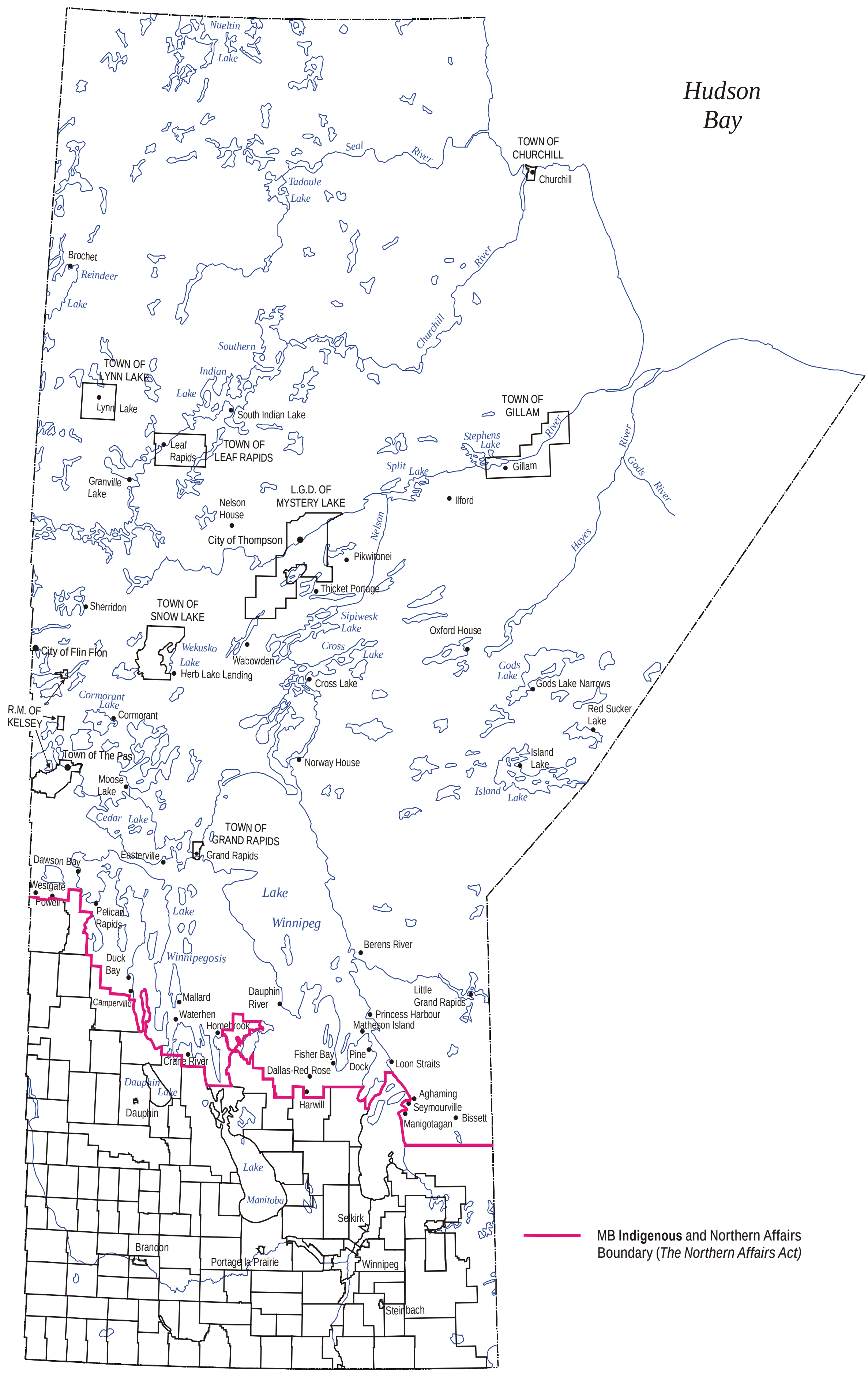
Nueltin
Lake
Hudson
Bay
Seal
River
Tadoule
Lake
TOWN OF
CHURCHILL
Churchill
Brochet
Reindeer
Lake
Churchill
River
Southern
Indian
Lake
TOWN OF
LYNN LAKE
Lynn Lake
South Indian Lake
Leaf
Rapids
TOWN OF
LEAF RAPIDS
TOWN OF
GILLAM
Stephens
Lake
Split
Lake
Gillam
River
Gods
River
Granville
Lake
L.G.D. OF
MYSTERY LAKE
Nelson
House
Ilford
City of Thompson
Nelson
Hayes
Pikwitonei
Thicket Portage
Sherridon
TOWN OF
SNOW LAKE
Sipiwesk
Lake
Oxford House
Wekusko
Lake
Wabowden
Cross
Lake
City of Flin Flon
Herb Lake Landing
Gods
Lake
Gods Lake Narrows
Cross Lake
Cormorant
Lake
Cormorant
R.M. OF
KELSEY
Red Sucker
Lake
Town of The Pas
Norway House
Island
Lake
Moose
Lake
Island
Lake
Cedar
Lake
TOWN OF
GRAND RAPIDS
Easterville
Grand Rapids
Dawson Bay
Westgate
Powell
Lake
Winnipeg
Pelican
Rapids
Lake
Winnipegosis
Berens River
Duck
Bay
Little
Grand Rapids
Mallard
Dauphin
River
Camperville
Waterhen
Princess Harbour
Matheson Island
Homebrook
Fisher Bay
Pine
Dock
Crane River
Loon Straits
Dallas-Red Rose
Dauphin
Lake
Aghaming
Harwill
Seymourville
Dauphin
Bissett
Manigotagan
Lake
Manitoba
Selkirk
Brandon
Portage la Prairie
Winnipeg
Steinbach
MB Indigenous and Northern Affairs
Boundary (The Northern Affairs Act)

MANITOBA HYDRO

BUSHING INSULATION POWER-FACTOR TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

comment

Average Temperature °C

Bushing Serial Number		Installed in Transformer			Nameplate Values	
		Power Factor			Power Factor	
		At °C	Corrected to 20°C	Capacitance	Corrected to 20°C	Capacitance
		%		pF	%	pF
HI	C1					
	C2					
H2	C1					
	C2					
H3	C1					
	C2					
H0	C1					
	C2					
X1	C1					
	C2					
X2	C1					
	C2					
X3	C1					
	C2					
X0	C1					
	C2					
Y1	C1					
	C2					
Y2	C1					
	C2					
Y3	C1					
	C2					
Y0	C1					
	C2					

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Version Numbers	1	1	2	112	1.1.2
Version Date	7-Aug-15				

Version 1.1.2 (07-Aug-2015)

Yellow & turquoise cells are for data entry.
Turquoise cells are optional. Enter if applicable.
White cells are locked.
Turquoise cells are optional.
They would be used only in certain cases such as a three-circuit transformer.

Fill-in the General Description sheet and the Tapchangers & Bushings sheet completely before entering the other sheets.

For zig-zag grounding transformers:
If test is done by shorting one phase and the tested currents are 68, 34.1, 34.2 then enter as 68/2=34, 34.1 34.2

Ensure the test report includes:

Original Test Sheets

DGA Test Reports

Test Failure Reports

Fibre-Optic Measurements

3-circuit Impedances for buried TV Transformers

LTC Test Report c/w Serial Numbers

PT Test Reports

CT Test Reports

MCIC Approval Reports for CTs

Excitation Curve c/w air-core reactance

Short-time Excitation (Volts per Hertz) curve

Inrush Current curve

Damage (I^2T) curve

Manitoba Hydro

TRANSFORMER DATA AND TEST SUMMARY

Manufacturer	
Plant Built	
P.O. #	
Spec. #	
Station Name	

Mftr's SO#	
Year Built	
PO Item#	
Spec ID#	

# of Phases	
No. of Wdg's	
Xfmr Type	
Dual LV Windings	

Angular Displacement(s)		
Winding Temperature Rise (°C)	65	
Oil Temperature Rise (°C)	65	

Main Transformer

	Voltage kV	Range %	# of Steps	Lightning Impulse Level (kV LIL) Line	Lightning Impulse Level (kV LIL) Neutral
HV					
LV					

MVA Ratings						
Type of Cooling	ONAN	ONAF	ONAF	ONAN	ONAF	ONAF
at 65°C Rise	@ 30°C Ambient			@ -15°C Ambient		
HV & LV	9	12	15	12.15	16.2	20.25

Re-connectable Windings	
Series Transformer in LTC circuit	
Buried Tertiary Winding	

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Page 1

MANITOBA HYDRO

Tapchanger & Bushing Data

Manufacturer:		Mftr's SO#:	
Plant Built:		Year Built:	
P.O. #:		PO Item#:	
Spec. #:		Spec ID#:	
Station Name:			

De-energized and Load Tap Changer Data:

Type of Switch	Manufacturer	Type	Serial Number of each Gear (if applicable)	Location	Circuit Varied	Voltage Rating (kV LIL)	Current Rating	% Boost	% Buck	# of Steps	Reduced Capacity Below Normal

DTC Winding Info

DTC Position	Voltage (kV) Wye	Voltage (kV) Delta	% of Rated Volts
1			
2			
3			
4			
5			

Series / Parallel and/or LTC Winding Info

S/P Position	LTC Position	Voltage (kV)	% of Rated Volts
1	-16		
	N	12.47	
	+16		
2	-16		
	N	24.94	
	+16		

Series Transformer

		Voltage kV	Lighning Impulse Level (kV LIL) Line	Neutral
HV	(Wye)			
LV	(Wye)			

MVA Ratings at 30°C Ambient

	ONAN	ONAF	ONAF
at 65°C Rise			

Series Transformer is Auto-connected? No

Other Serial Numbers

	Mftr	Model	SN
VT			
VRR (90)			

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printed 12-Jun-17 Page 2

MANITOBA HYDRO

POLARITY

Manufacturer:		Mftr's SO#:	
Plant Built:		Year Built:	
P.O. #:		PO Item#:	
Spec. #:		Spec ID#:	
Station Name:			

comment

Typically, values are not entered in all of these tables.

H to X Vector Volts

H1-H2		
H2-H3		
H3-H1		
H2-X2		
H2-X3		
H3-X2		
H3-X3		

Volts

H to X Vector S/P 2 Volts

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

MANITOBA HYDRO

RATIO S/P 1

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:
comment

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

At rated LTC position								
	H to X Ratio				H to Y Ratio			
Source Terminals								
Measure Terminals								
DTC Position	A	B	C	Calculated Ratio	A	B	C	Calculated Ratio
1								
2								
3								
4								
5								
6								
7								

At rated DTC position								
	H to X Ratio				H to Y Ratio			
Source Terminals								
Measure Terminals								
LTC Position	A	B	C	Calculated Ratio	A	B	C	Calculated Ratio
-16								
-15								
-14								
-13								
-12								
-11								
-10								
-9								
-8								
-7								
-6								
-5								
-4								
-3								
-2								
-1								
N								
+1								
+2								
+3								
+4								
+5								
+6								
+7								
+8								
+9								
+10								
+11								
+12								
+13								
+14								
+15								
+16								

At rated LTC and DTC positions				
	X to Y Ratio			
Source Terminals				
Measure Terminals				
	A	B	C	Calculated Ratio

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printed 12-Jun-17

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MANITOBA HYDRO

RATIO S/P 2

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

comment

Enter the ratio values that reflect the shipping connections.

At rated LTC position								
	H to X Ratio				**H to Y Ratio**			
Source Terminals								
Measure Terminals								
DTC Position	A	B	C	Calculated Ratio	A	B	C	Calculated Ratio
1								
2								
3								
4								
5								
6								
7								

At rated DTC position								
	H to X Ratio				**H to Y Ratio**			
Source Terminals								
Measure Terminals								
LTC Position	A	B	C	Calculated Ratio	A	B	C	Calculated Ratio
-16								
-15								
-14								
-13								
-12								
-11								
-10								
-9								
-8								
-7								
-6								
-5								
-4								
-3								
-2								
-1								
N								
+1								
+2								
+3								
+4								
+5								
+6								
+7								
+8								
+9								
+10								
+11								
+12								
+13								
+14								
+15								
+16								

At rated LTC and DTC positions				
	X to Y Ratio			
Source Terminals				
Measure Terminals				
	A	B	C	Calculated Ratio

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

MANITOBA HYDRO

COLD D.C. RESISTANCE S/P 1

Manufacturer:		Mftr's SO#:	
Plant Built:		Year Built:	
P.O. #:		PO Item#:	
Spec. #:		Spec ID#:	
Station Name:			

comment

All values in ohms unless stated otherwise.
Phase-to-phase measurments are not acceptable except for delta connected windings.

HV

Average Temperature

Terminals				
DTC Position	A	B	C	Average
1				
2				
3				
4				
5				
6				
7				

LV

Average Temperature

Terminals				
LTC Position	A	B	C	Average
-16				
-15				
-14				
-13				
-12				
-11				
-10				
-9				
-8				
-7				
-6				
-5				
-4				
-3				
-2				
-1				
N				
+1				
+2				
+3				
+4				
+5				
+6				
+7				
+8				
+9				
+10				
+11				
+12				
+13				
+14				
+15				
+16				

Average Temperature

Terminals				
LTC Position	A	B	C	Average

MANITOBA HYDRO **COLD D.C. RESISTANCE S/P 1** Page 5-1

Manufacturer: Mftr's SO#:
Plant Built: Year Built:
P.O. #: PO Item#:
Spec. #: Spec ID#:
Station Name:
comment

All values in ohms unless stated otherwise.
Phase-to-phase measurments are not acceptable except for delta connected windings.

Other Coil Average Temperature

Terminals				
LTC Position	A	B	C	Average

Other Coil Average Temperature

Terminals				
LTC Position	A	B	C	Average

Other Coil Average Temperature

Terminals				
Position	A	B	C	Average

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

MANITOBA HYDRO

COLD D.C. RESISTANCE S/P 2

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

comment

All values in ohms unless stated otherwise.
Phase-to-phase measurments are not acceptable except for delta connected windings.

HV

Average Temperature

Terminals				
DTC Position	A	B	C	Average
1				
2				
3				
4				
5				
6				
7				

LV

Average Temperature

Terminals				
LTC Position	A	B	C	Average
-16				
-15				
-14				
-13				
-12				
-11				
-10				
-9				
-8				
-7				
-6				
-5				
-4				
-3				
-2				
-1				
N				
+1				
+2				
+3				
+4				
+5				
+6				
+7				
+8				
+9				
+10				
+11				
+12				
+13				
+14				
+15				
+16				

Average Temperature

Terminals				
LTC Position	A	B	C	Average
-16				
N				
rated				
+16				

MANITOBA HYDRO

COLD D.C. RESISTANCE S/P 2

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

comment

All values in ohms unless stated otherwise.
Phase-to-phase measurments are not acceptable except for delta connected windings.

Other Coil Average Temperature

Terminals				
LTC Position	A	B	C	Average
-16				
N				
rated				
+16				

Other Coil Average Temperature

Terminals				
LTC Position	A	B	C	Average
-16				
N				
rated				
+16				

Other Coil Average Temperature

Terminals				
Position	A	B	C	Average

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

MANITOBA HYDRO

CORE LOSS TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Base MVA 9

comment

Before Dielectrics				
Average Temperature			°C	
% of Rated Voltage	Average Voltage kV	Excitation Current at base MVA A	%	Core Loss kW

Before Overvoltage Run				
Average Temperature			°C	
% of Rated Voltage	Average Voltage kV	Excitation Current at base MVA A	%	Core Loss kW

After Overvoltage Run				
Average Temperature			°C	
% of Rated Voltage	Average Voltage kV	Excitation Current at base MVA A	%	Core Loss kW

Coreloss at Rated Tap Position

	DTC	LTC	S/P
Tap Position#			

Rated Voltage kV

Coreloss at Bridging / Variable Flux Position(s)

	DTC	LTC	S/P
Tap Position#			

Rated Voltage kV

	DTC	LTC	S/P
Tap Position#			

Rated Voltage kV

GUARANTEES

	Measured		Guaranteed	
% of Rated Voltage	Excitation Current %	Core Loss kW	Excitation Current %	Core Loss kW
100 %				
110 %				

NOTE: A CALCULATED SATURATION CURVE FROM 100% RATED VOLTAGE INTO THE FULLY SATURATED REGION SHALL BE PROVIDED AND INCLUDED WITH THIS APPENDIX 7.
%Voltage vs %Excitation Current c/w air-core reactance.

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

MANITOBA HYDRO

HV to LV ONAN
LOAD LOSS AND IMPEDANCE TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

HV to LV

Supply: HV | Short: LV | Open:

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA 9

Measured Values

HV to LV ONAN at 9 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

MANITOBA HYDRO

HV to LV ONAF
LOAD LOSS AND IMPEDANCE TEST

Page 7 - S/P - A - 2

Manufacturer:		Mftr's SO#:	
Plant Built:		Year Built:	
P.O. #:		PO Item#:	
Spec. #:		Spec ID#:	Version 1.1.2 (07-Aug-2015)
Station Name:			printed 12-Jun-17

Comment:

HV to LV

Supply: HV | Short: LV | Open:

S/P pos															
DTC pos		1	1	1	2	2	2	5	5	5					
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16					
						rated									
Rated Voltage	Conn.														
HV															kV
LV															kV
															kV

85°C

Base MVA 15

Measured Values

HV to LV ONAF at 15 MVA 85°C

Supplied Impedance Voltage phase to phase	1&2													kV
	2&3													kV
	3&1													kV
Supplied Line Amps	1													A
	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

MANITOBA HYDRO

Page 7 - S/P - B - 1

LOAD LOSS AND IMPEDANCE TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Supply HV | Short | Open LV

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C Base MVA 9

Measured Values

at 9 MVA 85°C

Supplied Impedance Voltage phase to phase	1&2													kV
	2&3													kV
	3&1													kV
Supplied Line Amps	1													A
	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

MANITOBA HYDRO

LOAD LOSS AND IMPEDANCE TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Supply: HV Short: Open: LV

S/P pos															
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C **Base MVA** 15

Measured Values

at 15 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

MANITOBA HYDRO

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LOAD LOSS AND IMPEDANCE TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Supply LV | Short | Open HV

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA 9

Measured Values

at 9 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

MANITOBA HYDRO

LOAD LOSS AND IMPEDANCE TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Supply: LV   Short: Open: HV

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C   **Base MVA** 15

Measured Values

at 15 MVA 85°C

Supplied Impedance Voltage phase to phase	1&2													kV
	2&3													kV
	3&1													kV
Supplied Line Amps	1													A
	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

MANITOBA HYDRO

Leave This Page Blank
LOAD LOSS AND IMPEDANCE TEST

Page 7 - S/P - D - 1

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Leave This Page Blank Supply Short Open

S/P pos															
DTC pos		1	1	1	2	2	2	5	5	5					
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16					
						rated									
Rated Voltage	Conn.														
HV															kV
LV															kV
															kV

85°C

Base MVA 9

Measured Values

Leave This Page Blank **at 9 MVA 85°C**

Supplied	1&2														kV
Impedance Voltage	2&3														kV
phase to phase	3&1														kV
Supplied	1														A
Line Amps	2														A
	3														A
Supplied Load Loss															kW
at Temperature															°C
dc Resistance	Temp.														
HV															□
LV															□
TV															□
															□
															□

Calculated Losses & Impedance

Total dc Loss	85.0														kW
Stray Loss	85.0														kW
Load Loss	85.0														kW
Core Loss	-														kW
Total Loss	85.0														kW
%IX	-														%
%IR	85.0														%
%IZ	85.0														%

MANITOBA HYDRO

Leave This Page Blank
LOAD LOSS AND IMPEDANCE TEST

Page 7 - S/P - D - 2

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Leave This Page Blank Supply Short Open

S/P pos													
DTC pos	1	1	1	2	2	2	5	5	5				
LTC pos	-16	N	+16	-16	N	+16	-16	N	+16				
					rated								

Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C **Base MVA** 15

Measured Values

Leave This Page Blank **at 15 MVA 85°C**

Supplied Impedance Voltage phase to phase	1&2													kV
	2&3													kV
	3&1													kV
Supplied Line Amps	1													A
	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

MANITOBA HYDRO

HV to LV ONAN
LOAD LOSS AND IMPEDANCE TEST

Manufacturer: Mftr's SO#:
Plant Built: Year Built:
P.O. #: PO Item#:
Spec. #: Spec ID#: Version 1.1.2 (07-Aug-2015)
Station Name: printed 12-Jun-17
Comment:

HV to LV Supply: HV Short: LV Open:

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA 9

Measured Values — HV to LV ONAN at 9 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

Base MVA

Measured Values — HV to LV ONAN

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C

Calculated Losses & Impedance

Total dc Loss														kW
Stray Loss														kW
Load Loss														kW
Core Loss	-													kW
Total Loss														kW
%IX	-													%
%IR														%
%IZ														%

MANITOBA HYDRO

HV to LV ONAF
LOAD LOSS AND IMPEDANCE TEST

Page 7 - S/P - A - 2

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

HV to LV

Supply: HV | Short: LV | Open:

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA: 15

Measured Values — HV to LV ONAF at 15 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

Base MVA:

Measured Values — HV to LV ONAF

Supplied	1&2	38.80												kV
Impedance Voltage	2&3	39.00												kV
phase to phase	3&1	38.56												kV
Supplied	1	708.00												A
Line Amps	2	705.50												A
	3	704.50												A
Supplied Load Loss		654.60												kW
at Temperature		21.0												°C

Calculated Losses & Impedance

Total dc Loss														kW
Stray Loss		#VALUE!												kW
Load Loss														kW
Core Loss	-													kW
Total Loss														kW
%IX	-	#VALUE!												%
%IR														%
%IZ		#VALUE!												%

MANITOBA HYDRO

LOAD LOSS AND IMPEDANCE TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Supply HV | Short | Open LV

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA 9

Measured Values

at 9 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

Base MVA

Measured Values

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C

Calculated Losses & Impedance

Total dc Loss														kW
Stray Loss														kW
Load Loss														kW
Core Loss	-													kW
Total Loss														kW
%IX	-													%
%IR														%
%IZ														%

MANITOBA HYDRO

LOAD LOSS AND IMPEDANCE TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Supply HV | Short | Open LV

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA 15

Measured Values

at 15 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

Base MVA

Measured Values

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C

Calculated Losses & Impedance

Total dc Loss														kW
Stray Loss														kW
Load Loss														kW
Core Loss	-													kW
Total Loss														kW
%IX	-													%
%IR														%
%IZ														%

MANITOBA HYDRO

LOAD LOSS AND IMPEDANCE TEST

Manufacturer:		Mftr's SO#:	
Plant Built:		Year Built:	
P.O. #:		PO Item#:	
Spec. #:		Spec ID#:	
Station Name:			

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Supply LV Short Open HV

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA 9

Measured Values

at 9 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

Base MVA

Measured Values

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C

Calculated Losses & Impedance

Total dc Loss														kW
Stray Loss														kW
Load Loss														kW
Core Loss	-													kW
Total Loss														kW
%IX	-													%
%IR														%
%IZ														%

MANITOBA HYDRO

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LOAD LOSS AND IMPEDANCE TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Supply: LV | Short: | Open: HV

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA: 15

Measured Values

at 15 MVA 85°C

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														□
LV														□
TV														□
														□
														□

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

Base MVA:

Measured Values

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C

Calculated Losses & Impedance

Total dc Loss														kW
Stray Loss														kW
Load Loss														kW
Core Loss	-													kW
Total Loss														kW
%IX	-													%
%IR														%
%IZ														%

MANITOBA
HYDRO

Leave This Page Blank
LOAD LOSS AND IMPEDANCE TEST

Page 7 - S/P - D - 1

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Leave This Page Blank Supply Short Open

S/P pos														
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA 9

Measured Values **Leave This Page Blank** **at 9 MVA 85°C**

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														
LV														
TV														

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

Base MVA

Measured Values **Leave This Page Blank**

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C

Calculated Losses & Impedance

Total dc Loss														kW
Stray Loss														kW
Load Loss														kW
Core Loss	-													kW
Total Loss														kW
%IX	-													%
%IR														%
%IZ														%

MANITOBA HYDRO

Leave This Page Blank
LOAD LOSS AND IMPEDANCE TEST

Page 7 - S/P - D - 2

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

Comment:

Leave This Page Blank Supply Short Open

S/P pos															
DTC pos		1	1	1	2	2	2	5	5	5				
LTC pos		-16	N	+16	-16	N	+16	-16	N	+16				
						rated								
Rated Voltage	Conn.													
HV														kV
LV														kV
														kV

85°C

Base MVA 15

Measured Values — **Leave This Page Blank** — **at 15 MVA 85°C**

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C
dc Resistance	Temp.													
HV														
LV														
TV														

Calculated Losses & Impedance

Total dc Loss	85.0													kW
Stray Loss	85.0													kW
Load Loss	85.0													kW
Core Loss	-													kW
Total Loss	85.0													kW
%IX	-													%
%IR	85.0													%
%IZ	85.0													%

Base MVA

Measured Values — **Leave This Page Blank**

Supplied	1&2													kV
Impedance Voltage	2&3													kV
phase to phase	3&1													kV
Supplied	1													A
Line Amps	2													A
	3													A
Supplied Load Loss														kW
at Temperature														°C

Calculated Losses & Impedance

Total dc Loss														kW
Stray Loss														kW
Load Loss														kW
Core Loss	-													kW
Total Loss														kW
%IX	-													%
%IR														%
%IZ														%

MANITOBA HYDRO

ZERO SEQUENCE TEST

Base MVA: 9

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

Average Oil Temperature: °C

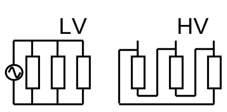
Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

comment

ZERO SEQUENCE TEST S/P 1

ZERO SEQUENCE TEST S/P 2

Wye - Delta [-optional Delta]

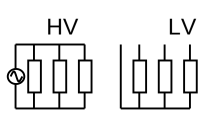


Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z0 @
DTC	LTC	kV	V	A	W	9 MVA

Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z0 @
DTC	LTC	kV	V	A	W	9 MVA

Wye - Wye [- Wye - Wye [- optional Delta]

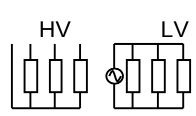
%Z1no - H TO Y



Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z1no @
DTC	LTC	kV	V	A	W	9 MVA

Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z1no @
DTC	LTC	kV	V	A	W	9 MVA

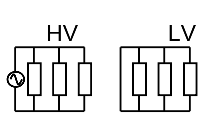
%Z2no - X TO Y



Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z2no @
DTC	LTC	kV	V	A	W	9 MVA

Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z2no @
DTC	LTC	kV	V	A	W	9 MVA

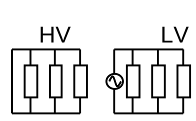
%Z1ns - H TO X & Y



Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z1ns @
DTC	LTC	kV	V	A	W	9 MVA

Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z1ns @
DTC	LTC	kV	V	A	W	9 MVA

%Z2ns - X TO H & Y



Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z2ns @
DTC	LTC	kV	V	A	W	9 MVA

Tap Pos.		V_{Rated}	$V_{Measured}$	$I_{Measured}$	$W_{Measured}$	%Z2ns @
DTC	LTC	kV	V	A	W	9 MVA

3-Circuit T-Diagram Components

Tap Pos.							
DTC	LTC	Zh	Zx	Zy	**Z h+x**	**Z x+y**	**Z h+y**

Tap Pos.							
DTC	LTC	Zh	Zx	Zy	**Z h+x**	**Z x+y**	**Z h+y**

MANITOBA HYDRO

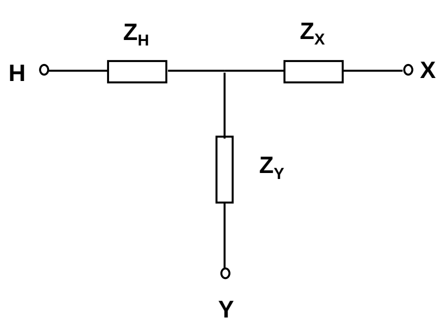
Positive-Sequence Impedance T-Diagrams

Manufacturer:		Mftr's SO#:	
Plant Built:		Year Built:	
P.O. #:		PO Item#:	
Spec. #:		Spec ID#:	
Station Name:			at 9 MVA, 85°C

comment

POSITIVE-SEQUENCE IMPEDANCE T-DIAGRAM

Tap Position		H+X		H+Y		X+Y		Z_H		Z_X		Z_Y	
DTC	LTC	% IR	% IX	% IR	% IX	% IR	% IX	% IR	% IX	% IR	% IX	% IR	% IX
S/P	1												
1	-16												
1	N												
1	+16												
2	-16												
2	N												
2	+16												
5	-16												
5	N												
5	+16												
S/P	2												
1	-16												
1	N												
1	+16												
2	-16												
2	N												
2	+16												
5	-16												
5	N												
5	+16												



Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

MANITOBA HYDRO

WTI & COOLING EQUIPMENT TESTS

Manufacturer:		Mftr's SO#:	
Plant Built:		Year Built:	
P.O. #:		PO Item#:	
Spec. #:		Spec ID#:	Version 1.1.2 (07-Aug-2015)
Station Name:			printed 12-Jun-17

comment

WTI CALIBRATION SETUP

Coil	MVA Rating	Injected Current from WTI CT	Voltage Across Heater Coil	Average Gradient over mean oil temp.	Hotspot Muliplier	Hotspot Gradient over top oil temp.
		A	V	°C		°C
HV						
LV						

AUXILIARY LOSSES

		Quantity of Auxiliary Devices	Voltage	Current	Total Watts	Full Load Current	Locked Rotor Current
			V	A	W	A	A
1st Stage ONAN	Fans						
	Pumps						
2nd Stage ONAF	Fans						
	Pumps						
3rd Stage ONAF	Fans						
	Pumps						

MANITOBA HYDRO

TRANSFORMER INSULATION POWER-FACTOR TEST

Manufacturer:
Plant Built:
P.O. #:
Spec. #:
Station Name:

Mftr's SO#:
Year Built:
PO Item#:
Spec ID#:

DTC Pos
LTC Pos.

comment

With Bushings and with Oil

Series Connection — Average Temperature °C

Parallel Connection (if applicable) — Average Temperature °C

TEST CONNECTION			Power Factor			Parallel Power Factor		
Winding Energized	Winding Grounded	Winding Guarded	At °C	Corrected to 20°C	Capacitance	At °C	Corrected to 20°C	Capacitance
			%		pF	%		pF
H	X							
Main Core*		H						
Main Clamp*		H						
LTC Reactor Core*		H						
LTC Reactor Clamp*		H						

* Low voltage test (not 10 kV)

INSULATION RESISTANCE TEST

	Main	LTC Reactor	Series Transformer
Core Insulation			
Clamp Insulation			

INSULATION RESISTANCE TEST

	HV		
Series			
Parallel			

With Bushings but without Oil

Shipping Connection — Average Temperature °C

Parallel Connection (if applicable) — Average Temperature °C

TEST CONNECTION			Power Factor			Parallel Power Factor		
Winding Energized	Winding Grounded	Winding Guarded	At °C	Corrected to 20°C	Capacitance	At °C	Corrected to 20°C	Capacitance
Low voltage test			%		pF	%		pF
H	X							
Main Core*		H						
Main Clamp*		H						
LTC Reactor Core*		H						
LTC Reactor Clamp*		H						

* Only required if shipped with HV and LV bushings (very small units)

INSULATION RESISTANCE TEST

	Main	LTC Reactor	Series Transformer
Core Insulation			
Clamp Insulation			

INSULATION RESISTANCE TEST

	HV		
Series			
Parallel			

Without Bushings and without Oil

Shipping Connection — Average Temperature °C

TEST CONNECTION			Power Factor		
Winding Energized	Winding Grounded	Winding Guarded	At °C	Corrected to 20°C	Capacitance
Low voltage test			%		pF
H	X				
Main Core		H			
Main Clamp		H			
LTC Reactor Core		H			
LTC Reactor Clamp		H			

Version 1.1.2 (07-Aug-2015)
printed 12-Jun-17

INSULATION RESISTANCE TEST

	Main	LTC Reactor	Series Transformer
Core Insulation			
Clamp Insulation			

INSULATION RESISTANCE TEST

HV		

Instructions

One document is used for both the full Design Review Document and the Simple Design Information Document.
The change is effected by the yellow cell below.

