

.1 The master control shall include driver units that meet the functional requirements associated with each motor involved with process control. Motor and drive unit selection shall be based upon the operating profile of the machine, with particular attention given to the limits of motor performance when operated at less than full speed with a VFD.

.2 The drive unit shall operate with an output of 100% continuous capacity without exceeding the motor specification for:

.1 Temperature rise.

.2 Full load current draw.

.3 Vibration.

.4 Noise.

.5 Phase slip.

.5 Programmable Logic Controller:

.1 PLC shall be an all-solid-state logic control system capable of performing same functions as conventional relays, timers, counters, and drum sequencers. System shall consist of a PLC, programmer unit, and all interconnecting cables.

.2 PLC shall be programmed in common PLC programming language. PLC shall be easily programmed with portable program panel.

.3 PLC shall be capable of operating in hostile industrial environmental (e.g., heat, electrical transients, RFI, vibration) without fans, air conditioning, or electrical filtering, at up to 60°C and 95% relative humidity, non-condensing.

.4 PLC shall be supplied as a programmed unit, fully operational, and with complete documentation of final operating program.

.5 Programmable logic controller unit shall consist of the following units:

.1 Central Processor: PLC shall be capable of relays, timers, counters, shift registers, and sequencers. PLC shall be capable of interfacing up to 112 discrete inputs or outputs. PLC shall have password protect to prevent unauthorized program changes.

.2 Memory: PLC memory shall be CMOS semi-conductor memory with battery backup. CMOS memory with battery backup shall retain program during power interruptions of up to 15 months. An LED shall indicate status of batteries. Each unit shall be supplied with sufficient memory to implement specified control functions plus reserve capacity of 30% of total provided. Reserve capacity shall be totally free from system use. Memory shall be programmed in multi-node configuration with multiple series or parallel contact, counters and timers.

.3 Input/Output Modules: All I/O modules shall contain isolating devices providing 1,500 V DC or more isolation from users wiring or other I/O modules. I/O housing and modules shall be of rugged construction and, with modules in place, shall be shielded against electrical nose and RFI. Outputs shall have capability of being “latched” so they are retentive through power interruption.

.1 Input modules, 24 V DC, shall provide eight 120 VAC inputs. Modules shall have LED indication for each input. 16 AC outputs supply shall be fused and controlled via the MCR. All output shall deenergize when control power is off and at emergency stop.

.2 Provide sufficient I/O modules with each PLC to implement specified control functions plus reserve capacity of ten percent of total provided.

.4 Power Supply: Power supply shall operate at the following:

.1 115 V AC rms plus or minus 15 percent continuously.

.2 115 V AC rms plus or minus 30 percent maximum 30 seconds.

.3 115 V AC rms plus or minus 100 percent maximum 17 milliseconds.

.4 Line spikes at 100 V AC (5,000 microseconds duration; 0.05% maximum duty cycle).

.5 Power supply shall contain capacitor to provide for orderly shutdown if incoming power does not meet specifications. If this occurs, PLC shall cease operation, forcing all outputs off. When AC power is within tolerances, operation shall resume automatically.

.6 Electrical/Pneumatic Auto Controls, Instruments and Devices:

.1 Pressure set points shall be adjustable for the slurry feed and restrictive gates as well as the wash cycles for the inner and outer channel washes of the press.

.2 Each channel shall be independently pressure/flow controlled to maintain a balance throughout the process.

.3 Inlet pressure shall be measured by transducers located in the main feed line, and the inlet to each dewatering channel. The main inlet pressure limits shall be operator adjustable through the HMI touch screen and shall be monitored by the PLC. They shall trigger appropriate alarms when operating outside the threshold limits. The independent channel pressure transducers shall also be monitored through the PLC and shall be used to control the electro-pneumatic regulator which in turn controls the operating pressure control valve to each channel.

.7 Rotary Press Control System:

.1 The rotary fan press dewatering system shall have a control system that can operate in either manual or automatic modes. The operator controls and display shall be accomplished by a touch screen, mounted in the door of the main control panel. The system shall be able to control flow, pressure, conditioning mixing, and operation and control of ancillary equipment listed in this Section of the Technical Specification. All control function shall be easily readable and adjusted from the touch screen operator control panel.