Simple Design Review Document FALSE

The information provided by the manufacturer in this workbook and in the Design Review Meeting is considered confidential and will not be shared with third parties outside of Manitoba Hydro.
It is also controlled with restricted access within Manitoba Hydro.

Yellow cells are input and are usually required.
Turquoise cells are optional input cells or used sometimes depending on the design.
They may contain a formula which can be overwritten if desired.

Fill-in the 'Ratings' sheet prior to proceeding with the remaining worksheets.

Some inputs on the Ratings sheet are used elsewhere in this workbook.
They also determine which areas are "whited-out" or 'blacked-out' as not applicable.

Metric / Imperial Units

This workbook is initialised for metric dimensions.
But if you normally design in imperial units, you may enter imperial values.
Ensure that you are consistent:
If you use imperial units, all units in this workbook must be imperial to avoid confusion.
On the 'General' worksheet, enter 'False' for the question
"Metric units are entered in this workbook?".
Changing this cell to 'False' will automatically change the units listed in each sheet.
Assumed metric / imperial units are shown further down in this sheet.
If you use a different unit, change the description in the adjacent cell.
You may need to adjust the formatting of the cell for decimal points.

Any unprotected cell with a formula may be overwritten.

The formulae are just suggestions.
Fill-in your actual values if desired.
For example, the 3-Circuit Losses sheet takes its values from the other loss sheets.
But it only does this for the first table.
The remaining tables still need input values.
Check the results. You can change the turquoise coloured cells if required.

Most drop-down boxes also just contain suggestions.

You do not have to choose from the list.
Enter whatever you feel is correct.
The only exceptions to this are on the 'Ratings' worksheet:
any drop-downs requiring a 'True' or 'False' response;
the 'Type of Series Transformer' drop-down;
the 'Type of Transformer', if a dc converter, must be HVDC.

Blacked-out areas do NOT require any input.
Whited-out worksheets do NOT require any input.
They are displayed this way just so that everyone knows something unnecessary is there.

For example, H+X&Y load loss is whited-out when the transformer does not have a dual LV.

Red columns or rows indicate the end of the sheet (like the ones here to the left and right).

Drawing numbers in Turquoise coloured cells do not need to be filled-in prior to the Design Rev

unless a drawing is attached for explanation.
MH may ask to view specific drawings at the design review meeting.
Feel free to attach explanatory drawings or sketches. These simplify and streamline the design review process.

This workbook does not need to be filled-out completely

but it should be as complete as practical for the Design Review Meeting.
More information given to MH up front lessens the details involved in the meeting.

Multiple people can work on multiple copies of this workbook at the same time.

The links between sheets are cosmetic except for SO#, date and coil names.
The workbooks can be easily combined either by the manufacturer or MH.

This workbook is not protected by a password.

Feel free to alter it to the needs of the design being reviewed.

Minimum Requirements:

Excel 2007 (conditional formating) for Windows, Excel2011 for Mac
It will work fine for other spreadsheet programs except for the conditional formatting used to white-out or black-out areas.

Glossary

Buried

A circuit or winding where the terminals are not brought out through bushings.

Circuit

Essentially the same as a winding.

Coil

A single coil wound at one time.

DTC

De-energised tapchanger

Dual LV

A transformer with two LV windings.
They both usually have the same voltage and each rated at half of the HV MVA.
A dual TV may also exist.

FCBN

Full Capacity Below Normal taps

ID

Inside Diameter

LTC

Load, on-load or under-load tapchanger.

LTC Reactor

Preventive Auto-Transformer to bridge the taps of a tap changer.

OD
Outside Diameter

RB
Radial Build

RCBN
Reduced Capacity Below Normal taps

S/P
Series / Parallel switch or linkboard

Tap Break
Major axial gap used for bridging taps

Winding
A winding can be composed of one or more coils.
For example, an LV coil connected with a tap coil is one winding.

3-Circuit Losses
Combined losses from three separate windings or circuits. The circuits are HV, LV and TV.
This does not apply for 4, 5 or 6-circuit transformers (dual LV, dual TV).

Limitations

Does not do 3-cct loss calculations for S/P (Only does series).

Assumed Imperial Units if Imperial Units are Used

Metric	Imperial	
mm	inch (")	
sq. mm	sq. inch	
sq. m	sq. inch	for core area
kg	pounds (#)	
litres	imperial gallons (not US)	
A/sq. mm	A/sq. inch	current density
mW/sq. mm	W/sq. inch	power density
mm/s	inch/s	oil velocity
kV/mm	kV/inch	electrical stress
kN	kilo-pounds	mechanical force
MPa or N/sq. mm	psi or ksi	mechanical stress
cubic m/hour	Cubic Feet per Minute (CFM)	fan air flow rate
litres/minute	Imperial Gallons per Minute (IGPM)	oil pump flow rate

Units that don't change

Volts (V)
kV
Amps (A)
Watts (W)
kW
MVA, kVA
Hertz (Hz)
°C or K
Ohms
Tesla (T)
dB

Oddball

MCM : thousands (roman numeral M) of circular mils
This is an imperial unit. Change to whatever suits you but specify the unit of measure.

Version History

current Version & SO Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)
enter here--> 2.0.7 2016 09 10
show imperial FALSE

Version	Date	by	Change
1.0.0	Feb 17/01	P. Franzen	Transferred from Word document.

			Expanded.
1.0.1	Mar 8/01	"	Added item numbering to sheets all load loss, 3-cct loss, aux loss & sl. Added to glossary. General: Added e-mail addresses; total weight relabeled taotal assembled weight; Additional reactor weights so that LTC & CLR are separate; Equipment: f: MH Specification # was cutoff (column width): changed to MH Spec#; Rating: Add comment Series transformer LIL s/b 1 class higher. Aux Loss & SL: added separate entry for series xfrmr. Core: clarified #step-laps and step-lap dimension. Added max shunt reactor gap height. Coil Sketch: Added clearance from core to shield & clarified. Coil Data: Clarified axial cooling ducts, clarified #Axial Passes; Fixed #dp format to 2dp for strand sizes; Clarifed 'per phase data'; Added corner area reduction, netting tape, epoxy, epoxy type; Elec Stress: fixed letter labels. Short-Circuit: Added elongation/displacement.
1.0.2	Oct 25/02 never issued	"	General: cosmetic changes. Core Loss: changed cell colouring. 2-cct Losses: changed cell colouring added reduced capacity MVA base & calc for RC column 3-cct Losses: cleaned-up formulae to allow different MVA bases for circuits. changed cell colouring. changed core loss retrieval.

1.0.3	Dec 9/02	Added Polarity for 1-phase to Rating: 7e. Added CW & SIL to Rating: 7g. 15 Coil Sketch: Added more notes. 11: 3-circuit Loss: clarified this is for 1 & 0 pf only. Added option to enter data in imperial units: added input cell in General; added description to these instructions; used formulae in sheets to select desired units. 16: Coil Data added ID & OD re-arranged Oil Flow to separate zig-zag and axial flow types. added more oil velocities. completely re-organised data removed 'This portion of Coil' because it is already included with HV-1, HV-2 instruction. Added note to include LTC reactor. 26: Tapchangers: added LTC: Iex and gaps 17: Circuit Data & 18 Temp Rises: corrected circuit name 'LV + Series SV & CV' to include LTC 19:Clamping: fixed permawood wording changed temp rise over ambient to over top oil 23: short-circuit added beam formulae, clarifications and references to Waters. 22: elec stress: added pb barriers qty & size 10: Losses Parallel Conn. fixed formula for to display first table. It only displayed if 3 or 4-cct, not 2-cct S/P.
1.0.4	July 31/03	**Deleted 55'C rise transformers** **18: Temperature Rise** Deleted second set of data for 65 of 55//65 rise.

Kept columns but left them optional & blank w/o formulae.

7: Rating

AB15 was =IF($X$22,IF(M12="",IF(L12="","",L12),M12),IF(G12="",IF(F12="","",F12),G12))
Now just =IF(G12="",IF(H12="","",H12),G12)
ie drop 55 option & fix mistake of F12 to H12 (ie ONAF2, not ONAN).
AA16 was =IF(X22,"ONAN55","ONAN65")
Now just text ONAN.
AB17:AB19 was =IF($X$22,IF(M23="",IF(L23="","",L23),M23),IF(H23="",IF(G23="","",G23),H23)
Now just =IF(H23="",IF(G23="","",G23),H23)
X22: Dual Temp Rise (T/F) deleted
Deleted W23:AA28 (55/65 rise)
Deleted secondary temperature inputs.

11: 3-cct Losses

G39 was =IF(NOT(Rating!$X$16),"n/a",IF(Rating!$X$22,IF(Rating!Y26="","n/a",Rating!Y26),IF(R
Now =IF(NOT(Rating!$X$16),"n/a",IF(Rating!AB17="","n/a",Rating!AB17))
J39 was =IF(G39="n/a","n/a",IF(Rating!$Y$25<>"",Rating!$Y$25+20,""))
Now =IF(G39="n/a","n/a",IF(Rating!$AB$15<>"",Rating!$AB$15+20,""))
F42 was =IF(Rating!$X$22,Rating!Y26,Rating!AB17)
Now =IF(Rating!$X$16,IF(Rating!AB17="","",Rating!AB17),"n/a")
G42 was =IF(Rating!$X$22,Rating!Y27,Rating!AB18)
Now =IF(Rating!$X$16,(F42/F7)^2*G7,"n/a")
Ditto H42
I7:K7 rearranged. Was HV MVA = LV + TV. Now LV = HV+TV
K7 was =IF(Rating!$X$16,Rating!F25,"n/a")   now =IF(Rating!$X$16,Rating!aa19,"n/a")
same change on I7 and I42 & K42

9: Core Loss

Deleted a & c "The transformer meets the specified requirement for excitation current?"
no real point in keeping this since values are given

10: Load Loss (both S & P)

Added extra 3 columns to separate series xfrmr & Reactor (both LTC & current limiting)

This was done to cover jobs like Brereton & Wuskwatim that could have both reactor & series

12: Auxilliary Losses
Clarified watts and amps per device

13:Sound Level
Added LTC reactor to individual list

14: Core Design
Added sketches for dimensions and yoke facing coil.
Moved widest sheet width from item 'a' to item 'e'
Added widest for wound legs, main & return yokes and return legs
Rearranged page breaks
Deleted core temp rise at 105% voltage.
Fixed formatting of dp for dimensions (now General)

15: Coil Sketch
Added two parallel halves outline
Added comment about multiple layers.

ALL: Added SO & date of intial data entry to every sheet

16: Coil Data
Rearranged page setup: got rid of instructions on repeated on each page.
Added inputs:
#Turns per half/Quarter

b2: added 2 Coils in Series, clarified 2 Series/Parallel Halves
Added dc loss for hotspot (was just rated dc loss + avg & hs eddies)
b13-15: Deleted Volts per Turn, Volts per Disk, Volts per Layer
fixed up lots of labels and comments
Deleted 'Axial Cooling Ducts' <T/F> : Redundant since #ducts is next input.

17: Circuit Data

Deleted W/lb since all modern designs have low value. It is also easy for us to calculate from oth
Added DTC/LTC tap position for each case
Added to circuit name list

18: Temperature Rise

Added to circuit name list
formatting

Instructions:

Made drawing numbers optional for turquoise cells.
This is most sheets except 'General'

19: Clamping

formatting
Added option to supply details on separate attachment.

22: Electrical Stresses

Added
- Oil Duct under Coil ID
- Oil Duct over Previous Coil OD
- Smallest Oil Duct
- Winding Cylinder Thickness
- Oil Stress at OD of Coil
- Individual oil and cylinder layers

23: Short-Circuit

Added option to choose units: kA or pu
Added "Type of currents for tables below": ie RMS vs peak & Symmetrical vs Asymmetrical
Added Waters and Del Vecchio references to force descriptions.

24: Cables & Grounds
Added comment that sheet does not need to be completed except for questions.

26: Tapchangers
Moved MOV stuff to MOV sheet (DTC, LTC & design)
Deleted LTC question "Are tie-in resistors required?" since redundant (we ask for data on resisto

27: MOV
Complete reorganise
Added reactor
Added items from tapchanger sheet: Location, Type and design limits

29: Tank
h5&6: reversed gas deflectors/piping questions to match the next spec where we ask for deflecto

1.0.5 July 22/04 **Rating**
Revisex cell X16 to allow entry of H+Y and X+Y impedance and load losses for buried TV.
was: =IF(AND(X15,NOT(L6),NOT(L4)),TRUE,FALSE)
changed to: =IF(AND(X15,NOT(L4)),TRUE,FALSE)

1.0.6 April 14/08 **11 3-Circuit Losses**
Fixed base MVA cells (G42:H42) at top rating
Removed formula and replaced with copying of F42

1.0.7 2008 08 08 9 Core Loss
Added more rows 30, 60, 80, 85, 90, and 120-130
Added saturation and air-core reactance.
23 Short-circuit
Added Titling Force in addition to stress.
Added top and bottom of each coil
17 Circuit Data

			Added Hotspot Stray
		16	Coil Data
			Added more stray loss taps
		7	Rating
			Added j Phase-shift LTC
1.0.8	2009 03 16	16	Coil Data
			Added 16e: Winding Direction and Lead Numbering Sketch
			16b12ab, 16b13ab: Added coil height per parallel half/quarter
		23	Short-Circuit
			added to 23 e & f (fault currents) for CV
			added 23 g 1-8, Axial and radial Magnetic flux density
			reorg Et
			Added boxes for end thrust (top & btm)
		9	Core Loss
			deleted Iex ratios
			added Iex for LTC Reactor
			added second air-core point for HV
		14	Core
			j1-4: added yes/no for core ground
		19	Clamping
			i1-4: added yes/no for clamp ground, plus dwg
1.0.9	2009 04 16		Created Simple Design Information Document from MH Design Review Document
2.0.0	2010 11 30		Rewrote Protect/Unprotect
			Made major changes to most sheets
			Added metric conversion to imperial on each relevant sheet
			Added trigger cell on Instructions.
			Combined Simple Design Info into Design Review Document
			Added several sheets for series xfmr, LTC reactor and current limiting reactor

		core coil sketch series xfmr clamping series xfmr Winding Other Split Electrical Stresses sheet into clearances and stresses sheets. Split Short-Circuit into currents and forces sheets Split Tapchangers into DTC, LTC and other. Added Current Limiting Reactor sheet Added LTC Reactor sheet Added sheets for series xfmrs core Coil sketch clamping Added Winding Other sheet for sub-contracted coils Combine Control Box & Wiring with Operational Safety on one sheet.
2.0.1	2012 10 16	General: Revised metric/imperial weight conversion. Added Imp to Metric volume conversion. 20&21: Clamping: Added clamping pressure, end ring thickness, bridge thickness, % offset and grade of mateiral for tie-rods and tie-plates. Core Loss: Added MVA base. Added example core loss curve with air-core. Fixed some conditional formating for 'series connection' 16 Coil Data: Added MW and Cable sketches to explain each. 16 Coil Data: Added flexible conductor to the Lead Gradient section. 29g End Thrust: Added per coil end thrust
2.0.2	2013 07 27	Fix metric imperial conversions 4 core sheets, 4 dp for sheet thickness conversion fixed most sheets with conversions to allow bidirectional conversion Added V & I axis labels to core loss curve.

2.0.3	2014 09 08	Renamed Sheet 26 from Electrical Stresses to Electrical Clearances Added Page Setup Magnification to cell A1 of each sheet. This allows use of a macro to reset this. Increase dp for gradients in Coil Data Increase dp for hotspot mulitplier in Circuit Data Increase dp on imperial page inElec Clr fix Tank page breaks fixed LTC sheet blanks-out if LV LTC because it only checks if there is an HV LTC Simplified Stray Flux sheet by putting most of it in one table. Added DTC 4 & LTC -15 to load losses Added intermediate LTC tap for +/-20% cases Added 'n' Capacitances to end of Coil Data. Deleted 'n' Comments. Added Core Steps sheet (11) for Des Review Doc Added core construction dwg request Re-arranged core loss, putting reactor before series xfmr Added current ref base to Coil Data losses & gradients, and Circuit Data Added cable diameter for lead gradients Added Tap Lead Numbering at Top (or OD) & Bottom (or ID) to Coil Data Added All losses and gradients are based on 2-Circuit loading at 1 (or 0) power factor. Coil Data clarified gradients as 2-circuit Added assembly and tank layout sketch requirements for shunts SC Current: Added box whether over-voltage is included in Amps. and provided eqn 1.1 x 1.41 x k x 0/v x xN x I Completely re-made Temp Rise, to accomodate 3-circuit loading
2.0.4	2015 01 13	Re-built Winding Direction Sheet. All new. Now only one set of sketches with type numbers. Temp Rise: cleaned up colour. Removed 3-cct calc formulae Coil Sketch Main & ST: fixed imperial calc to show as "". Grouped Objects.
2.0.5	2015 01 21	Rating: fixed F43 eqn for determinding if S/P is 2:1 IF(X42,IF(OR(AND(K42<>"",IF(K42="",FALSE,E42/K42<>2)),AND(K43<>"",IF(K43="",FALSE,E43/K

2.0.6	########	Core Main: Added flux density for main yoke, and rteturn leg & yoke Clarified max DC in core for HVDC or GIC Shrt-Cct: Deleted Offset Coil(s). Added Coil Offset in % for each coil column Changed offset labels to Case 1: Mfts's normal offset Case 2: 0.5% offset for Elongation or 0.3% offset for Displacement Case 3: no offset Case 4: additional if necessary
2.0.7	########	Special revision for Glemboro South PST Added Source & Load labels to ratings sheet Specified No-Load phase-shift on ratings sheet Added Load Capability Sheet Added PST Core Loss Sheet Added PST phase Angle sheet fixed hide/show LTC

To do

Add a transformer paralleling sheet
compare reactance, check short-circuit current

~~Add to coil sketch for dual LV. (partially done)~~
~~Add 2 parallel halves coil heights (electrical/mechanical)~~

Temp rise in Kelvins
~~Coil-coil insulation build~~
~~Add info to calc oil stress at OD of coil~~

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

1 General Information

a Supplier

1 Supplier's Name

Supplier's P.O. #:

b Design Review Data Entry Revision

1 Revision # **0**

2 Revision Date 2016/08/01

c Data Units of Measure

Metric **TRUE** **Metric units are entered in this workbook?**

Either metric (mm, kg, litres, N/sqmm...) or imperial (inch, pounds, gallons, psi…) is acceptable but be consistent.

d Meeting Information

Location

Date of meeting

e Contact Person

	Name	Title	Phone #	E-Mail
Manufacturer's				
Manitoba Hydro's	Mr. Peter Franzen	Apparatus Eng.	(204) 360-4747	pfranzen@hydro.mb.ca
For Questions on this File	Mr. Peter Franzen	Apparatus Eng.	(204) 360-4747	pfranzen@hydro.mb.ca

f Representatives

	Name	Title	Phone #	E-Mail
Manitoba Hydro's				
	Mr. Peter Franzen	Apparatus Eng.	(204) 360-4747	pfranzen@hydro.mb.ca
	Mr. Denis Wittevrongel	Q.A. Officer	(204) 792-1703	dwittevrongel@hydro.mb.ca
	Mr. Rodel Hernandez	Apparatus Eng.	(204) 360-4848	rhernandez@hydro.mb.ca
Manufacturer's				

g Equipment

1	Manufacturer :	6	M.H. RFP #:
2	Plant Location :	7	Spec ID#:
3	Year Built :	8	M.H. P.O. #:
4	Manufacurer's Serial #:	9	P.O. Item #:
5	Manufacurer's Other #:	10	Station Name:
		11	Delivery Date:

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

h **Mechanical Features and Primary Accessories**

(Approximate: not for construction purposes)

1 Dimensions

		Tank	Shipping	Assembled	
a	Height				mm
b	Width				mm
c	Length				mm

2 Oil Volumes

a	Main Tank		litres
b	All LTC		litres
c	Main Conservator		litres
d	LTC Conservator		litres
e	Rads / Coolers		litres
f	Total		litres

3 Weights

	Core		
a	Main Transformer		kg
b	Series Transformers		kg
c	LTC Reactors		kg
d	Current Limiting Reactors		kg
	Copper		
e	Main Transformer		kg
f	Series Transformers		kg
g	LTC Reactors		kg
h	Current Limiting Reactors		kg
	Core and Coils Assembly		
i	Main Transformer		kg
j	Series Transformers		kg
k	LTC Reactors		kg
l	Current Limiting Reactors		kg
	Total		kg
	Other		
m	Tank and Fittings		kg
n	Total Oil		kg
o	Total Assembled		kg
p	Shipping		kg

4 Q.A. Program

5 Shipped filled with

6 Conservator Type

7 General Description Enter a general desription as text if required.

8 Drawing Numbers if known

		Drawing #	Rev#
a	Outline		
b			
c			
d	Legend		
e	Rating Plate		
f			
g			
h	Shipping Outline		
i	Schematic Diagrams		
j			
k			
l			
m			
n			
o	Wiring Diagrams		
p			
q			
r			
s			
t			
u			

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

2 Transformer or Reactor Rating

a Type

1	Type of Transformer			
2	Type of Cooling			
3	#Phases			
4	Dual LV?			
5	Buried TV?			
6	LTC Reactor (Preventive Auto)?			
7	Current Limiting Reactor?			

b Rated Temperature Rises °C

1	Winding	65		
2	Oil	65		

c Angular Displacement(s) or Polarity

1	Primary	Symmetrical Extended Delta
2	Secondary	
3	Polarity for 1-phase	

d MVA

		65°C base	n/a	n/a
1	HV			
2	LV			
3	TV			

e Voltage

Series Connection

		Rated Voltage kV	Lightning Impulse Level (kV LIL) Line	Lightning Impulse Level (kV LIL) Neutral	Chopped Wave (kV LIL)	Switching Surge (kV SIL)
1	HV					
2	LV					
3	TV					

Parallel Connection if applicable

		Rated Voltage kV	Lightning Impulse Level (kV LIL) Line	Lightning Impulse Level (kV LIL) Neutral	Chopped Wave (kV LIL)	Switching Surge (kV SIL)
1	HV					
2	LV					
3	TV					

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

2 Transformer or Reactor Rating

f De-energized Tapchanger (DTC)

		Series Connection					Parallel Connection if applicable				
		Tap Range		#Steps	Equal Steps?	Reduced Capacity?	Tap Range		#Steps	Equal Steps?	Reduced Capacity?
		Boost +%	Buck -%				Boost +%	Buck -%			
1	HV										
2	LV										
3	TV										

g Voltage Load Tapchanger (LTC)

		Series Connection					Parallel Connection if applicable				
		Tap Range		#Steps	Equal Steps?	Reduced Capacity?	Tap Range		#Steps	Equal Steps?	Reduced Capacity?
		Boost +%	Buck -%				Boost +%	Buck -%			
1	HV										
2	LV										
3	TV										

h Phase-Shift Load Tapchanger (PSLTC)

		No-Load At Voltage LTC N					Tap Range		Tap Range	
		Tap Range		#Steps	Equal Steps?	Reduced Capacity?	At Voltage LTC Boost		At Voltage LTC Buck	
		Boost Advance °	Buck Retard °				Boost Advance °	Buck Retard °	Boost Advance °	Buck Retard °
1	HV									
2	LV									
3	TV									

Attach a rating plate or name plate drawing showing tap positions, numbering, voltages and currents.

3 Series Transformer for LTC

a Type of Series Transformer

b **MVA**

65°C		

c Voltage and Winding Lightning Impulse Level kV

			Rated Voltage kV	Lighning Impulse Level (kV LIL)	
				Line	Neutral
1	HV	(Wye)			
2	LV	(Wye)			

Series Transformer Voltage Class shall be one class higher than the main transformer per the Technical Specification.

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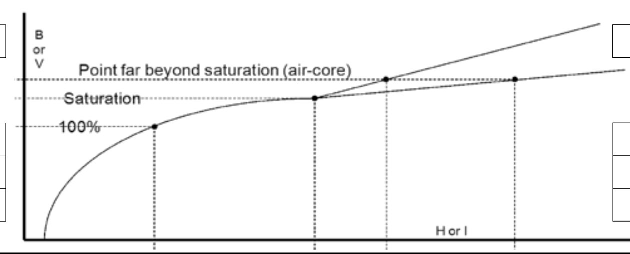
Design Review Data

4 Core Loss and Exciting Current

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

	Voltage	Please enter actual Position number. Tap Position #		Core Loss					Excitation Current at MVA base				
				Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor	Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor
				Guar.	Calc.	Calc.	Calc.	Calc.	Guar.	Calc.	Calc.	Calc.	Calc.
	%	DTC	LTC	kW	kW	kW	kW	kW	%	%	%	%	%
	Series Connection												
a	**Sum of Main, Series and LTC Reactor at Rated Tap**												
1	30												
2	60												
3	80												
4	85												
5	90												
6	95												
7	100												
8	105												
9	110												
10	115												
11	120												
12	125												
13	130												

			kW	% I
	Saturation Point			
14		Main transformer core		
	Point far beyond saturation (air-core)			
15		Main transformer core HV (SV+CV for auto)		
16		Main transformer core LV		
17		Main transformer core TV		



b	**Air-Core Reactance**	ohms	p.u.	at rated tap
1	HV			(SV+CV for auto)
2	LV			
3	TV			

4 Attach a %Excitation Current vs %Voltage curve extending into the air-core saturation region c/w the air-core reactance.

Either provide a curve with a change of scale to show more detail or provide two charts with one showing the operating region in more detail.

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Design Review Data

4 Core Loss and Exciting Current

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

		Voltage	Please enter actual Position number. Tap Position #		Core Loss					Excitation Current at MVA base				
					Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor	Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor
					Guar.	Calc.	Calc.	Calc.	Calc.	Guar.	Calc.	Calc.	Calc.	Calc.
		%	DTC	LTC	kW	kW	kW	kW	kW	%	%	%	%	%
		Series Connection												
		LTC Reactor Only												
d	1	30												
	2	60												
	3	80												
	4	85												
	5	90												
	6	95												
	7	100												
	8	105												
	9	110												
	10	115												
	11	120												
	12	125												
	13	130												
e		**Sum of Main, Series and LTC Reactor**												
	1	90					0.00	0.00				0.00	0.00	
	2	100					0.00	0.00				0.00	0.00	
	3	110					0.00	0.00				0.00	0.00	
	4	90					0.00	0.00	0.00			0.00	0.00	0.00
	5	100					0.00	0.00	0.00			0.00	0.00	0.00
	6	110					0.00	0.00	0.00			0.00	0.00	0.00

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Design Review Data

4 Core Loss and Exciting Current

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Voltage	Please enter actual Position number. Tap Position #		Core Loss						Excitation Current at MVA base				
			Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor		Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor
			Guar.	Calc.	Calc.	Calc.	Calc.		Guar.	Calc.	Calc.	Calc.	Calc.
%	DTC	LTC	kW	kW	kW	kW	kW		%	%	%	%	%

Series Connection

c **Series Transformer Only**

	Voltage %
1	30
2	60
3	80
4	85
5	90
6	95
7	100
8	105
9	110
10	115
11	120
12	125
13	130

Saturation Point

14 Series transformer core

Point far beyond saturation (air-core)

15 Series transformer core HV (SV+CV for auto)

16 Series transformer core LV

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Design Review Data

4 Core Loss and Exciting Current

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Voltage	Please enter actual Position number. Tap Position #		Core Loss						Excitation Current at MVA base					
			Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor		Main, Series and LTC Transformers			Main Xfrmr	Series Xfrmr	LTC Reactor
			Guar.	Calc.	Calc.	Calc.	Calc.		Guar.	Calc.		Calc.	Calc.	Calc.
%	DTC	LTC	kW	kW	kW	kW	kW		%	%		%	%	%

Parallel Connection (If different from series connection)

f **Sum of Main, Series and LTC Reactor at Rated Tap**

1 30
2 60
3 80
4 85
5 90
6 95
7 100
8 105
9 110
10 115
11 120
12 125
13 130

Saturation Point
14 Main transformer core

Point far beyond saturation (air-core)
15 Main transformer core HV (SV+CV for auto)
16 Main transformer core LV
17 Main transformer core TV

g **Air-Core Reactance** ohms p.u. at rated tap
1 HV (SV+CV for auto)
2 LV
3 TV
4 Attach a %Excitation Current vs %Voltage curve extending into the air-core saturation region c/w the air-core reactance.
Either provide a curve with a change of scale to show more detail or provide two charts with one showing the operating region in more detail.

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Design Review Data

4 Core Loss and Exciting Current

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

	Voltage	Please enter actual Position number. Tap Position #		Core Loss					Excitation Current at MVA base				
				Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor	Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor
				Guar.	Calc.	Calc.	Calc.	Calc.	Guar.	Calc.	Calc.	Calc.	Calc.
	%	DTC	LTC	kW	kW	kW	kW	kW	%	%	%	%	%
	Parallel Connection (If different from series connection)												
i	**LTC Reactor Only**												
1	30												
2	60												
3	80												
4	85												
5	90												
6	95												
7	100												
8	105												
9	110												
10	115												
11	120												
12	125												
13	130												
j	**Sum of Main, Series and LTC Reactor**												
1	90					0.00	0.00				0.00	0.00	
2	100					0.00	0.00				0.00	0.00	
3	110					0.00	0.00				0.00	0.00	
4													
5	90					0.00	0.00	0.00			0.00	0.00	0.00
6	100					0.00	0.00	0.00			0.00	0.00	0.00
	110					0.00	0.00	0.00			0.00	0.00	0.00

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Design Review Data

4 Core Loss and Exciting Current

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Voltage	Please enter actual Position number. Tap Position #		Core Loss						Excitation Current at MVA base					
			Main, Series and LTC Transformers		Main Xfrmr	Series Xfrmr	LTC Reactor		Main, Series and LTC Transformers			Main Xfrmr	Series Xfrmr	LTC Reactor
			Guar.	Calc.	Calc.	Calc.	Calc.		Guar.	Calc.		Calc.	Calc.	Calc.
%	DTC	LTC	kW	kW	kW	kW	kW		%	%		%	%	%

Parallel Connection (If different from series connection)

h **Series Transformer Only**

1	30
2	60
3	80
4	85
5	90
6	95
7	100
8	105
9	110
10	115
11	120
12	125
13	130

Saturation Point

14 Series transformer core

Point far beyond saturation (air-core)

15 Series transformer core HV (SV+CV for auto)

16 Series transformer core LV

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

5 **Load Loss and Reactance** **Full Capacity Below Normal** **Fill-in data only when applicable and relevant. If rated and neutral are the same tap, fill-in only once.**

Main Transformer MVA Base ____ Series Transformer MVA Base ____ Temperature Base 85 °C
Reduced Capacity MVA Base ____

a **2-Circuit Loading: H+X** Choose the main and series transformer MVAs so that losses and reactance may be added. FC: Full Capacity RC: Reduced Capacity

Series Connection

		Primary Voltage	Secondary Voltage	Please enter actual Position number. Tap Position #		Full Capacity Reactance				Load Loss with harmonics			Full Capacity Load Loss Components at 60 Hz.								
						Sum of Main and Series Transformers or Reactor		Main Xfrmr Only	Reactor or Series Xfmr Only	Sum of Main Xfrmr and Series Xfrmr / Reactor			Main Transformer			Series Transformer			LTC or Current Limiting Reactor		
						Guar.	Calc.	Calc.	Calc.	Guar.	FC Calc.	RC Calc.	I^2R Calc.	Winding Stray Calc.	Other Stray Calc.	I^2R Calc.	Winding Stray Calc.	Other Stray Calc.	I^2R Calc.	Winding Stray Calc.	Other Stray Calc.
		kV	kV	DTC	LTC	%	%	%	%	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
	1																				
	2																				
	3																				
	4				N																
	5																				
	6																				
	7																				
	8																				
	9																				
	10																				
	11				N																
	12																				
	13																				
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	15																				
rated	16																				
	17																				
	18																				
	19																				
	20																				
	21																				
	22				N																
	23																				
	24																				
	25																				

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

5 **Load Loss and Reactance** **Full Capacity Below Normal** **Fill-in data only when applicable and relevant. If rated and neutral are the same tap, fill-in only once.**

Main Transformer MVA Base n/a Series Transformer MVA Base Temperature Base 85 °C
Reduced Capacity MVA Base n/a

b **2-Circuit Loading: H+Y** Choose the main and series transformer MVAs so that losses and reactance may be added.

Series Connection

	Primary Voltage kV	Secondary Voltage kV	Tap Position # DTC	Tap Position # LTC	Full Capacity Reactance: Sum of Main and Series Transformers or Reactor Guar. %	Full Capacity Reactance: Sum of Main and Series Transformers or Reactor Calc. %	Main Xfrmr Only Calc. %	Reactor or Series Xfmr Only Calc. %	Load Loss with harmonics, Sum of Main Xfrmr and Series Xfrmr / Reactor: Guar. kW	FC Calc. kW	RC Calc. kW	Main Transformer I^2R Calc. kW	Main Transformer Winding Stray Calc. kW	Main Transformer Other Stray Calc. kW	Series Transformer I^2R Calc. kW	Series Transformer Winding Stray Calc. kW	Series Transformer Other Stray Calc. kW	LTC or Current Limiting Reactor I^2R Calc. kW	LTC or Current Limiting Reactor Winding Stray Calc. kW	LTC or Current Limiting Reactor Other Stray Calc. kW
1																				
2																				
3																				
4				N																
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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

5 **Load Loss and Reactance** **Full Capacity Below Normal** **Fill-in data only when applicable and relevant. If rated and neutral are the same tap, fill-in only once.**

Main Transformer MVA Base n/a Series Transformer MVA Base Temperature Base 85 °C
Reduced Capacity MVA Base n/a For dual LV design, Winding Stray and Other Stray may be combined if individual values are not known.

c **2-Circuit Loading: X+Y** Choose the main and series transformer MVAs so that losses and reactance may be added.

Series Connection

	Primary Voltage	Secondary Voltage	Tap Position #		Full Capacity Reactance: Sum of Main and Series Transformers or Reactor		Main Xfrmr Only	Reactor or Series Xfmr Only	Load Loss with harmonics: Sum of Main Xfrmr and Series Xfrmr / Reactor			Full Capacity Load Loss Components at 60 Hz. Main Transformer			Series Transformer			LTC or Current Limiting Reactor		
												I^2R	Winding Stray	Other Stray	I^2R	Winding Stray	Other Stray	I^2R	Winding Stray	Other Stray
					Guar.	Calc.	Calc.	Calc.	Guar.	FC Calc.	RC Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.
	kV	kV	DTC	LTC	%	%	%	%	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
1																				
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22				N																
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25																				

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01)   Version 2.0.7 (2016 09 10)

5 **Load Loss and Reactance**   **Full Capacity Below Normal**   **Fill-in data only when applicable and relevant. If rated and neutral are the same tap, fill-in only once.**

Main Transformer MVA Base n/a   Series Transformer MVA Base   Temperature Base 85 °C
Reduced Capacity MVA Base n/a

d **2-Circuit Loading: H+X&Y**   Choose the main and series transformer MVAs so that losses and reactance may be added.

Series Connection

	Primary Voltage	Secondary Voltage	Tap Position #		Full Capacity Reactance: Sum of Main and Series Transformers or Reactor		Main Xfmr Only	Reactor or Series Xfmr Only	Load Loss with harmonics: Sum of Main Xfmr and Series Xfmr / Reactor			Full Capacity Load Loss Components at 60 Hz. Main Transformer			Series Transformer			LTC or Current Limiting Reactor		
					Guar.	Calc.	Calc.	Calc.	Guar.	FC Calc.	RC Calc.	I^2R Calc.	Winding Stray Calc.	Other Stray Calc.	I^2R Calc.	Winding Stray Calc.	Other Stray Calc.	I^2R Calc.	Winding Stray Calc.	Other Stray Calc.
	kV	kV	DTC	LTC	%	%	%	%	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
1																				
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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

6 **Load Loss and Reactance** **Full Capacity Below Normal**

Main Transformer MVA Base n/a Series Transformer MVA Base Temperature Base 85 °C
Reduced Capacity MVA Base n/a

e **2-Circuit Loading: H+X** Choose the main and series transformer MVAs so that losses and reactance may be added. FC: Full Capacity RC: Reduced Capacity

Parallel Connection : If Different from Series Connection

	Primary Voltage	Secondary Voltage	Please enter actual Position number. Tap Position #		Full Capacity Reactance Sum of Main and Series Transformers or Reactor		Main Xfrmr Only	Reactor or Series Xfmr Only	Load Loss with harmonics Sum of Main Xfrmr and Series Xfrmr / Reactor			Full Capacity Load Loss Components at 60 Hz. Main Transformer			Series Transformer			LTC or Current Limiting Reactor		
												I^2R	Winding Stray	Other Stray	I^2R	Winding Stray	Other Stray	I^2R	Winding Stray	Other Stray
					Guar.	Calc.	Calc.	Calc.	Guar.	FC Calc.	RC Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.
	kV	kV	DTC	LTC	%	%	%	%	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

6 **Load Loss and Reactance** **Full Capacity Below Normal**

Main Transformer MVA Base n/a
Reduced Capacity MVA Base n/a
Series Transformer MVA Base
Temperature Base 85 °C

f **2-Circuit Loading: H+Y**

Choose the main and series transformer MVAs so that losses and reactance may be added.

Parallel Connection : If Different from Series Connection

	Primary Voltage kV	Secondary Voltage kV	Tap Position # DTC	Tap Position # LTC	Full Capacity Reactance: Sum of Main and Series Transformers or Reactor Guar. %	Full Capacity Reactance: Sum of Main and Series Transformers or Reactor Calc. %	Main Xfrmr Only Calc. %	Reactor or Series Xfmr Only Calc. %	Load Loss with harmonics: Sum of Main Xfrmr and Series Xfrmr / Reactor Guar. kW	FC Calc. kW	RC Calc. kW	Full Capacity Load Loss Components at 60 Hz.: Main Transformer I^2R Calc. kW	Main Transformer Winding Stray Calc. kW	Main Transformer Other Stray Calc. kW	Series Transformer I^2R Calc. kW	Series Transformer Winding Stray Calc. kW	Series Transformer Other Stray Calc. kW	LTC or Current Limiting Reactor I^2R Calc. kW	LTC or Current Limiting Reactor Winding Stray Calc. kW	LTC or Current Limiting Reactor Other Stray Calc. kW
1																				
2																				
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25																				

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

6 **Load Loss and Reactance** **Full Capacity Below Normal**

Main Transformer MVA Base n/a Series Transformer MVA Base Temperature Base 85 °C
Reduced Capacity MVA Base n/a For dual LV design, Winding Stray and Other Stray may be combined if individual values are not known.
g **2-Circuit Loading: X+Y** Choose the main and series transformer MVAs so that losses and reactance may be added.

Parallel Connection : If Different from Series Connection

	Primary Voltage	Secondary Voltage	Tap Position #		Full Capacity Reactance: Sum of Main and Series Transformers or Reactor		Main Xfmr Only	Reactor or Series Xfmr Only	Load Loss with harmonics: Sum of Main Xfmr and Series Xfmr / Reactor			Full Capacity Load Loss Components at 60 Hz.: Main Transformer I^2R	Main Transformer Winding Stray	Main Transformer Other Stray	Series Transformer I^2R	Series Transformer Winding Stray	Series Transformer Other Stray	LTC or Current Limiting Reactor I^2R	LTC or Current Limiting Reactor Winding Stray	LTC or Current Limiting Reactor Other Stray
					Guar.	Calc.	Calc.	Calc.	Guar.	FC Calc.	RC Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.	Calc.
	kV	kV	DTC	LTC	%	%	%	%	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW	kW
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21																				
22				N																
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24																				
25																				

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

6 **Load Loss and Reactance** **Full Capacity Below Normal**

Main Transformer MVA Base n/a Series Transformer MVA Base Temperature Base 85 °C
Reduced Capacity MVA Base n/a

h **2-Circuit Loading: H+X&Y**

Choose the main and series transformer MVAs so that losses and reactance may be added.

Parallel Connection : If Different from Series Connection

	Primary Voltage kV	Secondary Voltage kV	Tap Position # DTC	Tap Position # LTC	Full Capacity Reactance: Sum of Main and Series Transformers or Reactor Guar. %	Full Capacity Reactance: Sum of Main and Series Transformers or Reactor Calc. %	Full Capacity Reactance: Main Xfmr Only Calc. %	Full Capacity Reactance: Reactor or Series Xfmr Only Calc. %	Load Loss with harmonics: Sum of Main Xfmr and Series Xfmr / Reactor Guar. kW	Load Loss with harmonics: FC Calc. kW	Load Loss with harmonics: RC Calc. kW	Main Transformer I^2R Calc. kW	Main Transformer Winding Stray Calc. kW	Main Transformer Other Stray Calc. kW	Series Transformer I^2R Calc. kW	Series Transformer Winding Stray Calc. kW	Series Transformer Other Stray Calc. kW	LTC or Current Limiting Reactor I^2R Calc. kW	LTC or Current Limiting Reactor Winding Stray Calc. kW	LTC or Current Limiting Reactor Other Stray Calc. kW
1																				
2																				
3																				
4				N																
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16																				
17				N																
18																				
19																				
20																				
21																				
22				N																
23																				
24																				
25																				

Please fill-in all taps, even if those taps might not be suitable for full or overload loading.

Guaranteed losses are per the loss evaluation criteria.
Guaranteed reactances are at the tap extremes.

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Design Review Data

No data required here   Rev#: 0 (2016/08/01)   Version 2.0.7 (2016 09 10)

7 **3-Circuit Losses** This sheet applies only for power factors of 1 for the HV or LV, and 0 for the TV.

For HVDC transformer: use the harmonic losses. **n/a**

a Main Transformer MVA Base n/a Temperature Base n/a °C Cooling n/a

n/a

Tap Position # DTC	LTC	MVA n/a H+X kW	n/a H+Y kW	n/a X+Y kW	n/a H kW	n/a X kW	n/a Y kW	3-cct Load Loss kW	Core Loss kW	3-cct Total Loss kW
1										
2										
3										
4	N									
5										
6										
6										
7										
8										
9										
10	N									
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15										
16										
17										
18										
19										
20	N									
21										
21										
22										

n/a

b Main Transformer MVA Base n/a Temperature Base n/a °C Cooling n/a

n/a

Tap Position # DTC	LTC	MVA n/a H+X kW	n/a H+Y kW	n/a X+Y kW	n/a H kW	n/a X kW	n/a Y kW	3-cct Load Loss kW	Core Loss kW	3-cct Total Loss kW
1										
2										
3										
4	N									
5										
6										
6										
7										
8										
9										
10	N									
11										
12										
12										
13										
14										
15										
16										
17										
18										
19										
20	N									
21										
21										
22										

Manitoba Hydro

Design Review Data

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8 Sound Level

	Sound Level Type	% of Rated Volts %	Calculated Sound Level dB	Guaranteed Sound Level dB
a	Main Transformer core only	100		
b	Series Transformer core only	100		
c	LTC Reactor only	100		
d	Fans only	-		
e	Pumps only	-		
f				
g				
h				

i	Frequency		Hz (60,125,250,...)
j	Weighting	A	
k	With Sound Enclosure?		
l	Sound Reduction Techniques?		

9 Auxilliary Loads

	Auxilliary Loss		Quantity of Auxiliary Devices Active	Voltage V ϕ–ϕ	Watts per device W	Full Load Current per device A	Locked Rotor Current per device A
a	1st Stage	Fans					
b	n/a	Pumps					
c	2nd Stage	Fans					
d	n/a	Pumps					
e	3rd Stage	Fans					
f	n/a	Pumps					

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10 **Core Design** for **Main Transformer**

a **Core Steel**

1	Manufacturer		
2	Type (eg 23ZDKH85)		
3	Steel Thickness		mm
4	Lamination Factor		pu
5	Insulation Type		

Attach a copy of the manufacturer's curves including Real Power, Apparent Power and DC Magnetization if available.

Comments

b **Cutting / Stacking**

1	Mitre-Joint Type		(Fully-mitred, Semi-mitred, Butt-lap, Wound, n/a)
2	# Step-laps if applicable		(enter number of sheets or laps, not number of steps)
3	Step-Lap		mm per step
4	Allowable Mitre-joint gaps		mm
5	Allowable Burr on cut edge		mm
6	Are holes used to stack?		

Comments

c **Shunt Reactor Gaps**

1	Quantity per Leg		
2	Average Height		mm
3	Maximum Height		mm
4	Gap Material		

Comments

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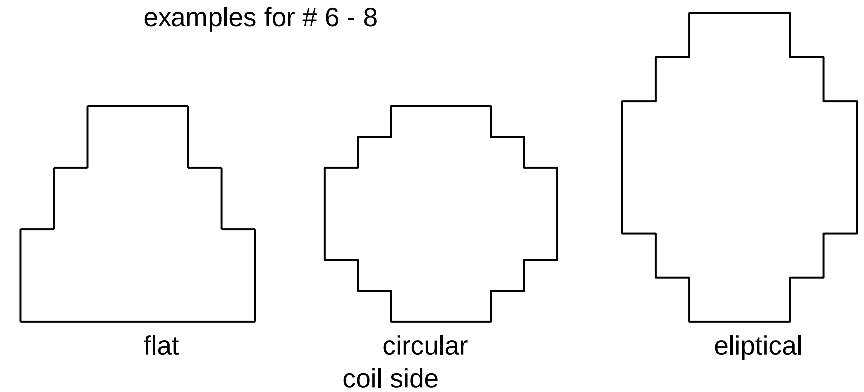
10 **Core Design** for **Main Transformer**

d **Construction**

1	Type of Core		core, shell
2	Circular or Rectangular		
3	#Legs		
4	# Wound Legs		
5	Core Bolts Used?		
6	Main Yoke facing Coil is		flat, circular, elliptical
7	Return Yoke facing Coil is		
8	Return Leg facing Coil is		

Comments

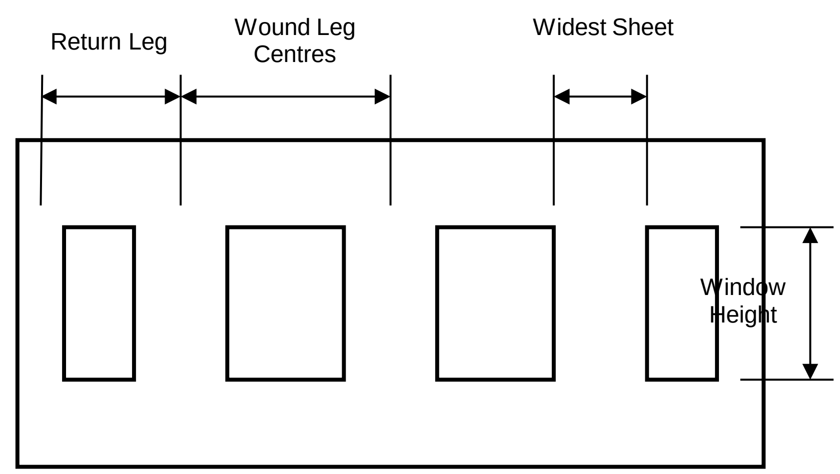
examples for # 6 - 8



e **Design**

Provide a core construction sketch, showing main item widths and step-lap joints detail.

1	Wound Leg Diameter		mm
2	Window Height		mm
3	Wound Leg Centres		mm
4	Return Leg Centres		mm
	Widest Sheet Width		
5	Wound Leg		mm
6	Main Yoke		mm
7	Return Yoke		mm
8	Return Leg		mm
	Area		
9	Wound Leg		sq. m
10	Main Yoke		sq. m or pu of Wound Leg
11	Return Yoke		sq. m or pu of Wound Leg
12	Return Leg		sq. m or pu of Wound Leg
13	Core Weight		kg



f **Flux Density at 100% Voltage**

		Wound Leg	Main Yoke	Return Leg	Return Yoke	
1	at Rated Tap					Tesla
2	at Maximum Flux Tap					Tesla
3	at Minimum Flux Tap					Tesla

4	Allowable dc current in core		A for HVDC or GIC

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10 Core Design for **Main Transformer**

g **Radial Flux Density at 110% Voltage** Not Applicable to Reactors

1	at Maximum Flux Tap		Tesla
2	Last Core Item Split?		(or other Measures? Explain below.)
3	Narrowest Sheet Width		mm
4	Narrowest Sheet Stack		mm
5	Manufacturer's Drawing #		Rev#

Comments

h **Maximum Core Temperature Rise above Oil**

		Internal	At Oil Duct	In Narrowest Width	
1	at 100% Voltage			°C	
2	at 110% Voltage				°C
3	at 115% Voltage			°C	

Include the dc current for HVDC transformers.

4	Number of Cooling Ducts		
5	Distribution		Equally-spaced, Mass-weighted spacing

i **Maximum Core Temperature Rise above Ambient**

Top or Mean Oil as applicable

1	ONAN Oil Temperature Rise	
2		

		Internal	At Oil Duct	In Narrowest Width	
3	at 100% Voltage			°C	
4	at 110% Voltage				°C
5	at 115% Voltage			°C	

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10 **Core Design** for **Main Transformer**

j **Core Grounding**

Is the core grounded externally through a bushing in the cover per the Technical Specification?

1 Main Core
2 Series Transformer
3 LTC Reactor
4 Current Limiting Reactor

5 Describe how the core is grounded including:
a how contact is ensured;
b how oil ducts are bridged.

k **Balancing Turns for 1-phase cores?**

1 Balancing Turns exist?
2 #Turns
3 Locations Return Legs, Bottom Return Yoke, Top Return Leg, Bottom Main Yoke ,Top Main Yol
4 Conductor Size
5 Expected Current
6 Manufacturer's Drawing # Rev# Attach a drawing showing assembly details. This can be a typical drawing.
Describe method of insulation, inter-connection and grounding:

l **Core Leg Shields**

Manufacturer's Drawing # Rev# Attach a drawing showing assembly details. This can be a typical drawing.
Describe the shield, its purpose, where it is located and how it is grounded.

n General

1 Has the core been designed to proven design concepts that have been tested?
2 List all the insulation materials that are in the finished core:
eg epoxy hardener(specify), T4 pressboard (step blocks), mylar,...

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11 **Core Steps** for **Main Transformer**

NOTE: Items can be core steel item#, Split Width, cooling duct or insulation.
Yoke and Returns are only required if different widths than Wound Leg.
Alternatively, you can specify % of Wound Leg, once.

This sheet is not required if you provide this information separately.

a Widths & Stacks

				Wound Leg Width	Stack	Yoke Width	Return Yoke Width	Return Leg Width		Wound Leg Width	Stack	Yoke Width	Return Yoke Width	Return Leg Width
1	Duct		mm						"					
2	Item#		mm						"					
3	Item#		mm						"					
4	Item#		mm						"					
5	Item#		mm						"					
6	Item#		mm						"					
7	Item#		mm						"					
8	Item#		mm						"					
9	Item#		mm						"					
10	Item#		mm						"					
11	Item#		mm						"					
12	Item#		mm						"					
13	Item#		mm						"					
14	Item#		mm						"					
15	Item#		mm						"					
16	Item#		mm						"					
17	Item#		mm						"					
18	Item#		mm						"					
19	Item#		mm						"					
20	Item#		mm						"					
21	Item#		mm						"					
22	Item#		mm						"					
23	Item#		mm						"					
24	Item#		mm						"					
25	Item#		mm						"					
26	Item#		mm						"					
27	Item#		mm						"					
28	Item#		mm						"					
29	Item#		mm						"					
30	Item#		mm						"					
31	Item#		mm						"					
32	Item#		mm						"					
33	Item#		mm						"					
34	Item#		mm						"					
35	Item#		mm						"					
36	Item#		mm						"					
37	Item#		mm						"					
38	Item#		mm						"					

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12 Core Design for **Series Transformer**

a	**Core Steel**		
1	Manufacturer		
2	Type (eg 23ZDKH85)		
3	Steel Thickness	mm	
4	Lamination Factor	pu	
5	Insulation Type		
b	**Cutting / Stacking**		
1	Mitre-Joint Type		(Fully-mitred, Semi-mitred, Butt-lap, Wound, n/a)
2	# Step-laps if applicable		(enter number of sheets or laps, not number of steps)
3	Step-Lap	mm per step	

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Design Review Data

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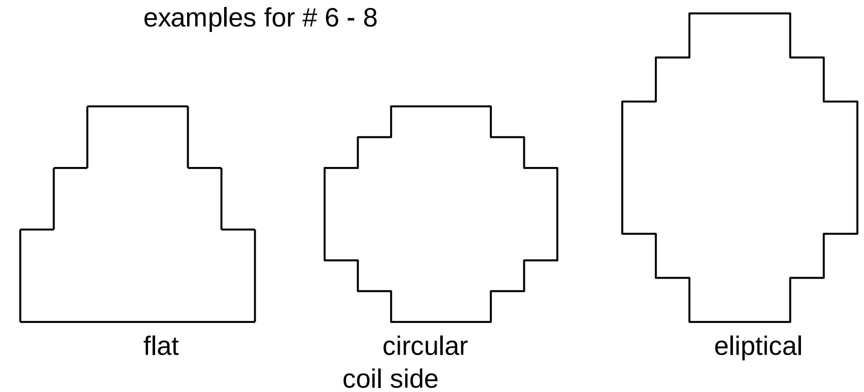
12 **Core Design** for **Series Transformer**

c **Construction**

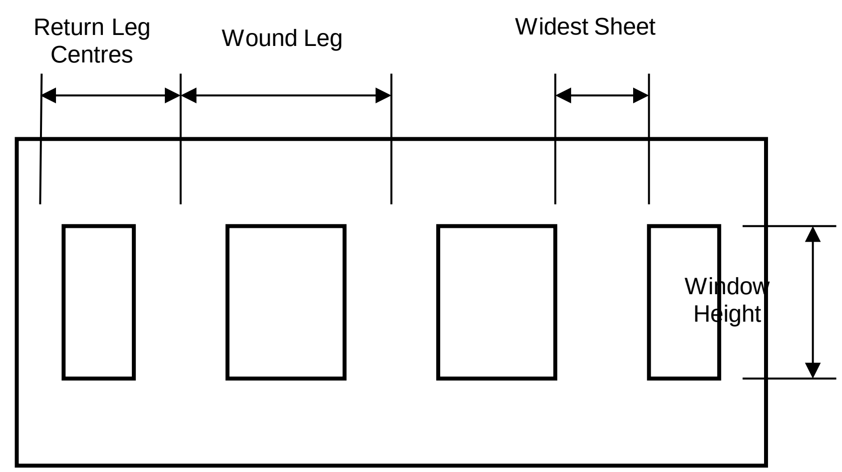
1	Type of Core	core, shell
2	Circular or Rectangular	
3	#Legs	
4	# Wound Legs	
5	Core Bolts Used?	
6	Main Yoke facing Coil is	flat, circular, elliptical
7	Return Yoke facing Coil is	
8	Return Leg facing Coil is	
	Comments	

examples for # 6 - 8



d **Design**

1	Wound Leg Diameter	mm
2	Window Height	mm
3	Wound Leg Centres	mm
4	Return Leg Centres	mm
	Widest Sheet Width	
5	Wound Leg	mm
6	Main Yoke	mm
7	Return Yoke	mm
8	Return Leg	mm
	Area	
9	Wound Leg	sq. m
10	Main Yoke	sq. m or pu of Wound Leg
11	Return Yoke	sq. m or pu of Wound Leg
12	Return Leg	sq. m or pu of Wound Leg
13	Core Weight	kg



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12 **Core Design** for **Series Transformer**

e **Flux Density at 100% Voltage**

1	at Rated Tap	Tesla
2	at Maximum Flux Tap	Tesla
3	at Minimum Flux Tap	Tesla

f **Maximum Core Temperature Rise above Oil**

		Internal	At Oil Duct	
1	at 100% Voltage			°C
2	at 110% Voltage			°C
3	at 115% Voltage			°C

4 Number of Cooling Ducts
5 Distribution — Equally-spaced, Mass-weighted spacing

g **Maximum Core Temperature Rise above Ambient**

Top or Mean Oil as applicable
1 ONAN Oil Temperature Rise
2

		Internal	At Oil Duct	
3	at 100% Voltage			°C
4	at 110% Voltage			°C
5	at 115% Voltage			°C

h **Core Grounding**

Is the core grounded externally through a bushing in the cover per the Technical Specification?
1 Series Transformer

2 Describe how the core is grounded including:
a how contact is ensured;
b how oil ducts are bridged.

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Design Review Data

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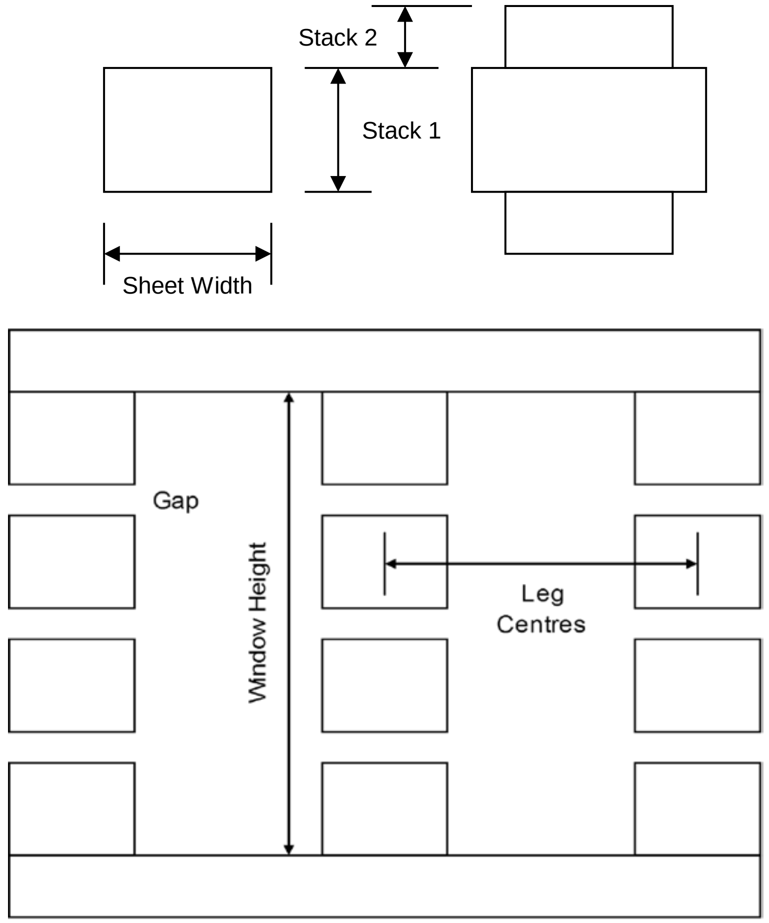
13 Core & Winding Design for LTC Reactor (Preventive Auto)

a	**Core Steel**		
1	Manufacturer		
2	Type (eg 23ZDKH85)		
3	Steel Thickness	mm	
4	Lamination Factor	pu	
5	Insulation Type		
b	**Core Gaps**		
1	Quantity per Leg		
2	Average Height	mm	
3	Maximum Height	mm	
4	Gap Material		
	Comments		
c	**Core Design**		
1	Sheet Width	mm	
2	Stack 1	mm	
3	Stack 2	mm	
4	Leg Centres	mm	
5	Window Height	mm	
6	Core Weight	kg	
d	**Bridging Tap at 100% Voltage**		
1	Flux Density	Tesla	
2	Circulating Current	A	
3	Reactance	% at main transformer's	MVA base



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Design Review Data

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13 **Core & Winding Design** for **LTC Reactor (Preventive Auto)**

e **Winding Design (If Magnet Wire or CTC, enter the reactor on the Coil Data worksheet)**

1	Number of Turns : 2 x		
2	Winding Type		
3	Coil Type		
4	Conductor Type		
5	Axial Conductor Height	mm	
6	Radial Conductor width	mm	
7	#Parallel Axially		
8	#Parallel Radially		
9	Insulation Thickness	mm	Diametric
10	Insulation Material		
11	Current Density (Bridging)	A/sqmm	
12	Total Radial Build	mm	
13	Mean Diameter or Turn	mm	
14	Coil Electrical Axial Height	mm	
15	Gradient (bridging)	°C	
16	Reactance	% at MVA base	

Comments

f **Core Grounding**

Is the core grounded externally through a bushing in the cover per the Technical Specification?