.2 In any start up sequence, the control system shall verify that no fault condition exists.

.3 The rotary press dewatering system control panel shall provide the operator capability to set and adjust the total flow rate to the fan press.

The panel shall also provide the operator capability to select the desired percentage ratio split of the primary sludge (digested sludge) and the water plant sludge. The selection of digested sludge percentage shall automatically select the percentage of water plant sludge. If the primary sludge selection is 100%, the water plant sludge pump should not turn on. The pump speed control shall be utilized to provide proper sludge flow rate based on the operator selection from the rotary press, in conjunction with the individual flow meters connected to each of the waste stream pump discharge pipes. The selection of mixing ratios shall be done prior to starting the dewatering process.

.4 The polymer dosage and PACI dosage shall be determined manually and adjust the feed rate locally prior to putting the rotary press system in the operation. The chemical feed system shall be in REMOTE mode to be controlled from the rotary press control panel.

.5 The operators shall select the sludge feed pumps manually to put into service and open and close the isolation valves accordingly. The pump should be in REMOTE mode at the local control panel located in the digester building.

.6 Arrange the rotary press sludge dewatering control panel to allow either "MANUAL" or "AUTOMATIC" control of the dewatering system via the HMI touch screen. When "MANUAL" operation is selected, all equipment associated with the dewatering system including sludge feed pumps, remote chemical feed system, and skid mounted rotary fan equipment shall be by "START/STOP" individually.

.7 The rotary press control shall provide the following signals to each of the remote sludge pumps VFD panels:

.1 START/STOP VFD enable signal – Dry Contact Closure.

.2 4-20 mAmp VFD Speed References.

.8 The following signals from each of the pump VFD controls shall be returned to the rotary press control panel:

.1 Remote disconnect status.

.2 VFD running signal - Dry Contact from VFD.

.9 At a minimum, the following control functions shall be located on the touch screen:

.1 Sludge Pump Total Flow Selections.

.2 Sludge Pump Mix Ratio.

.3 Slude Pump Speed.

.4 Remote Polymer System START/STOP/STATUS.

.5 Remote PACl system START/STOP/STATUS.

.6 Rotary Press Speed.

.7 Wash Water Selection.

.8 Skid Mounted Polymer Water Feed.

.9 Alarm Silence.

.10 Alarm Fault Reset.

.11 Screen Contrast.

.12 Fault History.

.13 Automation Set Points.

.14 Automation Status.

.15 Polymer System Status.

.10 The remote chemical feed system shall START/STOP from the rotary press control panel in Automatic or Manual mode. The polymer and water adjustments however shall be done manually at the local station.

.11 The pH monitor system associated with the remote chemical metering system shall send a signal to the rotary press control for an alarm activation on Hi/Low limit alarms for process pH levels. The pH adjustment will be manual.

.12 Interlocks: The following interlocks shall shut down all associated rotary press sludge dewatering equipment.

.1 Shut down of the sludge pump due to any reason shall shut down the rotary press system.

.2 Shut down of the chemical feed system due to any reason shall shut down the rotary fan press system.

.3 Wash water pump must be on and running.

.4 "EMERGENCY STOP" pushbutton shall be in operating position. "EMERGENCY STOP" pushbutton shall be hardwired directly to starters of all motor drives of the associated rotary press sludge dewatering system and to PLC for interlocking.

.13 Annunciation and Alarms: All fault and alarms shall be displayed and logged by the touch screen. The following alarms at minimum shall be required:

.1 Low Polymer Water Pressure for Polymer in Fan Press Skid System.

.2 Press Drive Fault.

.3 Sludge Drive Fault.

.4 Low Air Pressure.

.5 Analog Signal Loss.

.6 Low Wash Water Pressure.

.7 Air Compressor Malfunction.

.14 Separate alarm/annunciation light:

.1 Sludge pumps RUNNING light.

.2 Sludge pumps malfunction light.

.3 Remote polymer system running light.

.4 Remote polymer system malfunction light.

.15 Provide at least 20 percent spare capacity in control PLC and HMI windows.

.16 Wire all alarms to PLC system for relaying to remote location.

.17 All control system parameters shall be monitored by site's UCMS, but controlled by local panels.

Part 3 Execution

3.1 GENERAL

.1 General execution of this aspect of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, flushing, marking, testing, pre-comissioning, commissioning and site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical and Piping General Requirements of the Technical Specification, in addition to any specific requirements indicated below.

3.2 INSTALLATION

.1 Comply with manufacturer's written recommendations, including product technical bulletins, handling, storage and installation instructions, and datasheets.

.2 Provide certificate, signed by the manufacturer, stating that piping system has been installed in accordance with manufacturer's recommendations.

.3 System to be completely accessible for removal, modification and cleaning.

.4 Piping

- .1 Pitch 1:100 in direction of flow, without pockets, to low points.
- .2 Install valved drains at bottom of risers and at low points in system.
- .3 Provide air vents as required at high points.
- .4 Minimize contamination by leaving pipe valves and fittings in sealed cartons until prior to their use and seal openings in piping system after installation.
- .5 Use of thread lubricants shall comply with manufacturer’s recommendations.

.5 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

3.3 PRE-COMMISSIONING

.1 The Contractor shall, with the assistance of the equipment manufacturer, demonstrate, in the presence of the Engineer, all mechanical and electrical equipment.

.2 Provide bio-material to commence process.

.3 Perform initial testing to establish the integrity of the system with respect to:

- .1 Control system operation.
- .2 Alignment of all mechanical components.
- .3 Performance of safety and protection devices.
- .4 Excess vibration.
- .5 Noise levels.
- .6 Clearances.

.4 Submit relevant equipment repair procedures to the Engineer if repairable defects are identified during testing. Do not repair or use defective parts without prior approval from the Engineer.

.5 The equipment manufacturer’s representative shall be present to direct the pre-commissioning and to make control system adjustments required during pre-commissioning.

.6 Final system performance testing shall be undertaken by the equipment manufacturer at Site. Influent and effluent samples shall be collected and tested to verify performance during pre-commissioning. The equipment manufacturer's proposed acceptance criteria shall be included in their bid submission to the Contractor.

3.4 COMMISSIONING

.1 The Purchaser will commission the Packaged Wastewater Treatment Plant, ensuring the Packaged Wastewater Treatment Plant's controls are interacting with the UCMS as intended, only after the satisfactory completion of all pre-commissioning activities by the Contractor.

.2 The Contractor shall provide support during commissioning as requested by the Engineer.

3.5 PREPARATION

.1 Nameplates and Identification Tags

.1 In accordance with Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification.

.2 All equipment shall have a standard nameplate securely affixed in a conspicuous place, showing the following information.

.1 Equipment manufacturer's name and address.

.2 Purchaser’s equipment number.

.3 Equipment capacity.

.4 Equipment serial number.

.5 Equipment model number.

.6 Total weight of equipment.

.7 Year of manufacture.

.8 Shipping date.

.9 Other information the equipment manufacturer may consider necessary to complete identification of the equipment.

.2 Painting and Surface Preparation

.1 Surfaces normally painted shall be cleaned and finished with Coating System S-1 as set out in Appendix A, Section 09 90 00 Painting and Coating of the Technical Specification. Other surfaces subject to corrosion shall be coated with a corrosion preventative that is readily removable with a commercial solvent.

3.6 SITE QUALITY CONTROL

.1 Inspection and testing, unless stipulated below, shall be carried out at the equipment manufacturer's facilities and shall be available for witnessing and approval by the Engineer. A minimum of 24 Work Days notice to the Engineer shall be provided of all test points.

.2 The equipment manufacturer shall include in its scope of work, items, accessories and services that are usual or necessary to complete the work set out in this Section of the Technical Specification, but which may not have been specifically mentioned herein.

.3 The equipment manufacturer shall include sufficient commissioning services and performance testing to demonstrate regulatory compliance and satisfaction of performance guarantee parameters.