1 LTC Reactor

2 Describe how the core is grounded including:

a how contact is ensured;

b how oil ducts are bridged.

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Design Review Data

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14 Core & Reactance Design for **Current Limiting Reactor**

a Core Steel

1	Manufacturer	
2	Type (eg 23ZDKH85)	
3	Steel Thickness	mm
4	Lamination Factor	pu
5	Insulation Type	

b Core Design

1	Type (see sketches)	
2	If Type 5, sketch attached?	T/F
3	Sheet Width	mm
4	Stack	mm
5	Window Height	mm
6	Core Weight	kg
7	Rated Flux Density	Tesla
8	Flux Density during Fault	Tesla

Comments

d Impedance

1	%Reactance	%
2	at MVA	
3	Ohms	
4	Ohms during Fault	

Comments

f Core Grounding

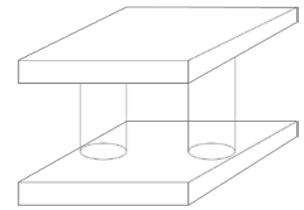
Is the core grounded externally through a bushing in the cover per the Technical Specification?

1 LTC Reactor

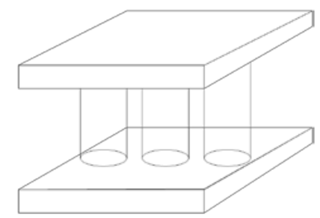
2 Describe how the core is grounded including:

a how contact is ensured;

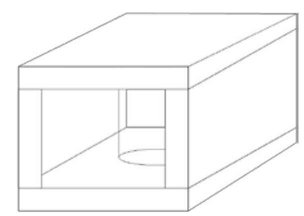
b how oil ducts are bridged.



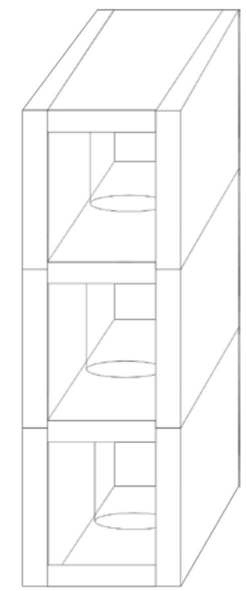
1: Single-Phase without side shields



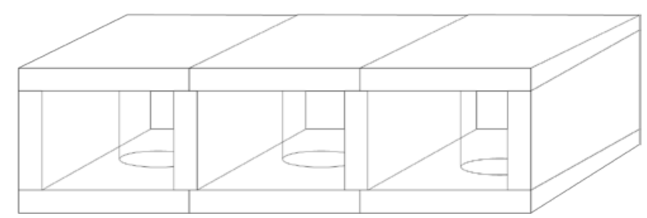
2: Three-Phase without side shields



3: Single-Phase with side shields



5: Three-Phase Vertical with side shields



4: Three-Phase Horizontal with side shields

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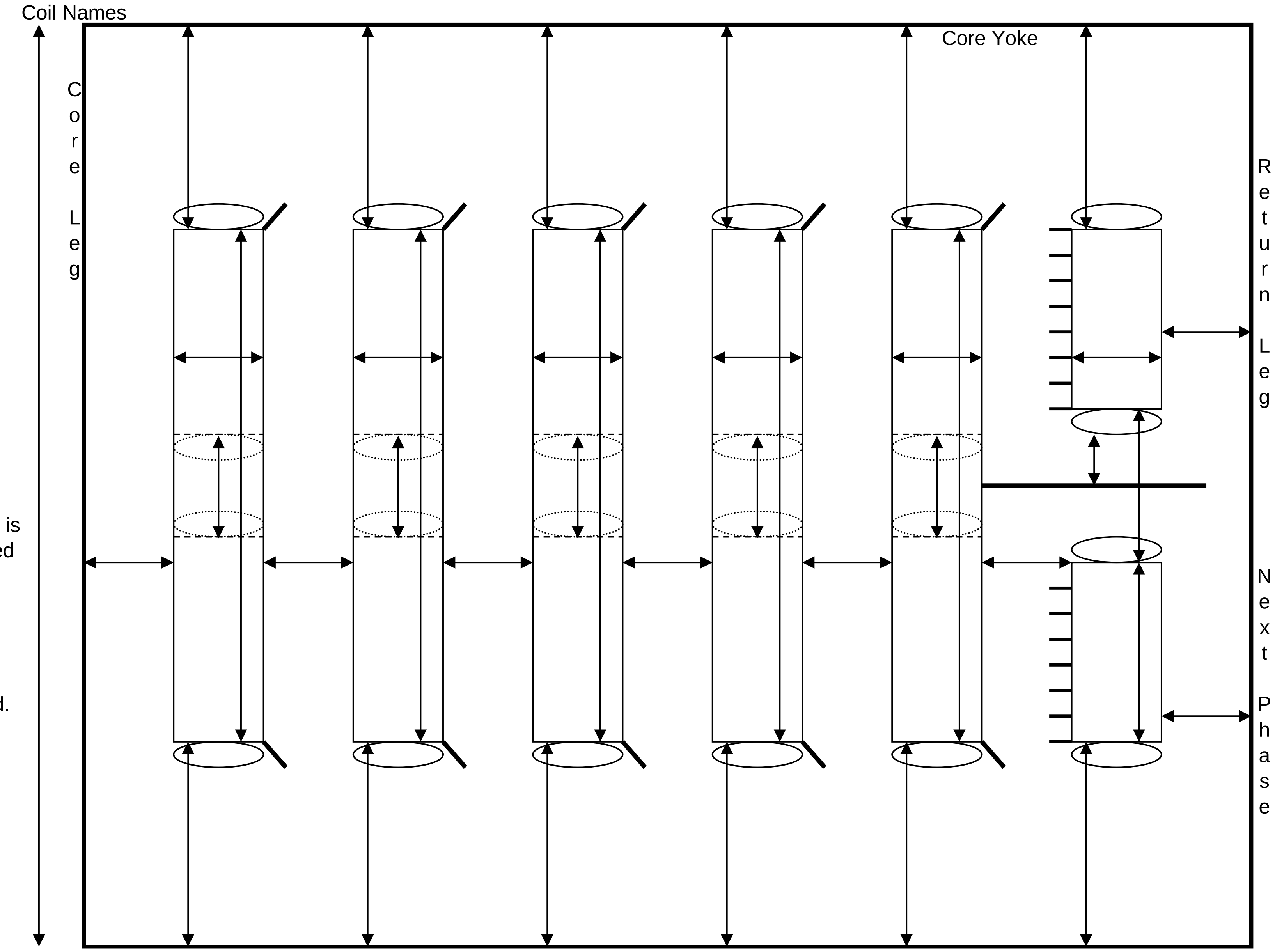
15 **Coil Geometry Sketch** for **Main Transformer**



This sheet is not required if a separate sketch with these details is provided.

The clearances are designed to proven design concepts that have been tested?

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Design Review Data

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15 **Coil Geometry Sketch** for **Main Transformer**

Instructions

1) Enter dimensions in the yellow cells as request above (metric or imperial units).
   If fewer than six coils exist, ignore the other coils (or delete them).
   If fewer than six coils exist, the clearance from the last coil to the next phase and return leg is still required.

2) Stress rings are shown here only to reference the dimensions.
   You can remove the ones that don't exist.

3) Alter the sketch to suit (eg two parallel halves are shown in dotted lines).
   Enter electrical heights of coils (not physical or mechanical) (ie coil height away from leads).
   Include any gaps or major changes in the amp-turns density (amp-turns/m)
   or describe them on a separate sheet if that is easier.
   This sheet should provide enough dimensions to perform a magnetic field plot under short-circuit conditions.

4) All coils are drawn with equal heights even though this may not be true.
   Enter the top and bottom electrical end clearances.

5) If a coil is made of multiple layers, show each layer separately.

6) The sketch shows radial clearance to the core leg, to the return leg and to the next phase.
   If a shielding cylinder is used on the wound leg, specify the clearance from the core leg to the metal of the shield.
   ## Clearance from wound core leg to the shield #
   If a shielding cylinder is used on the return leg, specify the clearance from the return leg to the metal of the shield.
   ## Clearance from return leg to the shield #

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Design Review Data

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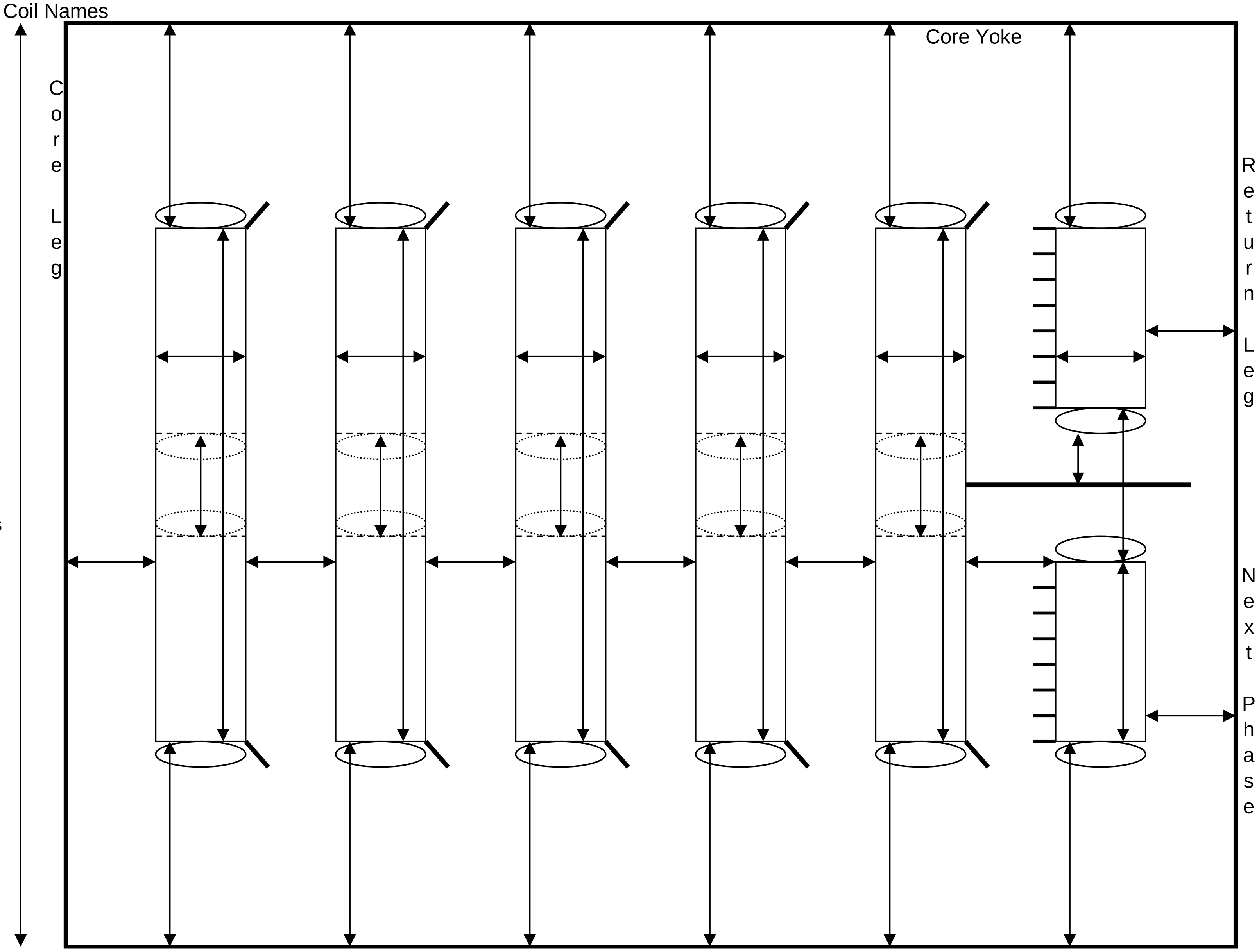
16 **Coil Geometry Sketch** for **Series Transformer**

Coil Names



This sheet is not required if a separate sketch with these details is provided.

The clearances are designed to proven design concepts that have been tested?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

16 **Coil Geometry Sketch** for **Series Transformer**

Instructions

1) Enter dimensions in the yellow cells as request above (metric or imperial units).
   If fewer than six coils exist, ignore the other coils (or delete them).
   If fewer than six coils exist, the clearance from the last coil to the next phase and return leg is still required.

2) Stress rings are shown here only to reference the dimensions.
   You can remove the ones that don't exist.

3) Alter the sketch to suit (eg two parallel halves are shown in dotted lines).
   Enter electrical heights of coils (not physical or mechanical) (ie coil height away from leads).
   Include any gaps or major changes in the amp-turns density (amp-turns/m)
   or describe them on a separate sheet if that is easier.
   This sheet should provide enough dimensions to perform a magnetic field plot under short-circuit conditions.

4) All coils are drawn with equal heights even though this may not be true.
   Enter the top and bottom electrical end clearances.

5) If a coil is made of multiple layers, show each layer separately.

6) The sketch shows radial clearance to the core leg, to the return leg and to the next phase.
   If a shielding cylinder is used on the wound leg, specify the clearance from the core leg to the metal of the shield.

Clearance from wound core leg to the shield
   If a shielding cylinder is used on the return leg, specify the clearance from the return leg to the metal of the shield.

Clearance from return leg to the shield

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Design Review Data

17 Coil Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.
All data is per phase or per leg or per layer.

				coil nearest core									
	1	Transformer Component											
	2	Coil Name											
a	3	Type of Winding											
	4				Have the coils been designed to proven design concepts that have been tested?								
b		Arrangement											
	1	Legs in Series or Parallel											
	2	Coil Connected as											
c		Current											
	1	Rated	A										
	2	Maximum	A										
	3	Rated Current Density	A/sqmm										
d		Turns											
	1	#Turns per Leg											
	2	#Turns per half or quarter											
	3	#Disks per Leg											
	4	Maximum #Turns per Disk											
	5	#Layers											
	6	#Turns per Layer											
e		For Taps Only											
	1	Location of taps											
	2	Average #Turns per Tap											
	3	Majority #Turns per Tap											
	4	Secondary #Turns per Tap											
	5	Extra Tap Section?	T/F										
	6	Loaded #Turns at Maximum Tap											
	7	Equal Turns per Tap?	T/F										
	8	Tap Style											
	9	Tap break axial gap	mm										
	10	Lead Numbering at Top (or OD)	eg: 1,3,5,4,2										
	11	ead Numbering at Bottom (or ID)											

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Design Review Data

17 Coil Data

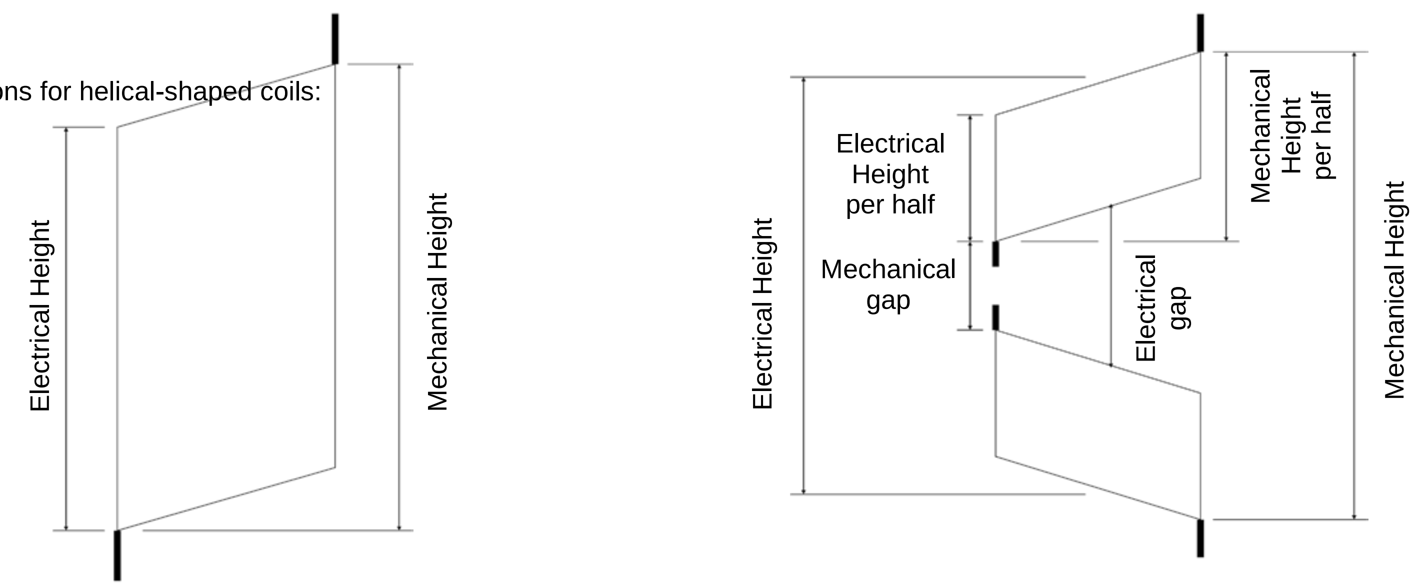
Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.

All data is per phase or per leg or per layer.

			coil nearest core									
1	Transformer Component											
2	Coil Name											
f	Dimensions see sketches below											
1	Mechanical Axial Height											
a	total	mm										
b	per half / quarter	mm										
c	centre gap	mm										
2	Electrical Axial Height											
a	total	mm										
b	per half / quarter	mm										
c	centre gap	mm										
3	Radial Build	mm										
4	Inside Diameter (ID)	mm										
5	Outside Diameter (OD)	mm										

Definitions for helical-shaped coils:



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Design Review Data

17 Coil Data

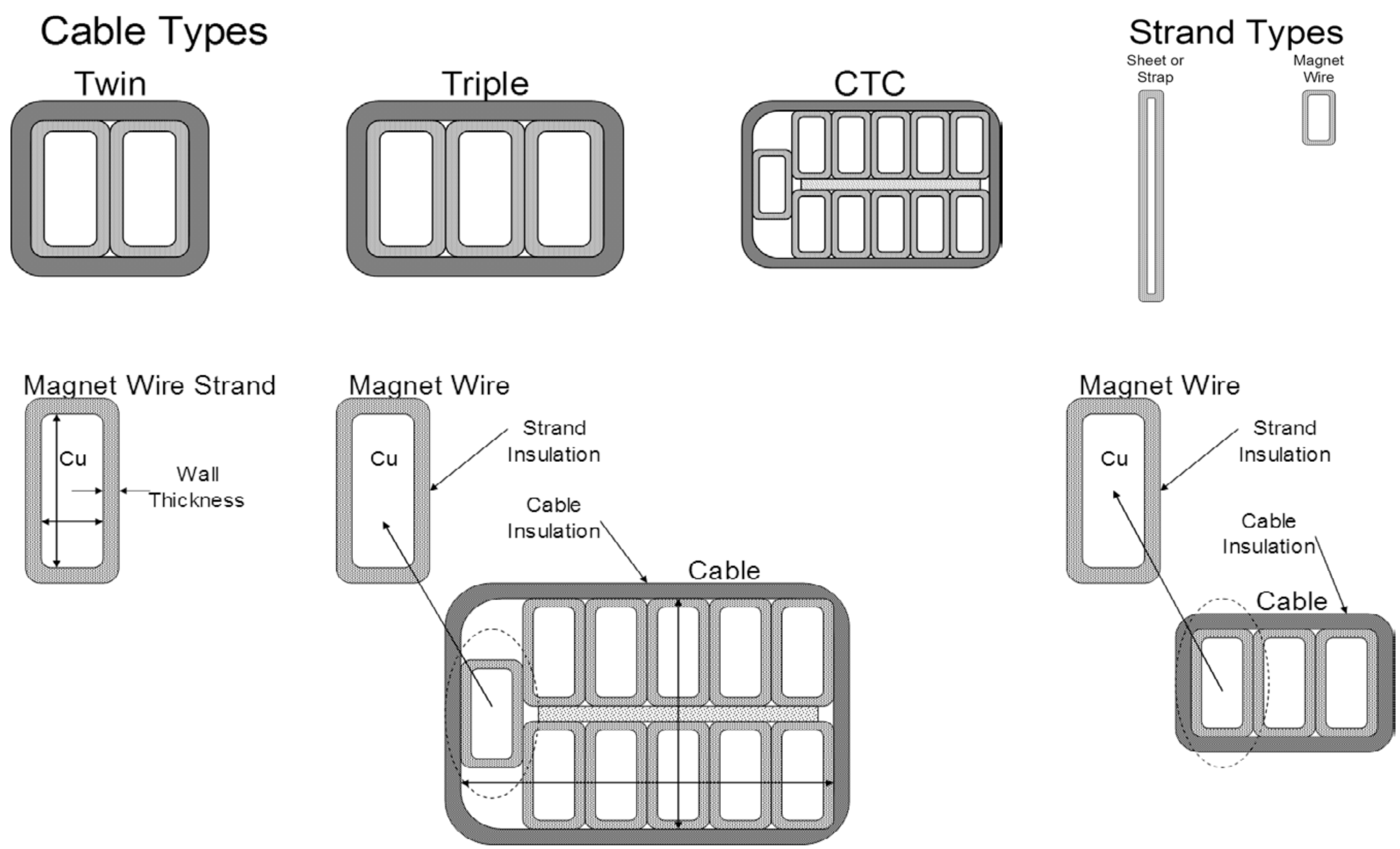
Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.

All data is per phase or per leg or per layer.

coil nearest core

	1	Transformer Component										
	2	Coil Name										
g	Winding Conductor											
	1	Manufacturer										



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Design Review Data

17 Coil Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.
All data is per phase or per leg or per layer.

coil nearest core

1	Transformer Component											
2	Coil Name											
g	Winding Conductor cont.											
	Cable											
2	Type											
2	#Parallel Axially											
3	#Parallel Radially											
4	Area per Cable	sqmm										
5	Un-insulated Cable Radial Dim.	mm										
6	Un-insulated Cable Axial Dim.	mm										
	Cable Insulation											
7	Type											
8	Diametric Thickness	mm										
9	Manufacturer											
10	Thermally-Upgraded Paper?	T/F										
11	Temperature Class	°C										
12	Nitrogen Content	%										
13	If CTC, is Separator used?	T/F										
	Magnet Wire Strands											
14	#Strands per Cable											
15	Un-insulated Radial Thickness	mm										
16	Un-insulated Axial Width	mm										
17	Corner Area Reduction	sqmm										
18	Epoxy-Bonding?	T/F										
19	Epoxy Type	Brand										
	Strand Insulation											
20	Type											
21	Diametric Thickness	mm										
22	Manufacturer											
23	Thermally-Upgraded Paper?	T/F										
24	Temperature Class	°C										
25	Nitrogen Content	%										

Manitoba Hydro

Design Review Data

17 Coil Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.

All data is per phase or per leg or per layer.

			coil nearest core									
1	Transformer Component											
2	Coil Name											
h	Spacing Material											
	Spacers											
1	#Spacers per Circle											
2	Circumferential Width	mm										
3	Between all disks?	T/F										
4	All ducts allow oil flow?	T/F										
5	Axial Height											
a	Disk 1 to Disk 2	mm										
b	Disk 2 to Disk 3	mm										
c	Disk 3 to Disk 4	mm										
d	Disk 4 to Disk 5	mm										
e	Disk 5 to Disk 6	mm										
f	Disk 6 to Disk 7	mm										
g	Disk 7 to Disk 8	mm										
h	Disk 8 to Disk 9	mm										
i	between DTC disks	mm										
j	other disks	mm										
6	Average Axial Height	mm										
	Duct Sticks											
7	Sticks on Inside Diameter											
a	#Sticks per Circle											
b	Circumferential Width	mm										
c	Radial Thickness	mm										
8	Sticks between layers											
a	#Sticks per Circle											
b	Circumferential Width	mm										
c	Radial Thickness	mm										
9	Sticks on Outside Diameter											
a	#Sticks per Circle											
b	Circumferential Width	mm										
c	Radial Thickness	mm										

Manitoba Hydro

Design Review Data

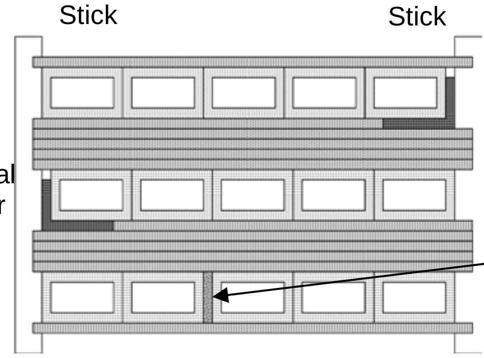
17 **Coil Data**

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.
All data is per phase or per leg or per layer.

		coil nearest core									
1 Transformer Component											
2 Coil Name											

h Spacing Material cont.



Solid Inter-disk Insulation

Caps & Collars											
10 Total number of cap rings											
11 Axial Thickness	mm										
12 Cap extends entire RB?	T/F										
13 Total number of collar rings											
14 Axial Thickness	mm										
15 Packing Location after											
Extra Tape on Cable											
16 Number of Disks on OD											
17 Wall Thickness	mm										
18 Number of Disks on ID											
19 Wall Thickness	mm										

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Design Review Data

17 Coil Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

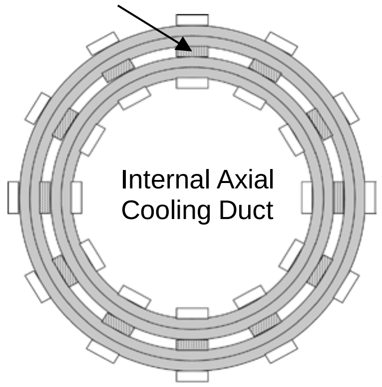
Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.

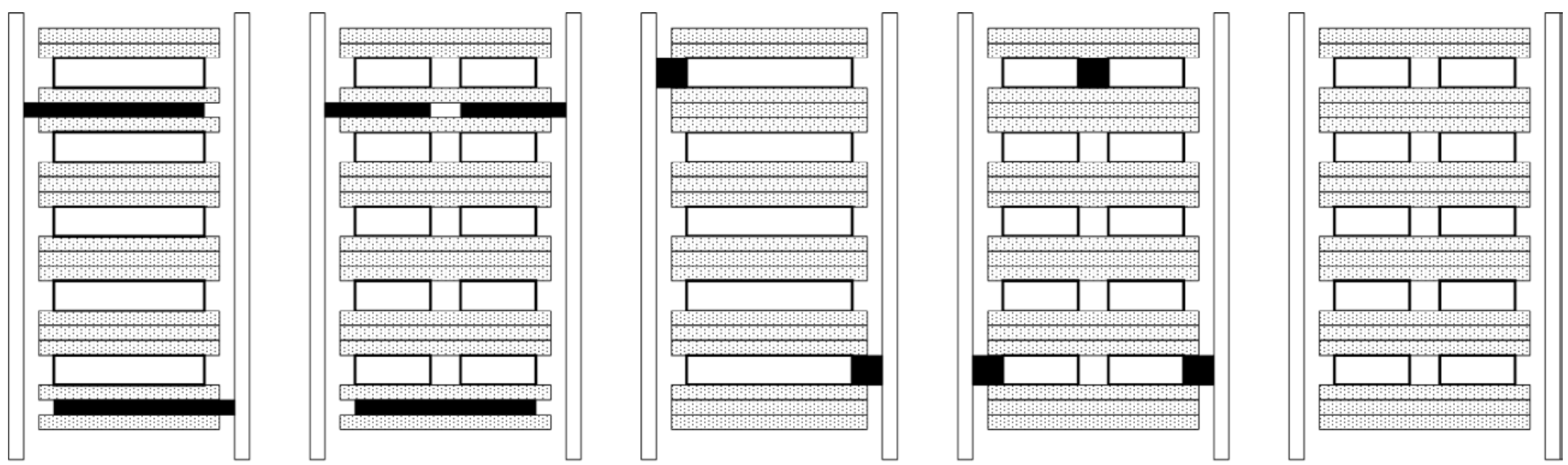
All data is per phase or per leg or per layer.

coil nearest core

1	Transformer Component										
2	Coil Name										

i Oil Flow (see sketches)





1	Oil Flow Method?											
2	Oil Blocking Material?											
	if zig-zag oil flow method											
3	# blockages on ID											
4	# blockages at centre											
5	# blockages on OD											
	if internal axial cooling ducts											
6	#Ducts in Radial Build											
7	Radial Duct Thickness	mm										
8	Block Width	mm										
9	#Supports per circle											
10	Clackband block spacing	mm										

Manitoba Hydro

Design Review Data

17 **Coil Data**

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.
All data is per phase or per leg or per layer.

			coil nearest core									
1	Transformer Component											
2	Coil Name											

j Forced Oil Flow Velocity (ODAF)

Based on 'n+1' pumps where applicable, otherwise 'n' pumps.