.4 The equipment manufacturer shall provide on-site training sufficient to satisfy the Purchaser's and regulatory requirements, complete with manuals, for all Purchaser's operating personnel.

3.7 CLEANING

.1 The requirements shall be in accordance with Subsection 7.40 Clean-up and Remeoval of Plant, Surplus Materials and Debris of the General Specification.

END OF SECTION

Part 1 General

1.1 SECTION INCLUDES

.1 The Work to be performed under this Section shall consist of supplying all labour, Materials, and Plant and performing all Work necessary as shown on the Purchaser's Drawings, as directed by the Engineer and as specified herein for the supply, transportation, handling, installation, testing, flushing, marking, pre-commissioning and commissioning of the Oil Water Separation Facility, including but not limited to the following:

- .1 Coalescing plates for oil/water separator chambers.
- .2 Belt Skimmers.
- .3 Oil Recovery Tanks.
- .4 Oil Recovery Tank Pumps.
- .5 Oil Recovery Tank Level Transmitters and Pump Controllers.
- .6 Floating Oil Skimmer.
- .7 Oil-in-Water Monitoring System.
- .8 Sampling Pumps.
- .9 Related piping, valves, and fittings.

.2 Refer to the Purchaser’s Drawings for additional scope details.

1.2 RELATED SECTIONS

.1 Those Sections or Subsections of the General Specification as set out below.

.2 Section 09 90 00 - Painting and Coating.

.3 Section 26 05 00 - Electrical General Requirements.

.4 Section 40 05 00 - Mechanical & Piping General Requirements.

1.3 REFERENCES

.1 This aspect of the Work shall be performed in accordance with the latest edition of the standards mentioned in effect at the time the Work is performed, except where specified otherwise.

.2 This aspect of the Work shall conform to all Laws applicable to this type of Work in effect at the time this Work is performed.

.3 At a minimum, this Work shall be performed in accordance with:

- .1 API Publication 421.
- .2 ASME B31.1 - Power Piping.
- .3 CCME PN 1326 - Environmental Code of Practice for Aboveground and Underground Storage Tank Systems Containing Petroleum and Allied Petroleum Products.
- .4 CSA B51 - Boilers, Pressure Vessels and Pressure Piping.
- .5 Federal Fisheries Act, Section 36(3).

.6 Manitoba Regulation 188/2001 - Storage and Handling of Petroleum Products and Allied Products.

.7 Provincial Environment Act, Manitoba Reg. 97/88R.

.8 ULC S601 - Standard for Shop Fabricated Steel Aboveground Tanks for Flammable and Combustible Liquids.

1.4 MEASUREMENT AND TARGET PRICE PROCEDURES

.1 The Contractor shall include the costs for the Oil Water Separation Facility in the Target Prices referenced in Section 22 14 00 Clearwater Drainage System of the Technical Specification.

1.5 SUBMITTALS

.1 General submittal requirements shall be in accordance with Subsection 21.7 Contractor's Documents of the General Specification.

.2 Submit for Engineer's review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification all applicable Contractor's Documents including material test reports, project data, shop drawings, installation manuals including installation and test plans, testing procedures, flushing procedures, pre-commissioning procedures, and operation and maintenance manuals for the equipment.

.3 Submit equipment manufacturer's performance calculations for the coalescing plates to the Engineer for review in accordance with Subsection 21.7.9 Engineer's Review of the General Specification prior to purchase.

.4 Provide list of recommended spare parts for the equipment.

.5 Submit all test results and reports for the equipment to the Engineer.

.6 The Contractor shall provide a simplified 3D-model of the equipment. The model shall indicate the interface points such as piping, valves, access hatches, control panels and other requirements for operation and maintenance of the equipment.

1.6 QUALITY MANAGEMENT

.1 Shall be in accordance with the requirements set out in Subsection 7.13 Project Quality Management of the General Specification.

.2 Follow the Contractor's Quality Management Plan.

.3 All pressure containing/retaining components, including pipe fittings, valves, expansion joints, flexible connectors, filters, strainers, measuring devices, capacity rated pressure relief devices, overall piping systems, pressure vessels, etc, must be registered through the Authorized Inspector for the Office of the Fire Commissioner Inspections and Technical Services Manitoba and shall receive a Canadian Registration Number as per the CSA B51 code.