	Radial											
1	Average	mm/s										
2	Maximum	mm/s										
	Axial at ID											
3	at duct stick	mm/s										
4	at spacer	mm/s										
5	Mftr's Oil Velocity Limit	mm/s										

Losses and gradients at rated 2-circuit MVA (H+X, H+Y, or X+Y) at 1 or 0 power factor.

k Weights & Losses

1	Bare Copper Weight	kg										
2	Coil dc Resistance	ohms										
3	Lead dc Resistance	ohms										
3	dc Resistance per tap	ohms										
4	S/P											
5	Current	A										
6	I^2R Loss	kW										
7	Average Stray Loss	kW										
8	S/P											
9	Current	A										
10	I^2R Loss	kW										
11	Average Stray Loss	kW										
12	S/P											
13	Current	A										
14	I^2R Loss	kW										
15	Average Stray Loss	kW										

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Design Review Data

17 **Coil Data**

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.

All data is per phase or per leg or per layer.

			coil nearest core									
1	Transformer Component											
2	Coil Name											

L 2-Circuit Coil Gradients

Note

Losses and gradients at rated 2-circuit MVA (H+X, H+Y, or X+Y) at 1 or 0 power factor.

LTC and LTC reactor hotspot gradient might be maximum at LTC -1 if RCBN, or -15 if FCBN.

DTC hotspot gradient will be maximum at DTC 4.

Worst case2-Circuit tap at ONAN MVA (or RCBN MVA) and 85°C

Coil Average

1	DTC#											
2	LTC#											
3	S/P											
4	Current	A										
5	I^2R Loss	kW										
6	Stray Loss	kW										
7	Radial Flux Density	T										
8	Axial Flux Density	T										
9	Power Density	mW/sqmm										
10	Gradient	°C										

Coil Hotspot

11	DTC#											
12	LTC#											
13	S/P											
14	Current	A										
15	I^2R Loss	kW										
16	Stray Loss	kW										
17	Radial Flux Density	T										
18	Axial Flux Density	T										
19	Power Density	mW/sqmm										
20	Gradient	°C										
21	Winding Hotspot Location											

Manitoba Hydro

Design Review Data

17 Coil Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.

All data is per phase or per leg or per layer.

coil nearest core

1	Transformer Component										
2	Coil Name										

L 2-Circuit Coil Gradients cont.

Note

Losses and gradients at rated 2-circuit MVA (H+X, H+Y, or X+Y) at 1 or 0 power factor.

LTC reactor hotspot gradient might be maximum at LTC -1 if RCBN, or -15 if FCBN.

DTC hotspot gradient will be maximum at DTC 4.

n/a

Coil Average

22	DTC#											
23	LTC#											
24	S/P											
25	Current	A										
26	I^2R Loss	kW										
27	Stray Loss	kW										
28	Radial Flux Density	T										
29	Axial Flux Density	T										
30	Power Density	mW/sqmm										
31	Gradient	°C										

Coil Hotspot

32	DTC#											
33	LTC#											
34	S/P											
35	Current	A										
36	I^2R Loss	kW										
37	Stray Loss	kW										
38	Radial Flux Density	T										
39	Axial Flux Density	T										
40	Power Density	mW/sqmm										
41	Gradient	°C										
42	Winding Hotspot Location											

Manitoba Hydro

Design Review Data

17 **Coil Data**

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.
All data is per phase or per leg or per layer.

coil nearest core

1	Transformer Component											
2	Coil Name											

m **Coil Leads**

These are the leads which exit the coil, and are normally formed from the coil's winding conductor.
Alternatively, this can be a flexible cable (eg MCM) brazed directly to the face of the coil.

Gradients at rated 2-circuit MVA (H+X, H+Y, or X+Y) at 1 or 0 power factor.

n/a

	Line End Lead											
1	Location											
2	Lead Type											
3	Quantity of Leads											
4	Lead Diameter or Size	mm										
5	Lead Insulation	mm										
6	Lead hotspot gradient	°C										
	Neutral End Lead											
7	Location											
8	Lead Type											
9	Quantity of Leads											
10	Lead Diameter or Size	mm										
11	Lead Insulation	mm										
12	Lead hotspot gradient	°C										
	Centre Lead											
13	Location											
14	Lead Type											
15	Quantity of Leads											
16	Lead Diameter or Size	mm										
17	Lead Insulation	mm										
18	Lead hotspot gradient	°C										
	DTC Lead if in main body of HV											
19	Lead Type											
20	Quantity of Leads											
21	Lead Diameter or Size	mm										
22	Lead Insulation	mm										
23	Lead hotspot gradient	°C										

Manitoba Hydro

Design Review Data

17 **Coil Data**

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Data is based on rated tap at ONAN MVA FCBN and 85°C unless otherwise specified.

All data is per phase or per leg or per layer.

coil nearest core

1	Transformer Component											
2	Coil Name											
n	**Capacitance Components (oil-filled)**											
	Coil-to-Previous Coil	pF										
	Coil-to-Wound Core Leg	pF										
	Coil-to-Return Core Leg	pF										
	Coil-to-Tank	pF										
	Coil-to-Leads	pF										
	Leads-to-Tank	pF										
	Line Bushing	pF										
	Neutral Bushing	pF										

Manitoba Hydro

Design Review Data

17 Coil Data

				coi
	1	Transformer Component		
	2	Coil Name		
a	3	Type of Winding		
	4			
b		Arrangement		
	1	Legs in Series or Parallel		
	2	Coil Connected as		
c		Current		
	1	Rated	A	
	2	Maximum	A	
	3	Rated Current Density	A/sqmm	
d		Turns		
	1	#Turns per Leg		
	2	#Turns per half or quarter		
	3	#Disks per Leg		
	4	Maximum #Turns per Disk		
	5	#Layers		
	6	#Turns per Layer		
e		For Taps Only		
	1	Location of taps		
	2	Average #Turns per Tap		
	3	Majority #Turns per Tap		
	4	Secondary #Turns per Tap		
	5	Extra Tap Section?	T/F	
	6	Loaded #Turns at Maximum Tap		
	7	Equal Turns per Tap?	T/F	
	8	Tap Style		
	9	Tap break axial gap	mm	
	10	Lead Numbering at Top (or OD)	eg: 1,3,5,4,2	
	11	ead Numbering at Bottom (or ID)		

Manitoba Hydro

Design Review Data

17 Coil Data

				coi
1		Transformer Component		
2		Coil Name		
f		Dimensions	see sketches below	
1		Mechanical Axial Height		
	a	total	mm	
	b	per half / quarter	mm	
	c	centre gap	mm	
2		Electrical Axial Height		
	a	total	mm	
	b	per half / quarter	mm	
	c	centre gap	mm	
3		Radial Build	mm	
4		Inside Diameter (ID)	mm	
5		Outside Diameter (OD)	mm	

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Design Review Data

17 Coil Data

coi

1	Transformer Component	
2	Coil Name	
g	Winding Conductor	
1	Manufacturer	

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Design Review Data

17 Coil Data

			coi
1	Transformer Component		
2	Coil Name		
g	Winding Conductor cont.		
	Cable		
2	Type		
2	#Parallel Axially		
3	#Parallel Radially		
4	Area per Cable	sqmm	
5	Un-insulated Cable Radial Dim.	mm	
6	Un-insulated Cable Axial Dim.	mm	
	Cable Insulation		
7	Type		
8	Diametric Thickness	mm	
9	Manufacturer		
10	Thermally-Upgraded Paper?	T/F	
11	Temperature Class	°C	
12	Nitrogen Content	%	
13	If CTC, is Separator used?	T/F	
	Magnet Wire Strands		
14	#Strands per Cable		
15	Un-insulated Radial Thickness	mm	
16	Un-insulated Axial Width	mm	
17	Corner Area Reduction	sqmm	
18	Epoxy-Bonding?	T/F	
19	Epoxy Type	Brand	
	Strand Insulation		
20	Type		
21	Diametric Thickness	mm	
22	Manufacturer		
23	Thermally-Upgraded Paper?	T/F	
24	Temperature Class	°C	
25	Nitrogen Content	%	

Manitoba Hydro

Design Review Data

17 Coil Data

				coi
	1	Transformer Component		
	2	Coil Name		
h		Spacing Material		
		Spacers		
	1	#Spacers per Circle		
	2	Circumferential Width	mm	
	3	Between all disks?	T/F	
	4	All ducts allow oil flow?	T/F	
	5	Axial Height		
	a	Disk 1 to Disk 2	mm	
	b	Disk 2 to Disk 3	mm	
	c	Disk 3 to Disk 4	mm	
	d	Disk 4 to Disk 5	mm	
	e	Disk 5 to Disk 6	mm	
	f	Disk 6 to Disk 7	mm	
	g	Disk 7 to Disk 8	mm	
	h	Disk 8 to Disk 9	mm	
	i	between DTC disks	mm	
	j	other disks	mm	
	6	Average Axial Height	mm	
		Duct Sticks		
	7	Sticks on Inside Diameter		
	a	#Sticks per Circle		
	b	Circumferential Width	mm	
	c	Radial Thickness	mm	
	8	Sticks between layers		
	a	#Sticks per Circle		
	b	Circumferential Width	mm	
	c	Radial Thickness	mm	
	9	Sticks on Outside Diameter		
	a	#Sticks per Circle		
	b	Circumferential Width	mm	
	c	Radial Thickness	mm	

Manitoba Hydro

Design Review Data

17 **Coil Data**

			coi
1	Transformer Component		
2	Coil Name		
h	Spacing Material cont.		
	Solid Inter-disk Insulation		
	Caps & Collars		
10	Total number of cap rings		
11	Axial Thickness	mm	
12	Cap extends entire RB?	T/F	
13	Total number of collar rings		
14	Axial Thickness	mm	
15	Packing Location after		
	Extra Tape on Cable		
16	Number of Disks on OD		
17	Wall Thickness	mm	
18	Number of Disks on ID		
19	Wall Thickness	mm	

Manitoba Hydro

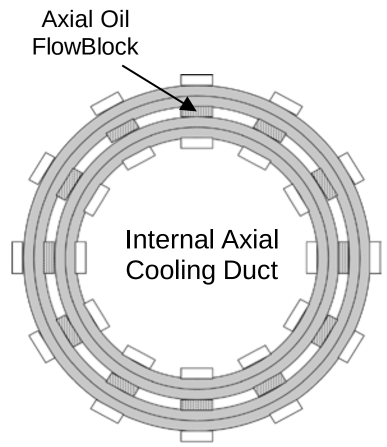
Design Review Data

17 Coil Data

coi

1	Transformer Component	
2	Coil Name	

i Oil Flow (see sketches)



1	Oil Flow Method?	
2	Oil Blocking Material?	
	if zig-zag oil flow method	
3	# blockages on ID	
4	# blockages at centre	
5	# blockages on OD	
	if internal axial cooling ducts	
6	#Ducts in Radial Build	
7	Radial Duct Thickness	mm
8	Block Width	mm
9	#Supports per circle	
10	Clackband block spacing	mm

Manitoba Hydro

Design Review Data

17 Coil Data

				coi
	1	Transformer Component		
	2	Coil Name		
j		Forced Oil Flow Velocity (ODAF)		
		Radial		
	1	Average	mm/s	
	2	Maximum	mm/s	
		Axial at ID		
	3	at duct stick	mm/s	
	4	at spacer	mm/s	
	5	Mftr's Oil Velocity Limit	mm/s	
k		Weights & Losses		
	1	Bare Copper Weight	kg	
	2	Coil dc Resistance	ohms	
	3	Lead dc Resistance	ohms	
	3	dc Resistance per tap	ohms	
	4	S/P		
	5	Current	A	
	6	I^2R Loss	kW	
	7	Average Stray Loss	kW	
	8	S/P		
	9	Current	A	
	10	I^2R Loss	kW	
	11	Average Stray Loss	kW	
	12	S/P		
	13	Current	A	
	14	I^2R Loss	kW	
	15	Average Stray Loss	kW	

Manitoba Hydro

Design Review Data

17 Coil Data

			coi
1	Transformer Component		
2	Coil Name		

L 2-Circuit Coil Gradients

	Coil Average	
1	DTC#	
2	LTC#	
3	S/P	
4	Current	A
5	I^2R Loss	kW
6	Stray Loss	kW
7	Radial Flux Density	T
8	Axial Flux Density	T
9	Power Density	mW/sqmm
10	Gradient	°C
	Coil Hotspot	
11	DTC#	
12	LTC#	
13	S/P	
14	Current	A
15	I^2R Loss	kW
16	Stray Loss	kW
17	Radial Flux Density	T
18	Axial Flux Density	T
19	Power Density	mW/sqmm
20	Gradient	°C
21	Winding Hotspot Location	

Manitoba Hydro

Design Review Data

17 Coil Data

			coi
1	Transformer Component		
2	Coil Name		
L	2-Circuit Coil Gradients cont.		
	Coil Average		
22	DTC#		
23	LTC#		
24	S/P		
25	Current	A	
26	I^2R Loss	kW	
27	Stray Loss	kW	
28	Radial Flux Density	T	
29	Axial Flux Density	T	
30	Power Density	mW/sqmm	
31	Gradient	°C	
	Coil Hotspot		
32	DTC#		
33	LTC#		
34	S/P		
35	Current	A	
36	I^2R Loss	kW	
37	Stray Loss	kW	
38	Radial Flux Density	T	
39	Axial Flux Density	T	
40	Power Density	mW/sqmm	
41	Gradient	°C	
42	Winding Hotspot Location		

Manitoba Hydro

Design Review Data

17 Coil Data

			coi
1	Transformer Component		
2	Coil Name		

m **Coil Leads**

	Line End Lead	
1	Location	
2	Lead Type	
3	Quantity of Leads	
4	Lead Diameter or Size	mm
5	Lead Insulation	mm
6	Lead hotspot gradient	°C
	Neutral End Lead	
7	Location	
8	Lead Type	
9	Quantity of Leads	
10	Lead Diameter or Size	mm
11	Lead Insulation	mm
12	Lead hotspot gradient	°C
	Centre Lead	
13	Location	
14	Lead Type	
15	Quantity of Leads	
16	Lead Diameter or Size	mm
17	Lead Insulation	mm
18	Lead hotspot gradient	°C
	DTC Lead if in main body of HV	
19	Lead Type	
20	Quantity of Leads	
21	Lead Diameter or Size	mm
22	Lead Insulation	mm
23	Lead hotspot gradient	°C

Manitoba Hydro

Design Review Data

17 Coil Data

			coi
1	Transformer Component		
2	Coil Name		
n	**Capacitance Components (oil-filled)**		
	Coil-to-Previous Coil	pF	
	Coil-to-Wound Core Leg	pF	
	Coil-to-Return Core Leg	pF	
	Coil-to-Tank	pF	
	Coil-to-Leads	pF	
	Leads-to-Tank	pF	
	Line Bushing	pF	
	Neutral Bushing	pF	

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Design Review Data

18

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Coil Winding Direction and Lead Numbering Sketch

For Main transformer, series transformer, LTC reactor and current-limiting reactor

Choose one of the winding configuration types shown in the Legend below, for each coil (or add your own sketch, either here or on a separate paper).
You can merge types. For example, a "57" would have the bottom tap leads on the opposite side.
Label and Number the leads (eg H1, H0).
Include the tap lead numbering matching the nameplate drawing (eg 1,3,5,7,…).
Show each layer of a multi-layer winding.
For interwound reactors, the leads should also be labeled as inside or outside.
Specify if lead is brought out on the opposite side of the core (half-turn added or lost)
Label the coils to suit. You don't have to use the examples given in the drop-down list.

For Each Coil:

Coil Label											
Type#											
Rotation (Plan view)											
a As viewed from											

1
2 **Lead Numbering:**

3 Top Lead(s)											
4 Centre Lead(s) (upper half)											
Centre Lead(s) (lower half)											
b Bottom Leads											

1
2 **If leads brought out on opposite side, is a half-turn added or subtracted?:**

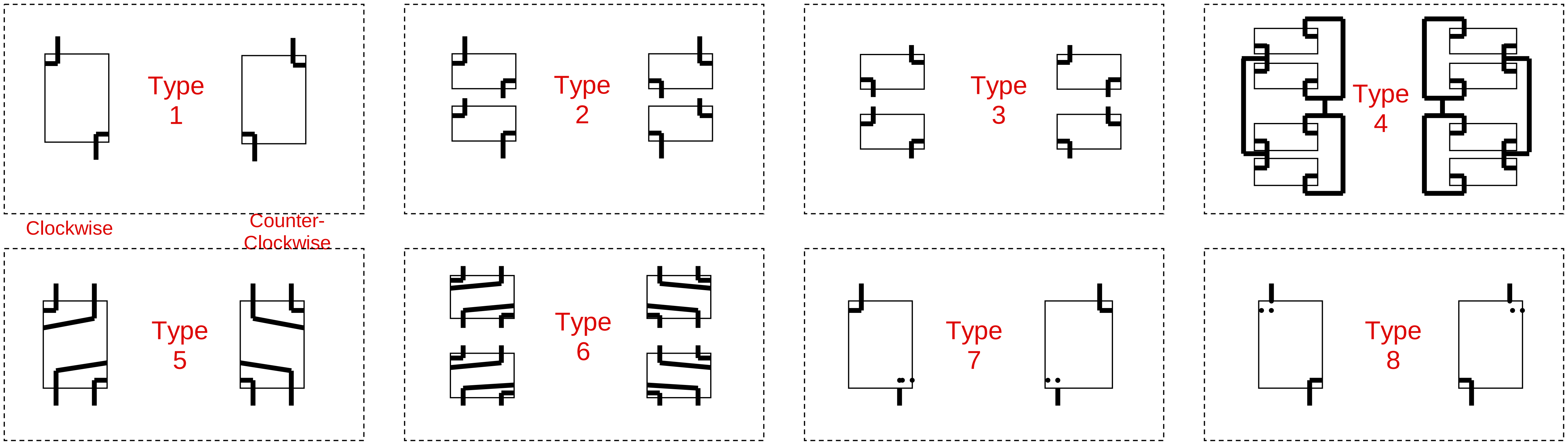
3 Top Lead(s)											
4 Centre Lead(s) (upper half)											
Centre Lead(s) (lower half)											
c Bottom Leads											

1

2 Comment											

3
4 **Type# Legend:**

d



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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

19 Circuit Data

Data is based on 85°C unless otherwise specified.
For HVDC transformer: Stray losses and gradients must include the harmonic losses.
This sheet considers each circuit such as LV plus the LTC which together form one winding or circuit.
Losses and gradients at rated 2-circuit MVA (H+X, H+Y, or X+Y) at 1 or 0 power factor.

a	Circuit Name											
b	Terminals											

c

1	#Turns											
2	dc Resistance	ohms										
3	Current	A										
4	I^2R Loss	kW										
5	Average Stray Loss	kW										

d **Neutral or Mid-Voltage Tap**

1	#Turns											
2	dc Resistance	ohms										
3	Current	A										
3	I^2R Loss	kW										
4	Average Stray Loss	kW										

e

1	#Turns											
2	dc Resistance	ohms										
3	Current	A										
3	I^2R Loss	kW										
4	Average Stray Loss	kW										

f

1	#Turns											
2	dc Resistance	ohms										
3	Current	A										
3	I^2R Loss	kW										
4	Average Stray Loss	kW										

g **Circuit Gradients**

worst case tap at ONAN MVA and 85°C

1	Voltage	kV										
2	DTC Tap Pos.											
3	LTC Tap Pos.											
4	S/P											
5	Current	A										
5	Average Gradient	°C										
6	Hotspot Gradient	°C										
7	Hotspot Multiplier											

n/a

8	Voltage	kV										
9	DTC Tap Pos.											
10	LTC Tap Pos.											
11	S/P											
12	Current	A										
12	Average Gradient	°C										
13	Hotspot Gradient	°C										
14	Hotspot Multiplier											

Manitoba Hydro

Design Review Data

20 Temperature Rises

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

				Simple 2-Circuit Loading			Simple 3-Circuit Loading if Applicable				Complex 3-Circuit Loading if Applicable			
a	**Condition**						$\text{Primary MVA} = \sqrt{\text{Secondary MVA}^2 + \text{TV MVA}^2}$				$\text{Primary MVA} > \sqrt{\text{Secondary MVA}^2 + \text{TV MVA}^2}$			
1		Cooling Scheme												
2		Rated Temperature Rise	°C	65			65		65					
3		N/P MVA Label	MVA											
4		Loading Scheme Label					Light	Heavy	Light	Heavy	Heavy			
5		Step-Up or Down		Step-Down	Step-Down	Step-Down	Step-Down		Step-Up		Step-Down		Step-Up	
6		Primary is					HV		LV		HV		LV	

b	**Oil Rise Test**													
1	Conditions													
a		Primary MVA	MVA											
b		Secondary MVA	MVA											
c		Secondary PF												
d		TV MVA	MVA											
e		TV PF												
2	Tap Positions													
a		DTC Pos. #												
b		LTC Pos. #												
c		S/P												
3	Voltages													
a		TV	kV											
b		LV	kV											
c		HV	kV											
4	Currents													
a		TV	A											
b		CV	A											
c		LV	A											
		HV	A											
5	Losses kW													
a		Load	kW											
b		Core	kW											
c		Total	kW											
6	Oil Temperature Rises above Ambient													
a		TOR	°C											
b		MOR	°C											
c		BOR	°C											

Manitoba Hydro

Design Review Data

20 Temperature Rises

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

a Condition

#	Item	Unit	Simple 2-Circuit Loading			Simple 3-Circuit Loading if Applicable $\text{Primary MVA} = \sqrt{\text{Secondary MVA}^2 + \text{TV MVA}^2}$				Complex 3-Circuit Loading if Applicable $\text{Primary MVA} > \sqrt{\text{Secondary MVA}^2 + \text{TV MVA}^2}$			
1	Cooling Scheme												
2	Rated Temperature Rise	°C	65			65		65					
3	N/P MVA Label	MVA											
4	Loading Scheme Label					Light	Heavy	Light	Heavy	Heavy			
5	Step-Up or Down		Step-Down	Step-Down	Step-Down	Step-Down		Step-Up		Step-Down		Step-Up	
6	Primary is					HV		LV		HV		LV	

c TV Winding Rise Test

#	Item	Unit	Simple 2-Circuit Loading			Simple 3-Circuit Loading				Complex 3-Circuit Loading			
1	Tap Positions												
a	DTC Pos. #												
b	LTC Pos. #												
c	S/P												
d	TV Voltage	kV											
e	TV Current	A											
2	Coil + Lead Resistances (dc)												
a	Current Limiting Reactor	ohms											
b	TV	ohms											
3	Winding Gradients												
a	Average Coil												
1	Current Limiting Reactor	K											
2	TV	K											
b	Average Circuit	K											
			Resistance-Weighted										
c	Coil Hotspot												
1	Current Limiting Reactor	K											
2	TV	K											
d	Lead Hotspot												
1	Current Limiting Reactor	K											
2	TV	K											
e	TV Hotspot Gradient Multiplier												
4	Winding Temperature Rise above Ambient												
a	Average	°C											
b	Hotspot assumed at top oil	°C											

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Design Review Data

20 Temperature Rises

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			Simple 2-Circuit Loading			Simple 3-Circuit Loading if Applicable $\text{Primary MVA} = \sqrt{\text{Secondary MVA}^2 + \text{TV MVA}^2}$				Complex 3-Circuit Loading if Applicable $\text{Primary MVA} > \sqrt{\text{Secondary MVA}^2 + \text{TV MVA}^2}$			
a	**Condition**												
1	Cooling Scheme												
2	Rated Temperature Rise	°C	65			65		65					
3	N/P MVA Label	MVA											
4	Loading Scheme Label					Light	Heavy	Light	Heavy	Heavy			
5	Step-Up or Down		Step-Down	Step-Down	Step-Down	Step-Down		Step-Up		Step-Down		Step-Up	
6	Primary is					HV		LV		HV		LV	

d	**LV Winding Rise Test**												
1	Tap Positions												
a	DTC Pos. #												
b	LTC Pos. #												
c	S/P												
d	LV Voltage	kV											
e	CV Current	A											
f	LV Current	A											
2	Coil + Lead Resistances (dc)												
a	PA (LTC Reactor)	ohms											
b	Series Xfmr LV or CV	ohms											
c	Series Xfmr HV or SV	ohms											
d	LV or CV	ohms											
e	LTC	ohms											
3	Winding Gradients												
a	Average Coil												
1	PA (LTC Reactor)	K											
2	Series Xfmr LV or CV	K											
3	Series Xfmr HV or SV	K											
4	LV or CV	K											
5	LTC	K											
b	Average Circuit	K											
			Resistance-Weighted										
c	Coil Hotspot												
1	PA (LTC Reactor)	K											
2	Series Xfmr LV or CV	K											
3	Series Xfmr HV or SV	K											
4	LV or CV	K											
5	LTC	K											
d	Lead Hotspot												
1	PA (LTC Reactor)	K											
2	Series Xfmr LV or CV	K											
3	Series Xfmr HV or SV	K											
4	LV or CV	K											
5	LTC	K											
e	LV Hotspot Gradient Multiplier												
4	Winding Temperature Rise above Ambient												
a	Average	°C											
b	Hotspot assumed at top oil	°C											

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Design Review Data

20 Temperature Rises

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

			Simple 2-Circuit Loading			Simple 3-Circuit Loading if Applicable $\text{Primary MVA} = \sqrt{\text{Secondary MVA}^2 + \text{TV MVA}^2}$				Complex 3-Circuit Loading if Applicable $\text{Primary MVA} > \sqrt{\text{Secondary MVA}^2 + \text{TV MVA}^2}$			
a	**Condition**												
1	Cooling Scheme												
2	Rated Temperature Rise	°C	65			65		65					
3	N/P MVA Label	MVA											
4	Loading Scheme Label					Light	Heavy	Light	Heavy	Heavy			
5	Step-Up or Down		Step-Down	Step-Down	Step-Down	Step-Down		Step-Up		Step-Down		Step-Up	
6	Primary is					HV		LV		HV		LV	

e		**HV Winding Rise Test**												
1		Tap Positions												
a		DTC Pos. #												
b		LTC Pos. #												
c		S/P												
d		HV Voltage	kV											
e		HV Current	A											
2		Coil + Lead Resistances (dc)												
a		LTC	ohms											
b		DTC	ohms											
c		HV or SV	ohms											
3		Winding Gradients												
a		Average Coil												
	1	PA (LTC Reactor)	K											
	1	LTC	K											
	2	DTC	K											
	3	HV or SV	K											
b		Average Circuit	K	Resistance-Weighted										
c		Coil Hotspot												
	1	PA (LTC Reactor)	K											
	2	LTC	K											
	3	DTC	K											
	4	HV or SV	K											
d		Lead Hotspot												
	1	PA (LTC Reactor)	K											
	2	LTC	K											
	3	DTC	K											
	4	HV or SV	K											
e		HV Hotspot Gradient Multiplier												
4		Winding Temperature Rise above Ambient												
	1	Average	°C											
	4	Hotspot assumed at top oil	°C											

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

21 Core and Coil Clamping Structure

Main Transformer

a Manufacturer's Drawing #'s ______ Rev# ______

b General Comments

Attach separate design information if that is more convenient.

c **Tie-rods**

1	Internal or External		
2	Material		
3	Material Grade		
4	Tie-Rod Temperature Rise		°C above top oil temperature
5	Allowable Stretch		%
	Wound Leg or between Wound Legs		
6	Quantity per side		
7	Diameter		mm
8	Tensile Strength per Rod		MPa
9	at		% offset
	Return Leg		
10	Quantity per side		
11	Diameter		mm
12	Tensile Strength per Rod		MPa
13	at		% offset

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

21 Core and Coil Clamping Structure

Main Transformer

d Tie-plates (Flitch-plates)

1	Material		
2	Material Grade		
3	Plate Temperature Rise		°C above top oil temperature
4	Allowable Stretch		%
	Wound Leg		
5	Quantity of Strips		
6	Width of Strip		mm
7	Thickness		mm
8	Tensile Strength per Plate		MPa
9	at		% offset
	Return Leg		
10	Quantity of Strips		
11	Width of Strip		mm
12	Thickness		mm
13	Tensile Strength per Plate		MPa
14	at		% offset

e Cross Frames (Clamps)

1	Material		
	Steel Construction		Hollow Structural, I-Beam, Beam

f Yoke and/or Return Leg Banding

Describe

g Clamping Structure Insulation

1 [ ] Clamping Structure is Insulated from the core?

2 Manufacturer's Drawing # [ ] Rev# [ ]

	Insulation Material	
3	Clamps	
4	Internal Tie-rods	
5	Bolts	

Comments

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

21 **Core and Coil Clamping Structure** **Main Transformer**

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

21 Core and Coil Clamping Structure

Main Transformer

h **Clamping Structure Isolation**

1 [ ] Clamping Structure is isolated (To prevent circulating currents in the structure)?

Manufacturer's Drawing # [ ] Rev# [ ]

Provide schematic showing isolation of clamps, tie-rods, tie-plates, base bars and cross-bars.
This sketch should also show how each member is grounded.

Isolation Material

2	Clamps	
3	Tie-rods	
4	Bolts	

Comments

i **Clamp Grounding**

Is the clamp grounded externally through a bushing in the cover per the Technical Specification?

1	Main Core	
2	Series Transformer	
3	LTC Reactor	
4	Current Limiting Reactor	

5 Manufacturer's Drawing # [ ] Rev# [ ]

j **Core Support Structure**

Describe how the core is supported (eg stepped blocks, dowling, epoxy).
Also describe how the coils are supported back to the core leg.
This includes the coil support blocks and the core & coil locating blocks.

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

21 Core and Coil Clamping Structure

Main Transformer

k **Base Bar Insulation**

[ ] Base Bars are isolated from Tank Floor?

Isolation Material [ ]

l **Clamp Blocking to Coil Assembly**

Describe the material (type & dimensions) and the method used.
Describe both under the clamp and in the core window.
Are blocks fastened in place or held by compression?

m **End Ring & End Insulation**

1 Clamping Pressure [ ] MPa

2 End Ring Thickness

Top [ ] mm
Bottom [ ] mm

3 Bridge Thickness

Top [ ] mm
Bottom [ ] mm

4 [ ] Perma-wood is used?

5 Materials [ ]

Comments

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

21 Core and Coil Clamping Structure

Main Transformer

n **Clamp Paint**

Clamps are painted?

Type of Paint

o **Coil & Coil Assebly Sizing**

Describe the procedure of sizing the coils, both individually and as an assembly.
Specify the clamping pressures and drying method.
Is drying done under pressure?
Is anything done differently for epoxy-bonded cables?

p **Final Clamping of Core and Coil Assembly**

Describe the final core and coil clamping procedure before, during and after the vapour phase cycle.
Specify the clamping pressures.
Is the assembly re-packed if it is loose? Is it re-packed all the way around including in the core window?

q General

1 Has the clamping structure been designed to proven design concepts that have been tested?

2 List any additional insulation materials that are not listed above and their use:

eg nitrile rubber

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

22 Core and Coil Clamping Structure

Series Transformer

a Manufacturer's Drawing #'s if known — Rev#

b General Comments

Attach separate design information if that is more convenient.

c **Tie-rods**

1	Internal or External	
2	Material	
3	Material Grade	
4	Tie-Rod Temperature Rise	°C above top oil temperature
5	Allowable Stretch	%
6	Clamping Pressure	MPa
	Wound Leg or between Wound Legs	
7	Quantity per side	
8	Diameter	mm
9	Tensile Strength per Rod	MPa
10	at	% offset
	Return Leg	
11	Quantity per side	
12	Diameter	mm
13	Tensile Strength per Rod	MPa
14	at	% offset

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

22 Core and Coil Clamping Structure

Series Transformer

d		**Tie-plates (Flitch-plates)**	
	1	Material	
	2	Material Grade	
	3	Plate Temperature Rise	°C above top oil temperature
	4	Allowable Stretch	%
	5	Clamping Pressure	MPa
		Wound Leg	
	6	Quantity of Strips	
	7	Width of Strip	mm
	8	Thickness	mm
	9	Tensile Strength per Plate	MPa
	10	at	% offset
		Return Leg	
	11	Quantity of Strips	
	12	Width of Strip	mm
	13	Thickness	mm
	14	Tensile Strength per Plate	MPa
	15	at	% offset
e		**Cross Frames (Clamps)**	
	1	Material	
		Steel Construction	Hollow Structural, I-Beam, Beam
f		**Yoke and/or Return Leg Banding**	
		Describe	
g		**Clamping Structure Insulation**	
	1	Clamping Structure is Insulated from the core?	
	2	Manufacturer's Drawing #	Rev#
		Insulation Material	
	3	Clamps	
	4	Internal Tie-rods	
	5	Bolts	
		Comments	

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

22 **Core and Coil Clamping Structure** **Series Transformer**

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

22 Core and Coil Clamping Structure

Series Transformer

h **Clamping Structure Isolation**

1 Clamping Structure is isolated (To prevent circulating currents in the structure)?

Manufacturer's Drawing # Rev#

Provide schematic showing isolation of clamps, tie-rods, tie-plates, base bars and cross-bars.
This sketch should also show how each member is grounded.

Isolation Material

2 Clamps

3 Tie-rods

4 Bolts

Comments

i **Clamp Grounding**

Is the clamp grounded externally through a bushing in the cover per the Technical Specification?

1 Main Core

2 Series Transformer

3 LTC Reactor

4 Current Limiting Reactor

5 Manufacturer's Drawing # Rev#

j **Core Support Structure**

Describe how the core is supported (eg stepped blocks, dowling, epoxy).
Also describe how the coils are supported back to the core leg.
This includes the coil support blocks and the core & coil locating blocks.

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

22 **Core and Coil Clamping Structure** **Series Transformer**

k **Base Bar Insulation**

Base Bars are isolated from Tank Floor?

Isolation Material

l **Clamp Blocking to Coil Assembly**

Describe the material (type & dimensions) and the method used.
Describe both under the clamp and in the core window.
Are blocks fastened in place or held by compression?

m **End Ring & End Insulation**

1 Clamping Pressure MPa

2 End Ring Thickness

Top mm
Bottom mm

3 Bridge Thickness

Top mm
Bottom mm

4 Perma-wood is used?

5 Materials

Comments

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

22 Core and Coil Clamping Structure

Series Transformer

n **Clamp Paint**

Clamps are painted?

Type of Paint

o **Coil & Coil Assebly Sizing**

Describe the procedure of sizing the coils, both individually and as an assembly.
Specify the clamping pressures and drying method.
Is drying done under pressure?
Is anything done differently for epoxy-bonded cables?

p **Final Clamping of Core and Coil Assembly**

Describe the final core and coil clamping procedure before, during and after the vapour phase cycle.
Specify the clamping pressures.
Is the assembly re-packed if it is loose? Is it re-packed all the way around including in the core window?

q General

1 Has the clamping structure been designed to proven design concepts that have been tested?

2 List any additional insulation materials that are not listed above and their use:

eg nitrile rubber

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

23 **Winding** **Main Transformer**

a Manufacturer's Drawing #'s if known

Drawing #	Rev#

b **Transpositions**

1 Describe locations, methods and philosophy.

2 How are transpositions supported for radial forces?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

23 **Winding** **Main Transformer**

c **Crossovers**

1 How are crossovers supported for radial forces?
2 How much are the crossovers allowed to reduce the inside axial oil duct?

d **Interleaving Connections**

1 Describe locations, methods and philosophy.
2 Are these connections made while winding or after winding?
3 Are they made tight to the winding or are they loose?
4 Do these connections extend past the radial build of the coil (ie are full-turns made)?
5 If so, and there is another winding over this one, is the radial clearance increased to accomodate the overbuild?

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

23 **Winding** **Main Transformer**

e **Brazing**

1 Is brazing performed only on the outside diameter of the coil?
2 Or is brazing also performed inside the coil?
3 Describe the brazing process.
4 If necessary, how are CTC cables brazed (strand-to-strand with insulation)?

f **Sizing**

1 What are the maximum allowable radial and axial oversizes allowed?
2 What are the remedies when the allowable limits are exceeded?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

23 **Winding** **Main Transformer**

g **CTC**

Are shorted strands checked for:

	by the manufacturer;
	while winding;
	while clamping;
	after final core & coil clamping?

If shorts are accepted, explain circumstances:

h **Epoxy-Bonded CTC**

1 Describe the curing process including duration, temperature, clamping pressure.

2 How is an epoxied coil sized?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

23 **Winding** **Main Transformer**

i **Winding Cylinders**

1 Are winding cylinders:

	pre-dried;
	oil-soaked;
	otherwise dimensionally stabilised?

2 | | Are cylinders pressboard?

3 For large diameter cylinders, what is done to prevent the cylinder from shrinking while drying and pulling away from the coil leaving the coil unsupported?

j Keyed Spacers

1		Are spacers locked-into (keyed) the inner duct stick?
2		Are spacers cleaned of fibres (burrs from cutting) to produce a clean edge?
3		Are spacers chamfered (rounded edges)?

Manitoba Hydro

Design Review Data

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23 **Winding** **Main Transformer**

k Coil Radial Tightness

1 What is done to ensure the sections of disk windings are wound tightly?
2 Are spacers oversized to accomodate overbuilds?
3 If a winder notices the coil is overbuilding while winding, what is done about it?
4 Does the winder regularly check for overbuilds?
5 If a coil is oversize, how far past the duct stick notch in the spacer is the conductor allowed to extend?
Would the stick be reduced to accomodate this?
Is there enough tolerance in the radial clearance to the next coil?

l Wind-Overs

1 Are any coils wound directly over another?
2 If so, is there a tolerance in the radial clearance to allow for overbuilds?

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

23 **Winding** **Main Transformer**

m Stress Rings

1 How are stress rings made?
2 How much insulation is added over the metal electrode?
3 Does the electrode or the paper line-up with the OD of the coil?
4 Are stress rings rebuilt if they are undersized?
5 How are leads brought through stress rings if necessary?
6 How are stress rings connected to the lead and is this connection brazed?

n General

1 Have the coils been designed to proven design concepts that have been tested?
2 List all the insulation materials that are in the finished coils:
eg Kraft paper, T4 pressboard, T3 pressboard(spacers),...

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

24 **Winding** **Series Transformer**

NOTE:

There is no need to duplicate information from the WINDING MAIN worksheet.
If the series transformer is manufactured in the same facility as the main transformer, with the sam
you can use the WINDING MAIN worksheet for both transformers.
Use this worksheet for different manufacturing facitlites, such as sub-contracted series transforme
or if different production rules apply to the series transformer.
Likewise, use this sheet for sub-contracted LTC reactors (preventive auto) or current limiting reacto

a Manufacturer's Drawing #'s if known Rev#

b **Transpositions**
1 Describe locations, methods and philosophy.
2 How are transpositions supported for radial forces?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

24 **Winding** **Series Transformer**

c **Crossovers**

1 How are crossovers supported for radial forces?
2 How much are the crossovers allowed to reduce the inside axial oil duct?

d **Interleaving Connections**

1 Describe locations, methods and philosophy.
2 Are these connections made while winding or after winding?
3 Are they made tight to the winding or are they loose?
4 Do these connections extend past the radial build of the coil (ie are full-turns made)?
5 If so, and there is another winding over this one, is the radial clearance increased to accomodate the overbuild?

Design Review Data

24 Winding

Series Transformer

e **Brazing**

1 Is brazing performed only on the outside diameter of the coil?
2 Or is brazing also performed inside the coil?
3 Describe the brazing process.
4 If necessary, how are CTC cables brazed (strand-to-strand with insulation)?

f **Sizing**

1 What are the maximum allowable radial and axial oversizes allowed?
2 What are the remedies when the allowable limits are exceeded?

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

24 **Winding** **Series Transformer**

g **CTC**

Are shorted strands checked for:

by the manufacturer;
while winding;
while clamping;
after final core & coil clamping?

If shorts are accepted, explain circumstances:

h **Epoxy-Bonded CTC**

1 Describe the curing process including duration, temperature, clamping pressure.

2 How is an epoxied coil sized?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

24 **Winding** **Series Transformer**

i **Winding Cylinders**

1 Are winding cylinders:
pre-dried;
oil-soaked;
otherwise dimensionally stabilised?

2 Are cylinders pressboard?

3 For large diameter cylinders, what is done to prevent the cylinder from shrinking while drying and pulling away from the coil leaving the coil unsupported?

j Keyed Spacers

1 Are spacers locked-into (keyed) the inner duct stick?

2 Are spacers cleaned of fibres (burrs from cutting) to produce a clean edge?

3 Are spacers chamfered (rounded edges)?

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

24 **Winding** **Series Transformer**

k Coil Radial Tightness

1 What is done to ensure the sections of disk windings are wound tightly?
2 Are spacers oversized to accomodate overbuilds?
3 If a winder notices the coil is overbuilding while winding, what is done about it?
4 Does the winder regularly check for overbuilds?
5 If a coil is oversize, how far past the duct stick notch in the spacer is the conductor allowed to extend?
Would the stick be reduced to accomodate this?
Is there enough tolerance in the radial clearance to the next coil?

l Wind-Overs

1 Are any coils wound directly over another?
2 If so, is there a tolerance in the radial clearance to allow for overbuilds?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

24 **Winding** **Series Transformer**

m Stress Rings
1 How are stress rings made?
2 How much insulation is added over the metal electrode?
3 Does the electrode or the paper line-up with the OD of the coil?
4 Are stress rings rebuilt if they are undersized?
5 How are leads brought through stress rings if necessary?
6 How are stress rings connected to the lead and is this connection brazed?

n General
1 Have the coils been designed to proven design concepts that have been tested?
2 List all the insulation materials that are in the finished coils:
eg Kraft paper, T4 pressboard, T3 pressboard(spacers),...

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

25 **End Insulation** **Main Transformer**

a Manufacturer's Drawing #'s if known

Drawing #	Rev#

b **Stress Plot**

1 Has a stress plot been done?

2 If so,

What is the value and location of the highest oil stress?
What is done to relieve this stress?
Do stress plots consider any critical leads?

Design Review Data

25 **End Insulation** **Main Transformer**

c **Stress Rings & Flanged collars**

1 Which coil ends (& centres) have these (if not mentioned elsewhere)?
2 How many collars?
3 How are sticks prevented from puncturing collars during clamping?
4 How are sticks prevented from puncturing stress rings or rubbing off the insulation on the conductor during clamping?
Fill-in the simple sketch on the next worksheet showing these.

d **Core Protection**

How are the steps of the core yoke insulated? Thickness of insulation?

e **Blocks**

Are blocks sized and/or chamfered to avoid oil wedges against stress rings?

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

25 **End Insulation** **Main Transformer**

f **Inter-Phase Barrier**

1 Is the barrier composed of oil and pressboard layers?

2 Thickness?

g **General**

1 Has the end insulation been designed to proven design concepts that have been tested?

2 Is any Perma-wood used in the structure?

3 List all the insulation materials used:

eg Crepe paper, T4 pressboard (wraps), T3 pressboard(collars),...

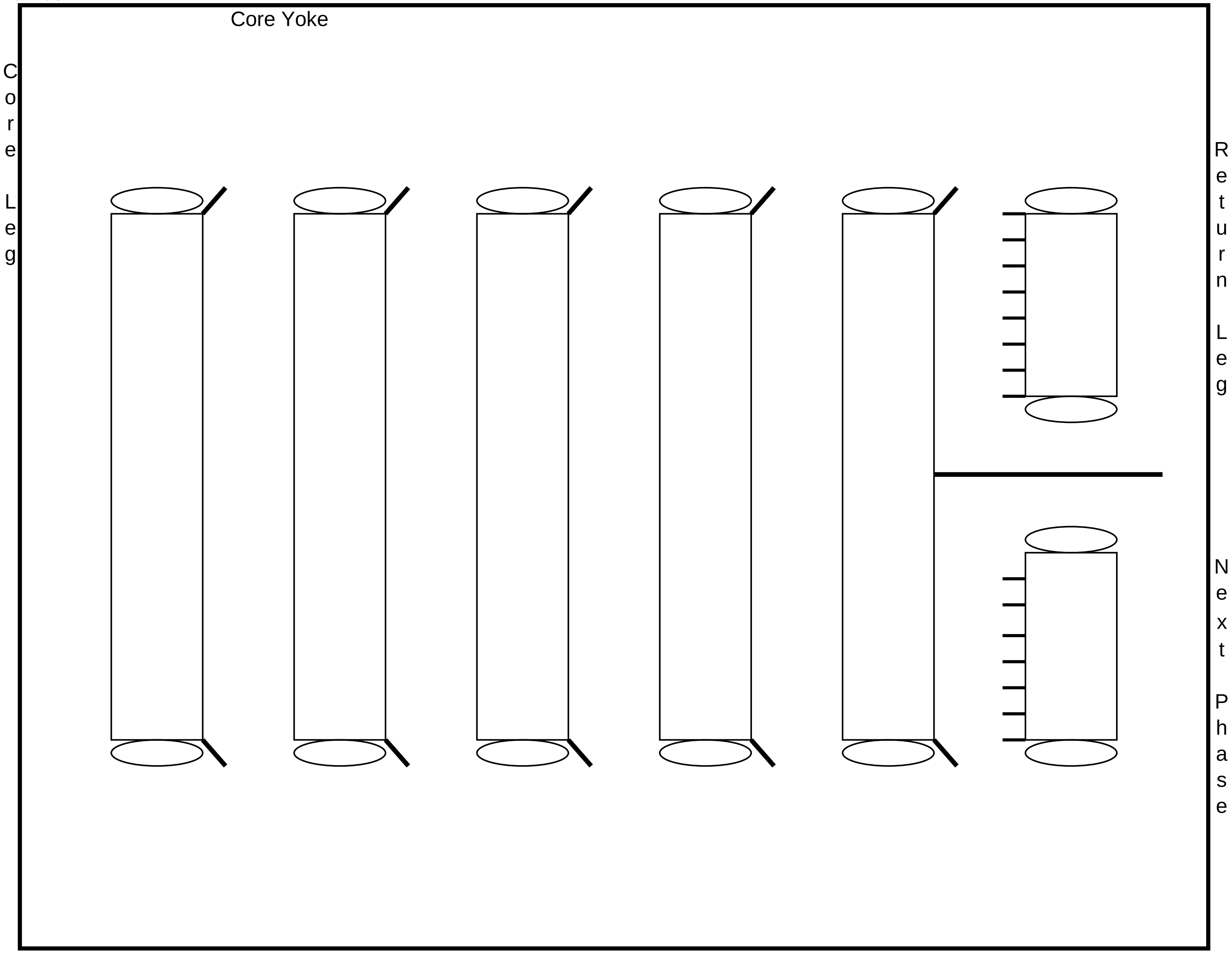
Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

26 **End Insulation Sketch** for **Main Transformer** **Fill-in another copy of this sheet for a series transformer if > 250 k**

Coil Names



This sheet is not required if a separate drawing is provided.

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

27 **Electrical Clearances**

NOTE: Clearances are required for all components and all coils.
Include clearances between layers.
But it is not necessary to include layers separated by axial cooling ducts.
If any shielding cylinders are used, enter in column D and provide details of shielding cylinder.

a	1	Transformer Component											
	2	Coil Name											
b		Clearance inside of Coil											
	1	kV LIL across Clearance	kV										
	2	Radial Clearance	mm										
	3	Oil Duct over previous coil	mm										
	4	Cylinder 1	mm										
	5	Oil duct 2	mm										
	6	Cylinder 2	mm										
	7	Oil duct 3	mm										
	8	Cylinder 3	mm										
	9	Oil duct 4	mm										
	10	Cylinder 4	mm										
	11	Oil duct 5	mm										
	12	Cylinder 5	mm										
	13	Oil duct 6	mm										
	14	Cylinder 6	mm										
	15	Oil duct 7	mm										
	16	Cylinder 7	mm										
	17	Oil duct 8	mm										
	18	Cylinder 8	mm										
	19	Oil duct 9	mm										
	20	Cylinder 9	mm										
	21	Oil duct 10	mm										
	22	Cylinder 10	mm										
	23	Oil duct 11	mm										
	24	Cylinder 11	mm										
	25	Oil duct 12	mm										
	26	Cylinder 12	mm										
	27	Oil duct 13	mm										
	28	Cylinder 13	mm										
	29	Oil duct 14	mm										
	30	Cylinder 14	mm										
	31	Oil duct 15	mm										
	32	Cylinder 15	mm										
	33	Oil duct 16	mm										
	34	Cylinder under coil	mm										
	35	Oil Duct under coil	mm										
	36	Total Oil	mm										
	37	Total Pressboard	mm										
	38	Largest Oil Duct	mm										
	39	Smallest Oil Duct	mm										
	40	# Pressboard Barriers											

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27 **Electrical Clearances**

NOTE: Clearances are required for all components and all coils.
Include clearances between layers.
But it is not necessary to include layers separated by axial cooling ducts.
If any shielding cylinders are used, enter in column D and provide details of shielding cylinder.

a	1	Transformer Component												
	2	Coil Name												
	41	Average Stress	kV/mm											

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Design Review Data

27 Electrical Clearances

a	1	Transformer Component	
	2	Coil Name	
b		Clearance inside of Coil	
	1	kV LIL across Clearance	
	2	Radial Clearance	
	3	Oil Duct over previous coil	
	4	Cylinder	1
	5	Oil duct	2
	6	Cylinder	2
	7	Oil duct	3
	8	Cylinder	3
	9	Oil duct	4
	10	Cylinder	4
	11	Oil duct	5
	12	Cylinder	5
	13	Oil duct	6
	14	Cylinder	6
	15	Oil duct	7
	16	Cylinder	7
	17	Oil duct	8
	18	Cylinder	8
	19	Oil duct	9
	20	Cylinder	9
	21	Oil duct	10
	22	Cylinder	10
	23	Oil duct	11
	24	Cylinder	11
	25	Oil duct	12
	26	Cylinder	12
	27	Oil duct	13
	28	Cylinder	13
	29	Oil duct	14
	30	Cylinder	14
	31	Oil duct	15
	32	Cylinder	15
	33	Oil duct	16
	34	Cylinder under coil	
	35	Oil Duct under coil	
	36	Total Oil	
	37	Total Pressboard	
	38	Largest Oil Duct	
	39	Smallest Oil Duct	
	40	# Pressboard Barriers	

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Design Review Data

27 Electrical Clearances

a	1	Transformer Component
	2	Coil Name
	41	Average Stress

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28 Electrical Stresses

Enter for Main Transformer, Series Transformer, LTC Reactor (Preventive Auto) and Current-Limiting Reactor

Data is only required for coils with impulse levels greater than 250 kV LIL to ground.

Add more lines as necessary

a Worst Case Impulse Voltages (see sketches below)

1		Transformer Component												
2		Coil Name												
3		Type of Winding												
4		Line End is on ID or OD?												
5	Disk 1 to Disk 2	Spacing	mm											
6	S-S	Stress	kV											
7		Strength	kV											
8		Oil Stress at OD of Coil	kV/mm											
9	Disk 2 to Disk 3	Spacing	mm											
10	P-P or S-S	Stress	kV											
11		Strength	kV											
12		Oil Stress at ID of Coil	kV/mm											
13	Disk 3 to Disk 4	Spacing	mm											
14	S-S	Stress	kV											
15		Strength	kV											
16		Oil Stress at ID of Coil	kV/mm											
17	Disk 4 to Disk 5	Spacing	mm											
18	P-P or S-S	Stress	kV											
19		Strength	kV											
20		Oil Stress at ID of Coil	kV/mm											
21	Disk 5 to Disk 6	Spacing	mm											
22	S-S	Stress	kV											
23		Strength	kV											
24		Oil Stress at ID of Coil	kV/mm											
25	Disk 6 to Disk 7	Spacing	mm											
26	P-P or S-S	Stress	kV											
27		Strength	kV											
28		Oil Stress at ID of Coil	kV/mm											
29	Disk 7 to Disk 8	Spacing	mm											
30	S-S	Stress	kV											
31		Strength	kV											
32		Oil Stress at ID of Coil	kV/mm											

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28 **Electrical Stresses**

a **Worst Case Impulse Voltages cont.**

Transformer Component												
Coil Name												

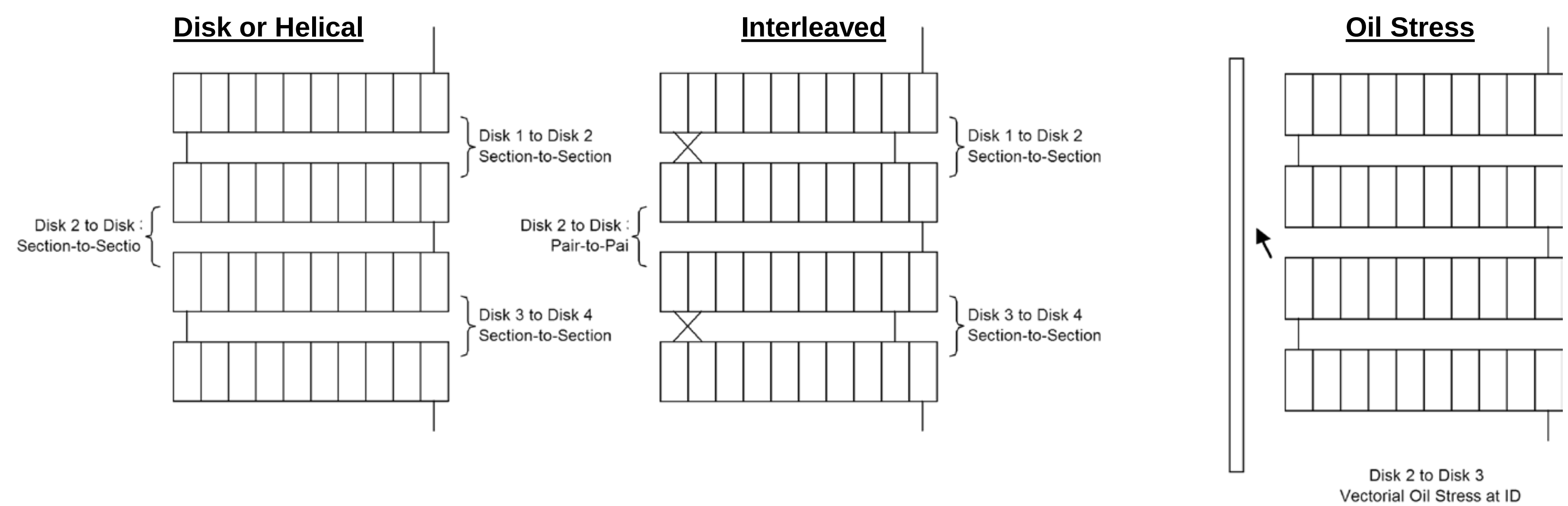
If Partly Interleaved or shielded : At Joint between this and Plain Disk

33	Disk to Disk	Spacing	mm											
34	S-S	Stress	kV											
35		Strength	kV											
36		Oil Stress at ID of Coil	kV/mm											
37	Next Disk to Disk	Spacing	mm											
38	S-S	Stress	kV											
39		Strength	kV											
40		Oil Stress at OD of Coil	kV/mm											
41	Next Disk to Disk	Spacing	mm											
42	S-S	Stress	kV											
43		Strength	kV											
44		Oil Stress at ID of Coil	kV/mm											

If DTC : At Tap Break

45		Spacing	mm											
46	S-S	Stress	kV											
47		Strength	kV											
48		Oil Stress at ID of Coil	kV/mm											

P-P : Pair-to-Pair
S-S : Section-to-Section



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Design Review Data

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28 Electrical Stresses

b **Safety Factors on Designed Withstand Strength**

on Manufacturer's kV Strength %

Weidmann Oil Stress Curves

De-Gassified Oil % Manufacturer's safety factor above the Weidmann curves

Gas-Saturated Oil %

c **Calculation**

Describe the method of Disk-to-Disk Impulse Voltage calculation
(eg Transmission-line capacitances, full model of capacitances & inductances,...)

d **Stress Reduction Techniques**

Describe the methods (if any) used to reduce the impulse stresses.
(eg solid insulation, shielded turns, internal collars)

e **Transferred Surge**

1 Specify the transferred surge from one coil to another if applicable.
2 What is done to control transferred surges (eg metal-oxide varistors)?

f **External Tie-Rods**

1 Stress Plot done?
2 External Tie-Rods checked? Are the tie-rods adequately insulated for all dielectric tests.

	Stress	Strength
3 kV/mm		

4 Describe the tie-rod insulation structure (eg crepe tape, crepe tape, oil duct and plus pressboard tube).

g General Have the coils and insulation been designed to proven design concepts that have been tested?

Manitoba Hydro

Design Review Data

28 **Electrical Stresses**

Enter for Main T
Data is only req
Add more lines

a **Worst Case Impulse Voltages**

1		Transformer Component
2		Coil Name
3		Type of Winding
4		Line End is on ID or OD?
5	Disk 1 to Disk 2	Spacing
6	S-S	Stress
7		Strength
8		Oil Stress at OD of Coil
9	Disk 2 to Disk 3	Spacing
10	P-P or S-S	Stress
11		Strength
12		Oil Stress at ID of Coil
13	Disk 3 to Disk 4	Spacing
14	S-S	Stress
15		Strength
16		Oil Stress at ID of Coil
17	Disk 4 to Disk 5	Spacing
18	P-P or S-S	Stress
19		Strength
20		Oil Stress at ID of Coil
21	Disk 5 to Disk 6	Spacing
22	S-S	Stress
23		Strength
24		Oil Stress at ID of Coil
25	Disk 6 to Disk 7	Spacing
26	P-P or S-S	Stress
27		Strength
28		Oil Stress at ID of Coil
29	Disk 7 to Disk 8	Spacing
30	S-S	Stress
31		Strength
32		Oil Stress at ID of Coil

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Design Review Data

28 **Electrical Stresses**

a **Worst Case Impulse Voltages**

		Transformer Component
		Coil Name
	If Partly Interleaved or shielded	
33	Disk to Disk	Spacing
34	S-S	Stress
35		Strength
36		Oil Stress at ID of Coil
37	Next Disk to Disk	Spacing
38	S-S	Stress
39		Strength
40		Oil Stress at OD of Coil
41	Next Disk to Disk	Spacing
42	S-S	Stress
43		Strength
44		Oil Stress at ID of Coil
	If DTC : At Tap Break	
45		Spacing
46	S-S	Stress
47		Strength
48		Oil Stress at ID of Coil

P-P : Pair-to-Pair

S-S : Section-to-Section

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Design Review Data

28 **Electrical Stresses**

b **Safety Factors on Designed V**
on Manufacturer's kV Strength
Weidmann Oil Stress Curves
De-Gassified Oil
Gas-Saturated Oil

c **Calculation**

d **Stress Reduction Techniques**

e **Transferred Surge**
1
2

f **External Tie-Rods**
1 Stress Plot don
2 External Tie-Ro
3
4

g General

Manitoba Hydro

Design Review Data

29 Short-Circuit Currents

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

a **Any Fault, Infinite Bus** [ ] Is the transformer designed to withstand any type of fault on any terminal with infeed on any other terminals and based on zero HV and LV system impedance?

b **Reactance during Fault**

	Positive-Sequence			
1	Current Limiting Reactor	%		during fault
2	Neutral Grounding Reactor	%		during fault
3	HV System	%		
4	LV System	%		
5	TV System	%		

	X0 / X1 Ratio										
6	DTC Tap Pos										
7	LTC Tap Pos										
8	S/P Pos										
9	Main Transformer H+X										
10	Main Transformer H+Y										
11	Main Transformer X+Y										
12	Series Transformer										
13	Current Limiting Reactor										
14	HV System										
15	LV System										
16	TV System										

c **Constants**

1	ANSI Asymmetry Factor		1.80
2	Pre-Fault Operating Voltage	%	110.00

d **Type of currents entered** RMS
Symmetrical

TRUE Is Pre-Fault Operating Voltage included in the currents below?
ie: are the stated currents calculated as follows: 1.1 x p.u. fault current x base current
If not, correct the 'c' & 'd' input above.