1.7 DELIVERY, STORAGE AND HANDLING

.1 Shall be in accordance with the requirements set out in Subsection 7.24 Inspections of Deliveries to Site and Storage of the General Specification.

.2 Materials delivered to the Site shall be clearly tagged for easy identification.

.3 Materials shall be stored in a secure area that will prevent contamination from deleterious materials.

.4 All items shall be handled with care and in accordance with manufacturer's recommendations to avoid damage prior to installation.

1.8 WARRANTY

.1 Shall be in accordance with the requirements of Section 25 Warranty of the General Specification.

Part 2 Products

2.1 EQUIPMENT

.1 Coalescing Plates - Tag Nos. 5750-SP-0207 to 0209

.1 Design Criteria: sizing calculations shall be based on an influent oil concentration of 1,000 ppm, and a mean oil particle diameter of 150 μm.

.2 The coalescing plates shall come in packages 610 mm long by 305 mm wide, with an actual plate height of 2,690 mm minimum.

.3 The plates shall be made of oleophilic polypropylene, and the frame shall be made of steel.

.4 The packages shall have plates spaced 6 mm apart.

.5 The plate packages shall be mounted in the concrete oil-water separator using fibreglass channel, fibreglass angle and PVC flat plate.

.6 A corrugated PVC plate shall be used as a spring seal between the walls of the separator and the plate packages.

.7 PVC pipe spacers shall be used where necessary, to ensure a tight fit against spring seal.

.8 Lifting lugs shall be provided on coalescing plates to facilitate installation and removal.

.9 The plate packages shall be Facet MPAK type, complete with all installation hardware, or the Purchaser's approved equivalent.

.2 Belt Skimmer - Tag Nos. 5750-SK-0001 to 0003

.1 A belt skimmer shall be installed above each oil-water separator to remove the oil from the surface.

.2 Each belt skimmer shall have a minimum removal rate of 35 litres per hour.

.3 The belt material shall be elastomer, and the wiper blades shall be constructed of Buna-N.

.4 The motor shall be rated for 120 Vac, 60 Hz.

.5 Each belt skimmer shall come with an oil concentrator, to minimize the amount of water contained in the skimmed product.

.6 Acceptable material: Abanaki Grease Grabber, with 8" belt, or the Purchaser's approved equivalent.

.3 Oil Recovery Tanks - Tag Nos. 5750-TK-0006 to 0008

.1 An oil recovery tank shall be installed to collect oil from each belt skimmer.

.2 Oil recovery tanks shall be single walled, and have a minimum capacity of 200 L.

.3 The tanks shall be made of carbon steel.

.4 The tanks shall have 2 in. female threaded connections on the top, for fill, drum pump and level controls.

.5 Tank dimensions: Length 1,100 mm, Width 400 mm, Height 500 mm.

.6 The tanks shall be provided with lifting lugs.

.7 Tank Code of Construction: ULC S601.

.4 Oil Recovery Pumps - Tag Nos. 5750-PP-0020 to 0022

.1 An oil recovery pump shall be mounted on top of each oil recovery tank to deliver recovered oil to the waste header.

.2 The pump shall have a rated capacity of 15 litres per minute (4 GPM) with a maximum discharge pressure of 345 kPa(g) [50 psi(g)].

.3 The motor shall be 120 Vac, 60 Hz.

.4 The pump tube shall be made of 316 stainless steel, and sized to suit the oil recovery tank.

.5 Acceptable material: GPI Pumps Model L5116, with two-piece suction tube, or the Purchaser's approved equivalent.

.5 Oil Recovery Tank Level Switches: refer to Section 40 90 25 Instrumentation for Piping Systems of the Technical Specification.

.6 Floating Oil Skimmer - Tag Nos. 5750-SK-0005

.1 The floating oil skimmer shall be capable of removing 1.2 L/s (20 GPM).

.2 It shall have an outlet size of 1-1/2 inches.