Not all faults need to be entered.
Usually only the worst cases need to be entered.
As a minimum, enter
Single-Line-to-Ground Fault on HV and LV.
Three-Phase Fault on TV
Enter all of the currents for each circuit and for each case.

Circuits
As a minimum, enter all of the circuits including the Common and the series transformer.
As a complex example, a dual LV (LTC with series transformer) with buried TV:
HV top, HV bottom, LVX, LVY, TV top, TV bottom.
Include the Exciter (LTC) and/or the Series and Common of each series transformer.
Include buried TV.
If this transformer is to parallel with an existing transformer,
also provide the expected fault current pushed into the existing transformer.

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Design Review Data

29 **Short-Circuit Currents** Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

e	Circuit Name										
f	**3-Phase Fault Currents in Coils RMS Symmetrical**										
1	Fault on Circuit										
2	DTC Tap Pos										
3	LTC Tap Pos										
4	S/P Pos										
5	Fault Current										
6	Fault on Circuit										
7	DTC Tap Pos										
8	LTC Tap Pos										
9	S/P Pos										
10	Fault Current										
11	Fault on Circuit										
12	DTC Tap Pos										
13	LTC Tap Pos										
14	S/P Pos										
15	Fault Current										
16	Fault on Circuit										
17	DTC Tap Pos										
18	LTC Tap Pos										
19	S/P Pos										
20	Fault Current										
21	Fault on Circuit										
22	DTC Tap Pos										
23	LTC Tap Pos										
24	S/P Pos										
25	Fault Current										
26	Fault on Circuit										
27	DTC Tap Pos										
28	LTC Tap Pos										
29	S/P Pos										
30	Fault Current										
31	Fault on Circuit										
32	DTC Tap Pos										
33	LTC Tap Pos										
34	S/P Pos										
35	Fault Current										

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Design Review Data

29 **Short-Circuit Currents**

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

	Circuit Name										

f **3-Phase Fault Currents in Coils RMS Symmetrical**

36	Fault on Circuit										
37	DTC Tap Pos										
38	LTC Tap Pos										
39	S/P Pos										
40	Fault Current										
41	Fault on Circuit										
42	DTC Tap Pos										
43	LTC Tap Pos										
44	S/P Pos										
45	Fault Current										
46	Fault on Circuit										
47	DTC Tap Pos										
48	LTC Tap Pos										
49	S/P Pos										
50	Fault Current										
51	Fault on Circuit										
52	DTC Tap Pos										
53	LTC Tap Pos										
54	S/P Pos										
55	Fault Current										
56	Fault on Circuit										
57	DTC Tap Pos										
58	LTC Tap Pos										
59	S/P Pos										
60	Fault Current										
61	Fault on Circuit										
62	DTC Tap Pos										
63	LTC Tap Pos										
64	S/P Pos										
65	Fault Current										
66	Fault on Circuit										
67	DTC Tap Pos										
68	LTC Tap Pos										
69	S/P Pos										
70	Fault Current										

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Design Review Data

29 Short-Circuit Currents

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Circuit Name

g Single-Line-to-Ground Fault Currents in Coils RMS Symmetrical

1	Fault on Circuit										
2	DTC Tap Pos										
3	LTC Tap Pos										
4	S/P Pos										
5	Fault Current										
6	Fault on Circuit										
7	DTC Tap Pos										
8	LTC Tap Pos										
9	S/P Pos										
10	Fault Current										
11	Fault on Circuit										
12	DTC Tap Pos										
13	LTC Tap Pos										
14	S/P Pos										
15	Fault Current										
16	Fault on Circuit										
17	DTC Tap Pos										
18	LTC Tap Pos										
19	S/P Pos										
20	Fault Current										
21	Fault on Circuit										
22	DTC Tap Pos										
23	LTC Tap Pos										
24	S/P Pos										
25	Fault Current										
26	Fault on Circuit										
27	DTC Tap Pos										
28	LTC Tap Pos										
29	S/P Pos										
30	Fault Current										
31	Fault on Circuit										
32	DTC Tap Pos										
33	LTC Tap Pos										
34	S/P Pos										
35	Fault Current										

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29 **Short-Circuit Currents**

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

	Circuit Name										

g **Single-Line-to-Ground Fault Currents in Coils RMS Symmetrical**

36	Fault on Circuit										
37	DTC Tap Pos										
38	LTC Tap Pos										
39	S/P Pos										
40	Fault Current										
41	Fault on Circuit										
42	DTC Tap Pos										
43	LTC Tap Pos										
44	S/P Pos										
45	Fault Current										
46	Fault on Circuit										
47	DTC Tap Pos										
48	LTC Tap Pos										
49	S/P Pos										
50	Fault Current										
51	Fault on Circuit										
52	DTC Tap Pos										
53	LTC Tap Pos										
54	S/P Pos										
55	Fault Current										
56	Fault on Circuit										
57	DTC Tap Pos										
58	LTC Tap Pos										
59	S/P Pos										
60	Fault Current										
61	Fault on Circuit										
62	DTC Tap Pos										
63	LTC Tap Pos										
64	S/P Pos										
65	Fault Current										
66	Fault on Circuit										
67	DTC Tap Pos										
68	LTC Tap Pos										
69	S/P Pos										
70	Fault Current										

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Design Review Data

30 Short-Circuit Forces and Stresses

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

a	**Coil Name (eg HV, SV)**											

These are the same coils as from the **Coil Data** sheet.
All coils are required, including series transformers and reactors.
Enter any appropriate name or choose from the list.

b **Magnetic Flux Density in Coil during Fault**

Enter for main and series transformer
Enter the values used to calculate the forces and stresses.

	Axial											
1	maximum inside coil	T										
2	at Top of Coil	T										
3	at Centre of Coil	T										
4	at Bottom of Coil	T										

	Radial											
5	maximum inside coil	T										
6	at Top of Coil	T										
7	at Centre of Coil	T										
8	at Bottom of Coil	T										

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Design Review Data

30 Short-Circuit Forces and Stresses

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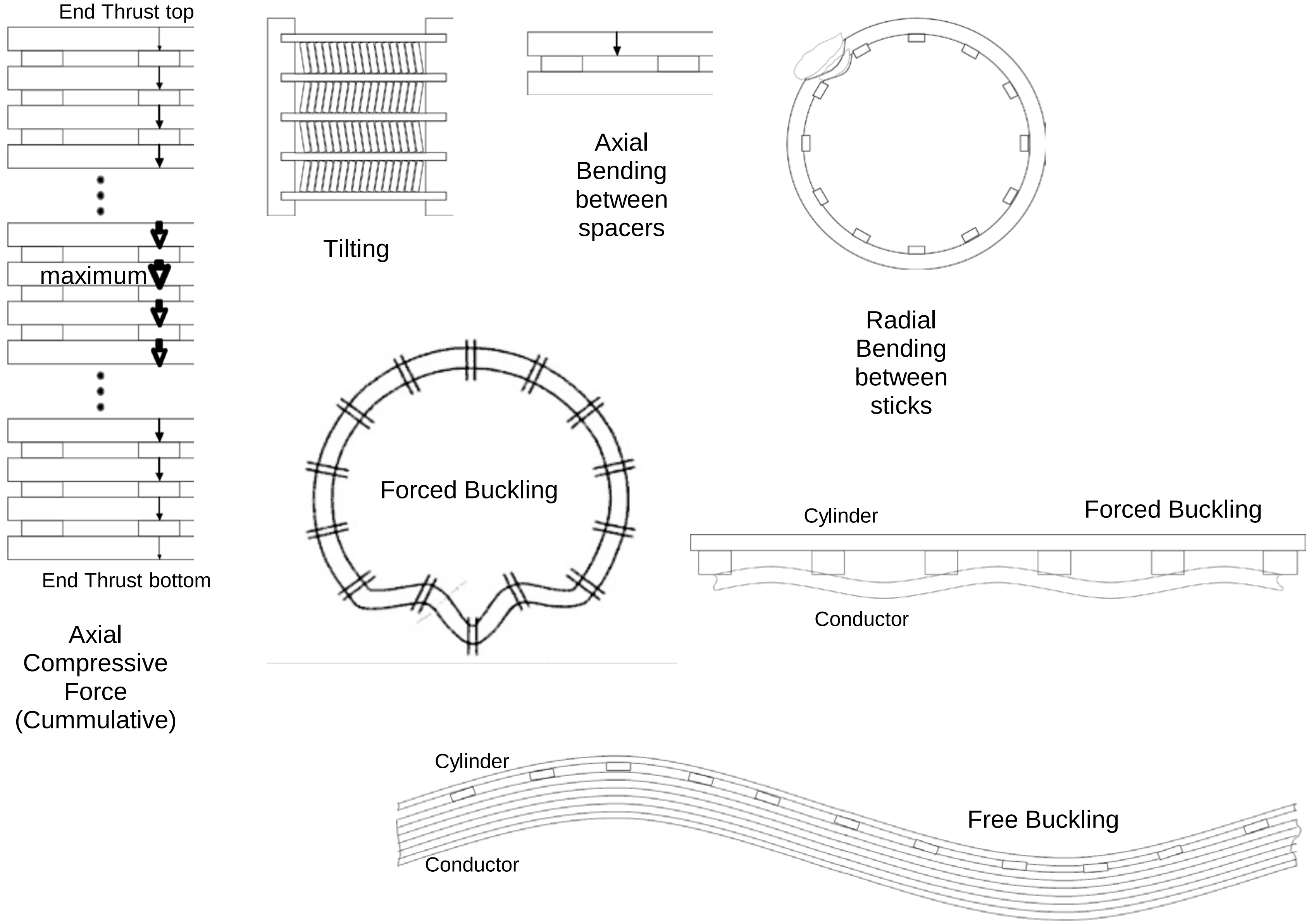
c Short-Circuit Forces and Stresses

The cell comments below reference the following books.
They are given for an explanation of which forces are desired: not what formula should be used.
1) 'The Short-Circuit Strength of Power Transformers' by M. Waters, 1966.
2) 'Transformer Design Principles' by R. Del Vecchio et al, 2002.
3) "Transformer Engineering Design and Practice" by S.V. Kulkarni, S.A. Khaparde, 2004

Pictorial description of forces



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Design Review Data

30 Short-Circuit Forces and Stresses

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

	Coil Name (eg HV, SV)											

d **Short-Circuit Forces and Stresses**

Forces are required regardless of whether epoxy bonding is used.

	Axial Compressive Force											
1	maximum inside coil	kN										
2	at Top of Coil	kN										
3	at Centre of Coil	kN										
4	at Bottom of Coil	kN										
	Axial Compressive Stress on Spacers											
5	Stress	MPa										
6	Withstand of Spacer	MPa										
	Critical Axial Tilting Stress or Force											
7	Stress	MPa										
8	Withstand	MPa										
	Axial Bending Stress between Spacers (Beam)											
9	Stress	MPa										
10	Withstand	MPa										
	Radial Buckling Stress (Hoop)											
11	Stress	MPa										
12	Withstand	MPa										
	Free-Buckling											
13	Free-Buckling Withstand	MPa										
14	based on #Epoxied Strands											
	Radial Bending Stress between Duct Sticks (Beam)											
15	Stress	MPa										
16	Withstand	MPa										
	Fischer's Radial Bending Stress (Forced Buckling) between Duct Sticks (Beam)											
17	Stress	MPa										
18	Withstand	MPa										

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Design Review Data

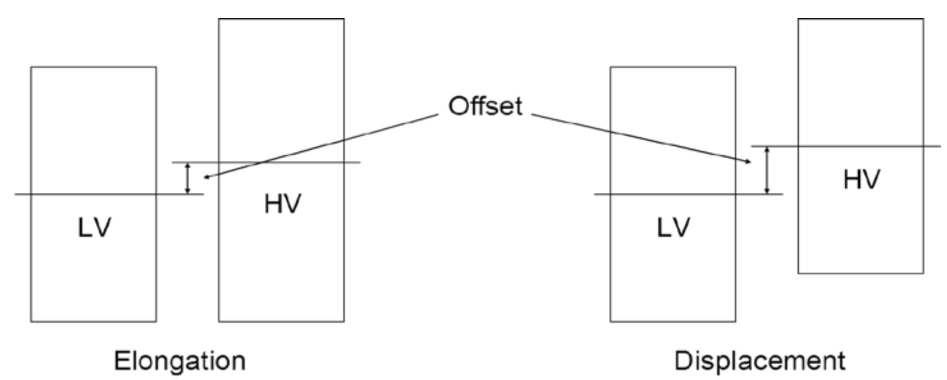
30 **Short-Circuit Forces and Stresses** Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

Coil Name (eg HV, SV)

e **Conductor Characteristics**

1	Minimum Proof Stress	MPa										
2	Offset	%										
3	ANSI Temperature for 2 second fault	°C										
4	Epoxy Softens?			Does the epoxy on any winding conductor soften and loose its strength during a 2 second fault?								
5	Modulus of Elasticity Without Stress : E_0	MPa										
6	Tangetial Modulus of Elasticity : E_T	MPa										
7	E_T used to calculate stress?			Is the tangential modulus of elasticity used in the calculations, and is it reduced based on the radial buckling stress?								
8	If necessary, explain											
9	Elasticity used	MPa		Modulus of elasticity used to calculate the stresses.								

f **Magnetic Centre-line Offset**



1	Elongation or Displacement?			Are the coils displaced or elongated to determine all of the forces?
2	Amount of offset	%		
3	Coils are offset?			
4	Exceptions or Comments?			

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Design Review Data

30 Short-Circuit Forces and Stresses

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

	Coil Name (eg HV, SV)											
g	**End Thrust**		What is the top and total bottom axial compressive force (End Thrust) exerted by each coil on the end ring or blocking.									
1	**Case 1**											
a	Fault Type											
b	Fault on Circuit											
c	DTC Tap Pos											
d	LTC Tap Pos											
e	S/P Pos											
f	Manufacturer's Normal Offset	%										
g	Top	kN										
h	Bottom	kN										
i	Sum Top	kN										
j	Sum Bottom	kN										
2	**Case 2**											
a	Fault Type											
b	Fault on Circuit											
c	DTC Tap Pos											
d	LTC Tap Pos											
e	S/P Pos											
f	**0.5% Offset**	%										
g	Top	kN										
h	Bottom	kN										
i	Sum Top	kN										
j	Sum Bottom	kN										
3	**Case 3**	if necessary										
a	Fault Type											
b	Fault on Circuit											
c	DTC Tap Pos											
d	LTC Tap Pos											
e	S/P Pos											
f	**No Offset**	%	0	0	0	0	0	0	0	0	0	0
g	Top	kN										
h	Bottom	kN										
i	Sum Top	kN										
j	Sum Bottom	kN										
4	**Case 4**	Other conditions if necessary										
a	Fault Type											
b	Fault on Circuit											
c	DTC Tap Pos											
d	LTC Tap Pos											
e	S/P Pos											
f	Amount of Offset	%										
g	Top	kN										
h	Bottom	kN										
i	Sum Top	kN										
j	Sum Bottom	kN										

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Design Review Data

30 **Short-Circuit Forces and Stresses** Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

h **Clamping Structure**

1 Design Criteria

Describe your design criteria (stresses and withstands and built-in safety-factors) such as:
tie-rod or tie-plate tension/stretch;
end ring bending;
clamp bending;
clamp shear;
clamp deflection;
section modulus.

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Design Review Data

30 **Short-Circuit Forces and**

a **Coil Name (eg HV, SV)**

b **Magnetic Flux Density**

	Axial
1	maximum inside coil
2	at Top of Coil
3	at Centre of Coil
4	at Bottom of Coil
	Radial
5	maximum inside coil
6	at Top of Coil
7	at Centre of Coil
8	at Bottom of Coil

Design Review Data

30 Short-Circuit Forces and

c Short-Circuit Forces and

Pictorial description of forces

Manitoba Hydro

Design Review Data

30 **Short-Circuit Forces and**

Coil Name (eg HV, SV)

d **Short-Circuit Forces and**

Axial Compressive Force
1 maximum inside coil
2 at Top of Coil
3 at Centre of Coil
4 at Bottom of Coil

Axial Compressive Stress on Spacers
5 Stress
6 Withstand of Spacer

Critical Axial Tilting Stress or Force
7 Stress
8 Withstand

Axial Bending Stress between Spacers (Beam)
9 Stress
10 Withstand

Radial Buckling Stress (Hoop)
11 Stress
12 Withstand

Free-Buckling
13 Free-Buckling Withstand
14 based on #Epoxied S

Radial Bending Stress between Duct Sticks (Beam)
15 Stress
16 Withstand

Fischer's Radial Bending Stress (Forced Buckling) between Duct Sticks (Beam)
17 Stress
18 Withstand

Manitoba Hydro

Design Review Data

30 **Short-Circuit Forces and**

Coil Name (eg HV, SV)

e **Conductor Characteristics**

1	Minimum Proof Stress
2	Offset
3	ANSI Temperature for 2 second fault
4	Epoxy Softens?
5	Modulus of Elasticity Without Stress : E_0
6	Tangetial Modulus of Elasticity : E_T
7	E_T used to calculate stress?
8	If necessary, explain
9	Elasticity used

f **Magnetic Centre-line Offs**

1	Elongation or Displacement?
2	Amount of offset
3	Coils are offset?
4	Exceptions or Comments?

Manitoba Hydro

Design Review Data

30 **Short-Circuit Forces and**

Coil Name (eg HV, SV)

g **End Thrust**

1		**Case 1**
	a	Fault Type
	b	Fault on Circuit
	c	DTC Tap Pos
	d	LTC Tap Pos
	e	S/P Pos
	f	Manufacturer's Normal Offset
	g	Top
	h	Bottom
	i	Sum Top
	j	Sum Bottom
2		**Case 2**
	a	Fault Type
	b	Fault on Circuit
	c	DTC Tap Pos
	d	LTC Tap Pos
	e	S/P Pos
	f	**0.5% Offset**
	g	Top
	h	Bottom
	i	Sum Top
	j	Sum Bottom
3		**Case 3**
	a	Fault Type
	b	Fault on Circuit
	c	DTC Tap Pos
	d	LTC Tap Pos
	e	S/P Pos
	f	**No Offset**
	g	Top
	h	Bottom
	i	Sum Top
	j	Sum Bottom
4		**Case 4**
	a	Fault Type
	b	Fault on Circuit
	c	DTC Tap Pos
	d	LTC Tap Pos
	e	S/P Pos
	f	Amount of Offset
	g	Top
	h	Bottom
	i	Sum Top
	j	Sum Bottom

Design Review Data

30 **Short-Circuit Forces and**

h **Clamping Structure**

1 Design Criteria

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Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

31 **Cables, Rods, Bars & Grounds**

Data is based on 85°C unless otherwise specified.
This sheet is designed for flexibility. Not every section needs to be completed: only the relevent sections.

e **Top-to-Bottom Connections**

		From										
		To										
1	Cable/Rod/Bar Size	MCM										
2	#Cables in Parallel											
3	Cable Ampacity	A										
4	Cable Insulation	mm										
5	Brazed or Crimped?											
6	#Bolts											
7	How is Lead/Cable supported.											
8	Distance between supports	mm										

Comments:

f **T-Connections**

		From										
		To										
1	Cable/Rod/Bar Size	MCM										
2	#Cables in Parallel											
3	Cable Ampacity	A										
4	Cable Insulation	mm										
5	Brazed or Crimped?											
6	#Bolts											
7	How is Lead/Cable supported.											
8	Distance between supports	mm										

Comments:

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Design Review Data

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31 Cables, Rods, Bars & Grounds

Data is based on 85°C unless otherwise specified.

This sheet is designed for flexibility. Not every section needs to be completed: only the relevent sections.

g Delta-Connections

	From										
	To										
1 Cable/Rod/Bar Size	MCM										
2 #Cables in Parallel											
3 Cable Ampacity	A										
4 Cable Insulation	mm										
5 Brazed or Crimped?											
6 #Bolts											
7 How is Lead/Cable supported.											
8 Distance between supports	mm										

Comments:

h Bushing-Connections

	From										
	To										
1 Cable/Rod/Bar Size	MCM										
2 #Cables in Parallel											
3 Cable Ampacity	A										
4 Cable Insulation	mm										
5 Brazed or Crimped?											
6 #Bolts											
7 How is Lead/Cable supported.											
8 Distance between supports	mm										

Comments:

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Design Review Data

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31 **Cables, Rods, Bars & Grounds**

Data is based on 85°C unless otherwise specified.

This sheet is designed for flexibility. Not every section needs to be completed: only the relevent sections.

i **Internal Ground Connections**

#	Item	Unit										
1	Grounded Item											
2	Terminated at											
3	Cable Size	MCM										
4	Cable Ampacity	A										
5	Cable Insulation	mm										
6	Brazed or Crimped?											
7	#Bolts											
8	How is Cable supported.											

Comments:

j **External Ground Connections**

This includes only those that were brought-out through a bushing.

#	Item	Unit										
1	Grounded Item											
2	Lead Block Manufacturer											
3	Catalog#											
3	Cable Size	MCM										
4	Resistor	ohms										
5	Resistor Power Rating	W										
6	Weather-tight box?	T/F										

Comments:

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Design Review Data

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31 **Cables, Rods, Bars & Grounds**

Data is based on 85°C unless otherwise specified.
This sheet is designed for flexibility. Not every section needs to be completed: only the relevent sections.

k **Crimped Connectors**

	At											
1	Type											
2	Size											
3	Ampacity	A										
4	#Bolts											

L **Brazed Connectors**

	At											
1	Type											
2	Ampacity	A										
3	#Bolts											

Comments:

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31 **Cables, Rods, Bars & Grounds** Data is based on 85°C unless otherwise specified.
This sheet is designed for flexibility. Not every section needs to be completed: only the relevent sections.

m **General**

1 [ ] Has the lead support structure been designed to proven design concepts that have been tested?

Comments:

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

32 Bushings, Auxilliary Transformer, PT's and CT's

Data is based on 85°C unless otherwise specified.

Most of this information is not required if it is, or will be provided elsewhere.
For example:
on outline, legend, nameplate, schematic or accessory drawings;
if bushings and VT are per specification model numbers.

a Bushings

#	Item	Unit										
1	Terminals											
2	Manufacturer											
3	Catalog#											
4	Voltage Class	kV										
5	Voltage Class	kV LIL										
6	Ampacity	A										
7	Connection Type											
8	#Bolts											
9	Shield?											
10	Special Basket Insulation?	Y/N										
11	How is Lead/Cable supported.											
	Internal Bushing Connector											
12	Manufacturer											
13	Catalog#											
14	Ampacity	A										
	External Bushing Connector											
15	Manufacturer											
16	Catalog#											
17	Ampacity	A										
17	Type of Conductor											

Comments:

b Auxilliary Transformer

#	Item	Unit	
1	Manufacturer		
2	Catalog or SO#		
3	Drawing#		
4	Power Rating	kVA	
5	Test Standard		

#	Item	Unit	Primary	Secondary
6	Voltage	kV		
7	Class	kV LIL		
8	Ampacity	A		
9	Lead Type			
10	Lead Size	Ga		

Secondary Lead Block

#	Item	
11	Manufacturer	
12	Catalog#	

13 [ ] Is it tested one LIL class higher than required by main transformer?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

32 **Bushings, Auxilliary Transformer, PT's and CT's** Data is based on 85°C unless otherwise specified.

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

32 **Bushings, Auxilliary Transformer, PT's and CT's** Data is based on 85°C unless otherwise specified.

c **Potential Transformer**

1	Manufacturer			
2	Catalog or S/N			
3	Drawing#			
4	Power Rating	kVA		
			Primary	Secondary
5	Voltage	kV		
6	Class	kV LIL		
7	Ampacity	A		
8	Lead Type			
9	Lead Size	Ga		
	Secondary Lead Block			
10	Manufacturer			
11	Catalog#			
12	Test Standard			

13 Is it tested one LIL class higher than required by main transformer?

d **Current Transformers**

1	Manufacturer			
2	Test Standard			
	Secondary			
3	Lead Type			
4	Lead Size	Ga		
5	Ampacity	A		
	Wire Runs			
6	Type of Wire			
	Connections			
7	lead to wire run			(Singled-Crimp, Double-Crimp)
8	wire run to block			(Crimped, Crimped and bolted)

8 Describe how the CT's are mounted.
Are they removeable without de-tanking the main transformer?
How are the internal leads supported?

e **General**

Have these supporting transformers been designed to proven design concepts that have been tested?

Manitoba Hydro

Design Review Data

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32 **Bushings, Auxilliary Transformer, PT's and CT's** Data is based on 85°C unless otherwise specified.

Manitoba Hydro

Design Review Data

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33 **De-energised Voltage Tapchanger** on **Main Transformer**

Duplicate this sheet if more DTCs

a **Type**

1 Manufacturer
2 Full Model#
3 Drive

b **Connections**

1 DTC in series with and carries same current as which winding (HV,LV,SV,CV,Line)?
2 Include a rating plate or sketch showing the exact connections between windings and the switch.

3 #Phases
4 Selector Type
5 Overall Type

c **Voltage Rating**

			Voltage to Ground		Voltage between terminals	
			Calculated	Limit	Calculated	Limit
1	Operating	kV				
2	Power Frequency	kV rms				
3	Impulse	kV LIL				

d **Current Rating**

			Calculated	Limit	
1	Rated	A			catalog rating
2	Overload	A			typically at 120% current and/or at 20°C contact rise

3 The DTC is suitable for the Manitoba Hydro loading per as described in the Technical Specification.

e **General**

Is a full test report available for the switch including temperature rise and short-circuit tests?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

34 **On-Load Tapchanger (LTC)** on **Main Transformer**

Duplicate this sheet if more LTCs

a **On-Load Tapchanger A (LTCA)**

1 Manufacturer
2 Full Model#
3 Drive

b **Connections**

1 LTC in series with and carries same current as which winding (HV,LV,SV,CV,Line)?
2 Include a rating plate or sketch showing the exact connections between windings and the switch.

Circuit
3 #Phases
4 Selector Type
5 Diverter Type
6 Overall Type
7 Series Transformer Used?

3 Contact Life Expectancy thousand operations at full load

c **Voltage Rating**

			Voltage to Ground		Voltage between terminals	
			Calculated	Limit	Calculated	Limit
1	Operating	kV				
2	Power Frequency	kV rms				
3	Impulse	kV LIL				

d **Current Rating**

			Calculated	Limit	
1	Rated	A			catalog rating
2	Overload	A			typically at 120% current or at 20°C contact rise

3 The DTC is suitable for the Manitoba Hydro loading per as described in the Technical Specification.

e **Recovery Voltage without Tie-in Resistors or Capacitors** at 110% voltage or MCOV

			Calculated	Limit
1	Recovery Voltage	kV		
2	Capacitive Current	mA		

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

34 **On-Load Tapchanger (LTC)** on **Main Transformer**

f **Recovery Voltage with Tie-in Resistors or Capacitors** at 110% voltage or MCOV

			Calculated	Limit	
1	Recovery Voltage	kV			at 110% voltage or MCOV
2	Capacitive Current	mA			

g **Tie-In Resistors**

1 Manufacturer
2 Model#
3 Designed by

			Quantity	Resistance	
4	Resistors	k-ohms			Total Effective Resistance k-ohms

			Instant.	Continuous	
5	Calc. Power Dissipation	W			The power rating is at the appropriate oil temperature.
6	Limit	W			
7	Voltage per Resistor	kV LIL			
8	Limit	kV LIL			

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

34 **On-Load Tapchanger (LTC)** on **Main Transformer**

h **Tie-In Capacitors**

1 Manufacturer
2 Model#
3 Designed by

			Quantity	Capacitance	
4	Capacitors	μF			Total Effective Resistance μF

			Instant.	Continuous	
5	Calc. Power Dissipation	W			The power rating is at the appropriate oil temperature.
6	Limit	W			
7	Voltage per Capacitor	kV LIL			
8	Limit	kV LIL			

i **Connection of Tie-in Resistors or Capacitors**

1 Describe the tie-in resistor or capacitor connections (eg 3 x 75 k-ohm series connected between K and 9).

2 Continuously or Momentarily connected?
If momentarily connected, desribe mechanism or specify ABB or MR type?

3 If the tie-in resistors or capacitors are not built-in to the gear, describe where they are physically located.
Describe accessibility to resistors or capcitors (from handhole, space available, shielded by pressboard, etc).

j **General**

Is a full test report available for the switch including temperature rise and short-circuit tests?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

35 Other De-energised Switch on **Main Transformer**

Duplicate this sheet if more switche

a Type

1	Purpose		(eg Reversing,Selector,Switch in/out)
1	Manufacturer		
2	Full Model#		
3	Drive		

b Connections

1 [ ] Switch in series with and carries same current as which winding (HV,LV,SV,CV,Line)?

2 Include a rating plate or sketch showing the exact connections between windings and the switch.

3	#Phases	
4	Selector Type	

c Voltage Rating

			Voltage to Ground		Voltage between terminals	
			Calculated	Limit	Calculated	Limit
1	Operating	kV				
2	Power Frequency	kV rms				
3	Impulse	kV LIL				

d Current Rating

			Calculated	Limit	
1	Rated	A			catalog rating
2	Overload	A			typically at 120% current and/or at 20°C contact rise

3 [ ] The switch is suitable for the Manitoba Hydro loading per [ ]
as described in the Technical Specification.

e General

[ ] Is a full test report available for the switch including temperature rise and short-circuit tests?