.3 The adjustable weir and floats shall be made of 304 stainless steel.

.4 Acceptable material: Megator Alpha 1-1/2 in., or the Purchaser's approved equivalent.

.7 Oil-in-Water Monitoring System

.1 The oil-in-water monitor shall be a continuous flow-through type, using a fluorescent technology that is selective to hydrocarbons in water.

.2 The operating range shall be suitable for 0 - 20 parts per million (ppm).

.3 The sensor shall be a non-contacting type with no mechanical or pneumatic devices necessary to maintain a continuous on-line operation.

.4 The flow shall be directed across a sensing glass that has been treated to negate background interference due to any normal operational coatings on the glass.

.5 Suspended solids up to 400 mg/L shall have minimal interference with the output signal.

.6 An isolated 4-20 mA output signal will be standard with a selectable range.

.7 Four 10 amp SPDT relays shall be available; two relays for alarm set-points, each with full differential to eliminate control chattering and allow a concentrated stream to adequately clear prior to rest; one relay to alarm on a negative offset drift, and one relay to alarm on a maintenance requirement or fault condition.

.8 Relay time delay and output signal filtering shall be standard and selectable via the keypad.

.9 A sample sequencing system, complete with solenoid valves and an adjustable timer, shall allow the monitor to sample each of the three channels of the oil-water separator.

.10 Acceptable Material:

.1 Sample sequencing system: Sentry Sample Sequencer IV, or the Purchaser's approved equivalent.

.2 Monitor: Arjay Engineering HydroSense Model 2410 or the Purchaser's approved equivalent.

.8 Sampling Pumps - Tag Nos. 5750-PP-0030 to 0032

.1 A sampling pump shall be installed for the oil-in-water monitoring system, one per oil/water separator channel.

.2 Type: Rotary gear.

.3 Capacity: 5 L/min at 30 psig.

.4 Connections: 3/8” Inlet and Outlet.

.5 Motor: 1/3 hp, 1,140 rpm, 115 Vac, 60 Hz.

.6 Integral relief valve, set at 414 kPag (60 psig).

.7 Acceptable material: Oberdorfer Model N991R or the Purchaser's approved equivalent.

.8 For each pump motor, provide manual motor starter with neon pilot light, 120 Vac, single phase and set to motor full load current.

.9 Protective Coating

.1 All equipment shall be painted to manufacturer’s factory standard coating system.

2.2 COMPONENTS

.1 Foot Valve

.1 A foot valve shall be installed on each sampling pump suction line.

.2 Size: 3/4 in.

.3 Complete with strainer basket.

.4 Perforations: 1/8 in.

.5 Acceptable material: Chemline Plastics Model FT, True Union foot Valve.

.2 Manifold Sampling Valve Assembly

.1 Solenoid Valves (one per oil/water separator channel) shall be three-way, two-position, universal operation, direct acting, brass body, 1/4” NPT ports, 0-60 psi operating pressure differential, ASCO Model 8320P174, 12 – 24 Vdc, c/w mounting bracket.

.2 Solenoid valves shall be installed in a NEMA 2 rated enclosure.

2.3 MATERIALS

.1 For piping materials (pipe, fittings, flanges, valves, etc.) refer to the applicable Material Specification in Section 40 05 00 Mechanical and Piping General Requirements of the Technical Specification.

.2 Paint for piping: in accordance with Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification. Paint colour shall be green, per colour code indicated in Appendix A of the said Section 09 90 00.

.3 Refer to Part 2 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification for additional material requirements.

Part 3 Execution

3.1 GENERAL

.1 General execution of this aspect of the Work, including but not limited to fabrication, installation, examination, preparation, cleaning, testing, flushing, marking, pre-commissioning, commissioning and site quality control, shall be completed in accordance with Part 3 of Section 40 05 00 Mechanical & Piping General Requirements of the Technical Specification.

.2 Paint all pipe, fittings, and valves in accordance with Appendix A of Section 09 90 00 Painting and Coating of the Technical Specification.

.3 Electrical installation: in accordance with Section 26 05 00 Electrical General Requirements of the Technical Specification.

END OF SECTION