Manitoba Hydro

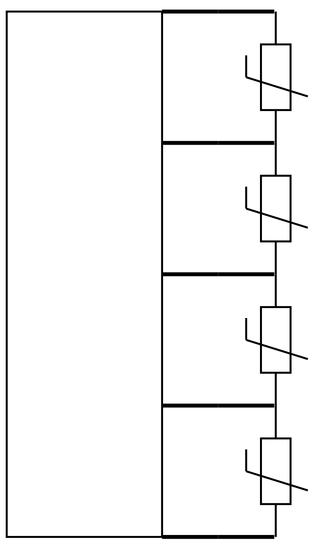
Design Review Data

36 Metal-Oxide Varistors

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

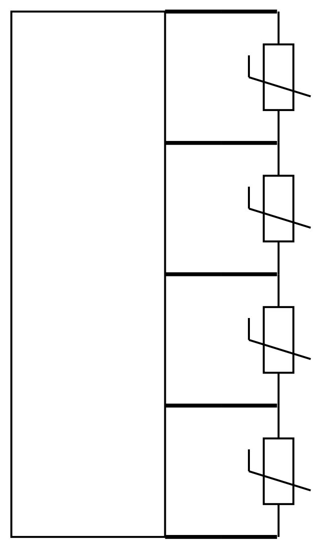
a Connections Sketch

DTC Tap Lead#



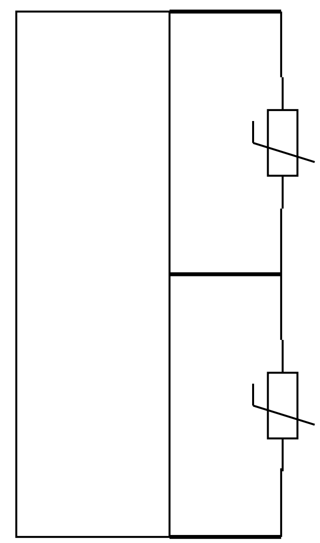
Quantity of disks

LTC Tap Lead#



Quantity of disks

Current Limiting Reactor



Quantity of disks

b Location & Accessibility

1 Describe where the varistors are physically located.
2 Describe accessibility to disks (from handhole, space available, shielded by pressboard, etc).

c Type

1	Manufacturer	
2	Model#	
3	Diameter mm	

4 [ ] The disks are designed for use with oil?

d Design Votage Limits per Disk

1	Operating	kV	
2	Power Frequency	kV rms	
3	Impulse	kV LIL	

4 [ ] Do the disks conduct during the switching surge test and affect its waveshape?

Manitoba Hydro

Design Review Data

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37 **Stray Flux Control by Shunts or Deflectors** **Main Transformer**

a	Location	HV Wall	LV Wall	LTC Wall	Cabinet Wall	Clamps	Core Leg	
b	Material							
c	Quantity							
d	Width							mm
e	Height/Length							mm
f	Thickness							mm
g	Centreline Spacing							mm
h	Avg Flux Density							T at

Provide a shunt assembly drawing.
For transformers larger than 60 MVA, or with high current leads (eg interwound taps connected top-to-bottom):
provide a tank layout sketch showing coils, core, clamps, leads, tank wall and shunts.

i Are shunts isolated and grounded at one point only? (**Provide details if not.**)
j Do shunts carry any significant circulating current?

k Details:

L **General**
Have these been designed to proven design concepts that have been tested?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

38 **Tank Design** This sheet may have a mixture of metric and imperial dimensions

a **Skids**

1			Material
2		mm	Material Thickness
3			The base and skids are suitable for jacking and pulling in all directions?

b **Tank Floor (Base)**

1			Material
2		mm	Material Thickness
3			The base is one piece?
4		If not, how is it welded?	
5			The base is suitable for jacking and pulling in all directions?

c **Tank Walls**

1			Material
2		mm	Material Thickness
3			Tank wall welds do not occur behind the stiffeners?
4		mm	Maximum allowable deflection of the tank walls during full vacuum.

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Design Review Data

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38 **Tank Design** This sheet may have a mixture of metric and imperial dimensions

d **Tank Walls Stiffeners**

1 [ ] Internal stiffeners, other than gussets at the bottom of the tank wall, are not used?
2 If they are used, provide details.

HV Side Wall Stiffeners
3 [ ] Type
4 [ ] Material

LV Side Wall Stiffeners
5 [ ] Type
6 [ ] Material

Control Cabinet End Wall Stiffeners
7 [ ] Type
8 [ ] Material

Conservator End Wall Stiffeners
9 [ ] Type
10 [ ] Material

11 [ ] Stiffeners are empty (ie they are not filled with sand or some other material)?
12 [ ] If not empty, what is the fill material?
13 [ ] If not empty, what is the weight of the fill material?
14 [ ] Sealed stiffeners are equipped with drains and plugs?
15 [ ] Open stiffeners prevent water and debris from collecting?

Manitoba Hydro

Design Review Data

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38 **Tank Design** This sheet may have a mixture of metric and imperial dimensions

e **Top Weld Flange**

1		mm	Material Width
2		mm	Material Thickness
3			Metal gasket stops are provided?
4			Gasket stops are sized for the gasket thickness?
5			A flame stop for welding is provided?

f **Tank Cover**

1			Material
2		mm	Material Thickness
3			Cover Style
4		degrees	Cover Slope
5			Entire transformer tank cover is sloped?
6	If not, which part is not sloped (eg area for in-tank LTC)?		
7		mm	Maximum allowable deflection of the cover during full vacuum.

g **Cover Stiffeners**

1		Type
2		Material
3		Internal stiffeners are used?
4		External stiffeners are **not** used?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

38 **Tank Design** This sheet may have a mixture of metric and imperial dimensions

h **Bushing Turrets**

Removable bushing turrets?

1		HV
2		HVN
3		LV
4		LVN
5		TV

Material for High Current Bushing Turrets (>2000 Amps)

	HV Turret		Grade if Stainless Steel
6		Flange	
7		Turret	
8		3-phase Turret Box	
9		Insert between 3-phase Turrets	

	LV Turret		Grade if Stainless Steel
10		Flange	
11		Turret	
12		3-phase Turret Box	
13		Insert between 3-phase Turrets	

	TV Turret		Grade if Stainless Steel
14		Flange	
15		Turret	
16		3-phase Turret Box	
17		Insert between 3-phase Turrets	

i **Jack Steps**

1			Material
2		mm	Material Thickness
3			Jack step design requires one or two jack steps to support the total weight of the assembled transformer?
4			If not, explain why and how much is supported.

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Design Review Data

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38 Tank Design

This sheet may have a mixture of metric and imperial dimensions

j Main Conservator Tank

1		mm	Diameter
2		mm	Length
3		litres	Cylinder Volume
			Oil Volume at
4		litres	110°C
5		litres	105°C
6		litres	20°C
7		litres	-50°C
8			Breather Type
9			Conservator is suitable for full vacuum?
10			The conservator slopes towards the main sections manhole end?
11			The fill pipe protrudes into the tank per MH spec?
12			The drain valve is at the lowest end?
13			The connection pipe protrudes into the conservator tank for sump?

k LTC Conservator Tank

1		mm	Diameter
2		mm	Length
3		litres	Cylinder Volume
			Oil Volume at
4		litres	110°C
5		litres	105°C
6		litres	20°C
7		litres	-50°C
8			Breather Type
9			Conservator is suitable for full vacuum?
10			The conservator slopes towards the main sections manhole end?
11			The fill pipe protrudes into the tank per MH spec?
12			The drain valve is at the lowest end (if separate conservator)?
13			The connection pipe protrudes into the conservator tank for sump?

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38 **Tank Design** This sheet may have a mixture of metric and imperial dimensions

L **Piping and Gas Collection**

1		Type
2		Material
		Bushing turret has gas deflector or is piped
3		HV
4		HVN
5		LV
6		LVN
7		TV
		Cover manholes and handholes
8		Piped or filled to inhibit gas being trapped?
		In-tank LTC turret
9		Piped?
10		Bell jar design?
		Bleeders are provided on
11		bushing turrets?
12		radiator bank headers?
13		LTC turret?

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38 **Tank Design** This sheet may have a mixture of metric and imperial dimensions

m **Internal Shipping Braces**

1 O-ring gaskets are set in grooves?

1 Internal shipping braces are used?
2 Clamps braced for shipping?

n **Gaskets**

1 Bushing flange to turret has inner and outer gasket stops for non-O-ring gaskets for bushings > 66 kV?

2 All other non-O-ring gaskets have gasket stops? If not, explain.

3 Describe the gasket stop.

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38 **Tank Design** This sheet may have a mixture of metric and imperial dimensions

o **Paint**

Internal

1		Manufacturer
2		Type
3		Colour

4		The inside of the tank is painted?
5		The clamping structure is painted?
6		The inside of the conservator tank is painted?

External Primer

7		Manufacturer
8		Type

External Primer

9		Manufacturer
10		Type
11		Colour

12 Describe the procedures used to prepare surfaces for painting.
Are special coatings used? If so, describe them.

p **Other Comments**

q **General**

Have these been designed to proven design concepts that have been tested?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

39 Cooling Equipment

a Radiators or Coolers

1	Manufacturer		
2	Model		
3	Drawing #		
4	Total Quantity		(n+1 for coolers)
5	Quantity per Rad Bank		
6	One (1) Extra Cooler?		
7	All coolers active?		
8	Header Spacing		mm
9	Width of Panel		mm
10	# of Panels		
11	Oil Capacity per rad		litres
12	Rad bank oil capacity		litres
13	Bleeder Size		mm
14	Drain Size		mm

15 Bleeder and drain plugs are provided on each radiator/cooler?

Comments:

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Design Review Data

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39 Cooling Equipment

b **Fans (if applicable)**

1	Manufacturer		
2	Model		
3	Total Quantity		
4	Quantity per Rad Bank		
5	Diameter		mm or inch
6	Blade Pitch		degrees
7	Volume Flow Rate		CFM
8	Fan Mounting		(horizontal,vertical)
	Motor		
9	#phases		
10	Voltage		V (120,208,240,120/208)
11	Loss		W
12	Full-Load Current		A
13	Locked-Rotor Current		A

14 Fan blades are mounted inside a shroud to channel the air flow?

Comments:

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

39 Cooling Equipment

c Pumps (if applicable)

1	Manufacturer		
2	Model		
3	Pump Type		(axial flow,centrifugal flow)
4	Total Quantity		
5	Quantity per Rad Bank		
6	Impeller Diameter		mm or inch
7	Type of bearings		(sleeve,ball)
8	Volume Flow Rate		litres/min
9	Oil is pumped into		(tank,windings)
	Motor		
10	#phases		
11	Voltage		V (120,208,240,120/208)
12	Loss		W
13	Full-Load Current		A
14	Locked-Rotor Current		A

15 A bearing-wear system (not electronic monitor) is provided?

16 Oil is pumped into the windings without the use of a baffle across the entire tank?
If a baffle is used, provide details.

17 Describe the path of how the oil is forced into the coils.

Design Review Data

39 Cooling Equipment

c **Pumps (if applicable) cont.**

18 If a pump fails, can oil re-circulate back through the dead pump?
What, if anything, prevents this backfeed (eg flapper valves, centrifigal pumps, large cooler restriction).

19 Is there any loss of MVA capacity on the loss of one pump? If so, how much.

20 How does the loss of one or more pumps affect the winding hotspot gradient.

21 Provide oil flow schematic showing oil flow:
without any pumps operating (if applicable);
with n pumps operating;
with n+1 pumps operating.

Comments:

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

39 **Cooling Equipment**

d **Radiator or Cooler Valves**

1 Manufacturer

2 Model

3 Each radiator or cooler has two valves (inlet and outlet)?

Comments:

e **Pump Valves (if applicable)**

1 Manufacturer

2 Model

3 Each pump has two valves (inlet and outlet)?

Comments:

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

39 Cooling Equipment

f Header (if applicable)

1 [ ] Bleeder and drain plugs are provided on each header?
2 Bleeder Size [ ] inch
3 Drain Size [ ] inch

4 [ ] Each header has a valve on each inlet and outlet?

Comments:

g General

[ ] Has this been designed to proven design concepts that have been tested?

Manitoba Hydro

Design Review Data

Rev#: 0 (2016/08/01) Version 2.0.7 (2016 09 10)

40 Control Box and Wiring

a **Control Box**

1	Manufacturer	
2	Material	
3	Size	

4 [ ] The control box is weatherproof?

5 [ ] The control box meets NEMA-4 requirements?

b **Wiring**

Comments

41 Operation, Safety and Maintenance

a **Operating Conditions**

[ ] The contractor has taken into account the operating conditions at site and the equipment is capable of operating at -50 to 40°C ambient?

b **Safety Requirements**

[ ] The contractor has taken into consideration the safety requirements as defined by the specification and others that are required to safely work on the unit during normal maintenance procedures?

c **Maintenance Requirements**

1 [ ] The contractor has taken into consideration the maintenance requirements of the unit, the components and the accessories to ensure easy access to those that require frequent maintenance?

2 [ ] The contractor has defined special maintenance procedures and tools that are required to carry out the work?

3 [ ] The contractor has provided in the Maintenance Manual, all information sheets on all components so Manitoba Hydro can carry out the work without dependance on the contractor or sub-supplier?

Minimum Standards for Drawings Produced and Submitted by Fabricators, Manufacturers And Construction Companies

Purpose

All drawings submitted to Manitoba Hydro shall conform to these standards to ensure consistency with the corporation's internally produced drawings including numbering, file naming, distribution and archival system which is paperless and cannot process any hardcopies. Preliminary drawings issued for discussion or reviews do not need to conform to these standards.

Definitions

Collaboration Tool – software tool used to collaborate with other people internal and external to the corporation (ie – *SharePoint®)*

Controlled Document – any record that requires a Corporate System Classification Index (SCI) number or sequential number to track revisions of the work

Authentication – The sealing of engineer drawings meeting the requirements of Engineers Geoscientists Manitoba guideline "*Authentication of Hardcopy and Electronic Professional Documents*"

eSealed – electronically authenticated engineering drawing meeting the requirements of the Engineers Geoscientists Manitoba guideline *"Authentication of Hardcopy and Electronic Professional Documents" and clause "1.1.5 Electronic Seal"* therein

PDF/A – standardized version of PDF meeting PDF/A - 1b ISO 19005-1 Level B, required for the preservation of archived electronic document. ConsignO software from Notarius shall be used for verifying compliance.

Hybrid AutoCAD drawings – AutoCAD drawings enhanced with digital images imported by Raster Design to create raster/vector drawings

Hardcopy – paper, Mylar, anything physical or printed out

1.0 Drawing Format and Submissions

If drawings are submitted not meeting this specification they will be returned for re-submission at no extra cost to Manitoba Hydro. Hardcopy drawings will not be accepted.

All drawings shall be submitted in PDF/A format meeting requirements under *Definitions* and 2.0 herein along with their associated .dwg files as specified below via email, collaboration tool or disk.

Unless otherwise specified in the tender documents all drawings are to be computer generated in *Autodesk® AutoCAD* .dwg electronic format. They are to meet 3.0 and 4.1 herein with an electronic drawing validation printout as per 4.1.4 herein.

If hybrid AutoCAD drawings containing bitonal/black and white raster data are specified/required they must be produced *in Autodesk® AutoCAD* .dwg format with their *TIFF® file*s embedded into the .dwg using *Autodesk® RasterDesign* . If hybrid AutoCAD drawings containing colour raster data are specified/required they must be produced in *Autodesk® AutoCAD* .dwg format with their *TIFF® file*s attached using *Autodesk® AutoCAD - Autodesk® RasterDesign* is not required.

The seal box of all .dwg files must be left blank. However, all other title block boxes should show signatures/initials to reflect what is shown on the associated PDF/A.

If drawings are revised after initial submission due to design changes an appropriate revision description must be added to the title block and the revision number updated.

All submissions must be sent to Manitoba Hydro's contact, as specified in the tender documents, complete with a drawing transmittal containing:

a) The fabricator, manufacturer or construction company Name
b) Project Name
c) Drawing, Sheet and Revision Numbers as per 3.1 herein
d) Drawing Title
e) Date of Submission
f) RFP/RFQ/SPEC Purchase Order Number

2.0 Drawings requiring Engineer Authentication

Engineering drawings requiring authentication as per Engineers Geoscientists Manitoba act http://web2.gov.mb.ca/laws/statutes/ccsm/e120e.php must be eSealed as per *Definitions* herein.PDF/A's must show the image of Engineers Geoscientists Manitoba member seal complete with signature and date, and applicable "*Certificate of Authorization*" or "*Consulting*" stamps. Their authentication must also show on printed or plotted hardcopy of the drawing.

ALTERNATIVELY, temporary licensee's of Engineers Geoscientists Manitoba must eSeal as per *Definitions* herein. However, the drawing must show the image of his or her manual seal issued by their professional association, validated by signing the document in the vicinity of the seal, marked with his or her license number and its expiry date directly below the seal, and indicate the date upon which it was affixed. Their authentication must show on printed or plotted hardcopy of the drawing.

As per Engineers Geoscientists Manitoba act, by laws and guidelines noted herein all engineering drawings must have every revision authenticated.

3.0 Drafting standards

All drafting shall conform to the *National CAD Standard* (http://www.nationalcadstandard.org/) unless otherwise specified by Manitoba Hydro.

3.1 Drawing numbering, file naming and revision convention

3.1.1 All drawings submitted must be numbered in accordance with Manitoba Hydro drawing number system (SCI) in order to be compatible with the drawing archival system.

3.1.2 Electronic PDF/A files must be named similar to the drawing number:

Dwg # 1-00100-DD-99999-0001 Sht. 0001 to be filed as
1-00100-DD-99999-0001 0001_PDF.pdf

3.1.3 Electronic .dwg type files must be named similar to the drawing number:

Dwg # 1-00100-DD-99999-0001 Sht. 0001 to be filed as
1-00100-DD-99999-0001 0001.dwg for *Autodesk® AutoCAD* files

3.1.4 Electronic .tif type files for Hybrid Drawings must be named similar to the drawing number:

Dwg # 1-00100-DD-99999-0001 Sht. 0001 to be filed as

1-00100-DD-99999-0001 0001_REF1.tif for *TIFF®* images

3.1.5 Drawing numbers will be supplied by Manitoba Hydro. However, drawing titles must first be submitted as per 1.4 herein to Manitoba Hydro's contact, as specified in the tender documents, for approval and acceptance.

3.1.6 Sheet numbers are to be 4 digits and revision numbers to be 2 digits, both to show at least a zero for each digit. The first issue of drawings ready for construction, fabrication and/or archiving shall show the revision number 00. Alpha digits are **not** acceptable unless specified by Manitoba Hydro's contact as specified in the tender documents.

3.2 Drawing titles

3.2.1 All drawing titles shall be approved by Manitoba Hydro's contact, as noted in the tender documents, in writing or by e-mail prior to issuing the drawings. They shall be descriptive but concise. The composition of a drawing title shall usually occupy three lines, but never more than four lines.

Example: POWERHOUSE
13.8 kV GENERATOR CIRCUIT BREAKER
CONTROL PANEL
WIRING DIAGRAM

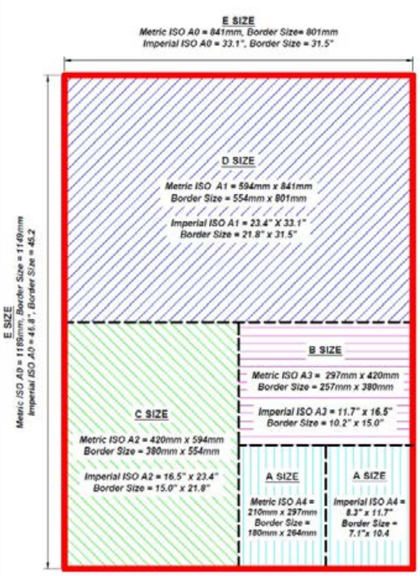
Line 1 ... Area of the Work
Line 2 ... Specific subject
Line 3 ... Name of equipment or system (if necessary)
Line 4 ... Type of drawing

3.2.2 The name of the facility must appear in the box directly above the title box.

3.3 Drawing sizes

3.3.1 Drawing sizes shall be selected from the following table:

MANITOBA HYDRO DRAWING SHEET SIZES & PLOT SETTINGS FOR NEW BORDERS



PLOT SETTINGS FOR BORDERS IN MODEL SPACE
Note: N.T.S. (1:1) Scale

METRIC DRAWINGS			IMPERIAL DRAWINGS		
Border Size	Paper Size	Plot Scale	Border Size	Paper Size	Plot Scale
A SIZE	ISO A4 - 210 x 297	1:1, 1 mm = 1 unit	A SIZE	ISO A4 - 210 x 297	1:1, 1 Inches = 1 unit
B SIZE	ISO A3 - 297 x 420	1:1, 1 mm = 1 unit	B SIZE	ISO A3 - 297 x 420	1:1, 1 Inches = 1 unit
C SIZE	ISO A2 - 420 x 594	1:1, 1 mm = 1 unit	C SIZE	ISO A2 - 420 x 594	1:1, 1 Inches = 1 unit
D SIZE	ISO A1 - 594 x 841	1:1, 1 mm = 1 unit	D SIZE	ISO A1 - 594 x 841	1:1, 1 Inches = 1 unit
E SIZE	ISO AO - 841 x 1189	1:1, 1 mm = 1 unit	E SIZE	ISO AO - 841 x 1189	1:1, 1 Inches = 1 unit

PLOT SETTINGS FOR BORDERS IN PAPER SPACE
Note: N.T.S. (1:1) Scale

METRIC DRAWINGS			IMPERIAL DRAWINGS		
Border Size	Paper Size	Plot Scale	Border Size	Paper Size	Plot Scale
A SIZE	ISO A4 - 210 x 297	1:1, 1 mm = 1 unit	A SIZE	ISO A4 - 210 x 297	1:1, 1 Inches = 1 unit Custom, 1 mm = .03937 unit
B SIZE	ISO A3 - 297 x 420	1:1, 1 mm = 1 unit	B SIZE	ISO A3 - 297 x 420	1:1, 1 Inches = 1 unit Custom, 1 mm = .03937 unit
C SIZE	ISO A2 - 420 x 594	1:1, 1 mm = 1 unit	C SIZE	ISO A2 - 420 x 594	1:1, 1 Inches = 1 unit Custom, 1 mm = .03937 unit
D SIZE	ISO A1 - 594 x 841	1:1, 1 mm = 1 unit	D SIZE	ISO A1 - 594 x 841	1:1, 1 Inches = 1 unit Custom, 1 mm = .03937 unit
E SIZE	ISO AO - 841 x 1189	1:1, 1 mm = 1 unit	E SIZE	ISO AO - 841 x 1189	1:1, 1 Inches = 1 unit Custom, 1 mm = .03937 unit

3.4 Drawing limits

3.4.1 Drawing limits must be set as follows. The lower limit must be set to 0,0 and the upper limits to the plotting scale factor multiplied by the coordinates shown below for the particular drawing border size and by a metric conversion factor (25.4), if applicable.

- A (A4) - 8.3, 11.8

- B (A3) - 11.7, 16.5
- C (A2) - 23.4, 16.5
- D (A1) - 33.1, 23.4
- E (A0) - 46.8, 33.1

All information in the drawing shall be within these limits.

3.5 Scanning of manually drafted drawings

3.5.1 When creating hybrid drawings, manually drafted drawings shall be scanned at maximum 300 DPI. They shall be saved as tiff images and numbered as per 3.1 herein.

3.6 Drawing borders and setup

3.6.1 The fabricator, manufacturer or construction company shall use the drawing borders and AutoLISP setup programs supplied by Manitoba Hydro. An application program for installing the drawing borders and the AutoLISP program for setting up the drawing in Manitoba Hydro format will be provided.

3.6.2 The drawing borders may not be modified in any way. The addition of the fabricator, manufacturer or construction company name, company logo and approval block should never affect the title block in any way.

3.7 Line widths

3.7.1 The plotted line widths most commonly used shall be 0.25 mm, 0.35 mm, 0.50 mm, and 0.70 mm. Manitoba Hydro requires that polylines, rather than plotter pen mapping, be used to obtain line weights. **Manitoba Hydro will not accept drawings that require custom CTB files.**

3.8 Lettering

3.8.1 All lettering shall be done using the ARIAL and ARIAL (using the bold font style) as distributed with AutoCAD. Required fonts are on the Manitoba Hydro Electronic Standards (MHEDS) CD. AutoCAD .shx format files, with the exception of the afore mentioned lettering fonts, shall not be used. The minimum plotted lettering height for sheet sizes ‘C’ and less shall be 2.5mm (0.10”), and for sheets sizes ‘D’ and greater shall be 3.0 mm (0.12").

3.9 Scale

3.9.1 In general, all dimensioned drawings shall be drawn to scale. However, the title block shall only show the scale as “NTS”.

3.10 Hatching

3.10.1 In order to reduce the size of drawing files, AutoCAD hatching shall be used sparingly.

3.11 Time/Date stamps

3.11.1 If the fabricator, manufacturer or construction company uses a system that inserts a time or date stamp anywhere on the drawing to record the last time that the drawing was edited or plotted, the stamp shall be removed before the final drawing is submission to Manitoba Hydro in electronic format.

3.12 Electronic drawing transmittal

3.12.1 All electronic drawings shall be submitted to Manitoba Hydro zoomed to extents, limits and all layers turned on. As well, all unused blocks in the drawing shall be purged.

3.13 Multiple layouts

3.13.1 All electronic drawings submitted to Manitoba Hydro shall have only one layout per *Autodesk® AutoCAD* .dwg.

3.14 Binding XRef's

3.14.1 All electronic drawings submitted to Manitoba Hydro shall have any xref'ed drawing bound into the current drawing file using the **INSERT** type of the XBIND command within the *Autodesk®* drafting application.

4.0 Software

Unless otherwise requested, all electronic drawings submitted to Manitoba Hydro shall be in *Autodesk® AutoCAD* .dwg format. All raster images shall be submitted in .tif format. If the fabricator, manufacturer or construction company uses software other than AutoCAD then the drawings shall be translated to AutoCAD .dwg format prior to submission. The fabricator, manufacturer or construction company shall use a version of AutoCAD software that provides 100% bi-directional compatibility with the version in use at Manitoba Hydro. If, during the course of the project, Manitoba Hydro or the fabricator, manufacturer or construction company upgrades to a newer release of the software, the external agency shall ensure that 100% bi-directional compatibility is maintained.

Bi-directional compatible shall mean that electronic drawings shall be achievable and manipulatable, in the Purchaser's computerized drawing system without any modification by the Purchaser.

The fabricator, manufacturer or construction company shall also check the electronic drawings prior to submission with the Manitoba Hydro Title Block

Validator program supplied by Manitoba Hydro. A printout of the program's output file *Validation Results.log* shall be forwarded to Manitoba Hydro.

Other formats, if specified, shall follow the standards as outlined herein.

4.1 Autodesk® AutoCAD

4.1.1 The latest version of *Autodesk® AutoCAD* as communicated by Manitoba Hydro in use at the time of initiating the Work shall be used unless otherwise specified.

4.1.2 Drawing installation software setup complete with drawing borders, title block and ***Title Block Validator*** program will be supplied by Manitoba Hydro on request. A selection of standard drawing sizes and attributes are provided in this setup. Manitoba Hydro will provide assistance in complying with its standard setup as required.

DRAWING BORDERS AND TITLE BLOCKS MUST NOT BE MODIFIED, EXPLODED, RENAMED OR, OTHERWISE; MANITOBA HYDRO'S DRAWING SETUP WILL NOT FUNCTION PROPERLY.

4.1.3 The fabricator, manufacturer or construction company's name, company logo, approval block, drawing number and miscellaneous information shall be inserted as separate text or blocks.

4.1.4 All final electronic drawing files submitted for archiving must be checked by Manitoba Hydro's ***Title Block Validator*** program prior to submission to ensure compatibility with Manitoba Hydro's drawing archival system. This program will output a file *validation results.log* which must be printed and submitted as per 1.0 herein. Drawings issued for final submission not complying with this program will be returned for the appropriate revisions.

4.1.5 All drawings submitted shall be zoomed to extents in 2D plan view, limits and all layers turned on. *Autodesk® AutoCAD* .shx format files, with the exception of the lettering fonts mentioned herein, must **not** be used.

4.1.6 All lettering shall be done using fonts as provided by *Autodesk® AutoCAD* or the fonts supplied by Manitoba Hydro as part of the drawing installation software.

4.2 Autodesk® Raster Design

4.2.1 The latest version of *Autodesk® Raster Design* as communicated by Manitoba Hydro in use at the time of initiating the work shall be used unless otherwise specified.

4.3 Autodesk® Inventor

4.3.1 The latest version of *Autodesk® Inventor* as communicated by Manitoba Hydro in use at the time of initiating the work shall be used unless otherwise specified.

4.3.2 The fabricator, manufacturer or construction company shall submit the electronic *Autodesk® Inventor* Project file (i.e. three dimensional model) created during the design such that it may be edited by others. In addition the fabricator, manufacturer or construction company shall submit individual drawings in hard copy and *Autodesk®* Inventor .idw format that are exact replicas of the sheets generated from the *Autodesk® Inventor* Project Model.

4.4 GE® Smallworld GIS

4.4.1 The latest version of *GE® Smallworld eGIS Distribution Product* or the *GE® Smallworld eGIS Communication Product* as communicated by Manitoba Hydro in use at the time of initiating the Work shall be used unless otherwise specified. The Work shall be performed through Manitoba Hydro's network.

4.5 ESRI® ArcGIS

4.5.1 The latest version of *ESRI® ArcGIS* as communicated by Manitoba Hydro in use at the time of initiating the Work shall be used unless otherwise specified. Work to be done through Manitoba Hydro's network shall be performed using Manitoba Hydro's *ESRI® ArcGIS* software

4.6 Bentley® AutoPLANT

4.6.1 The latest version of *Bentley® AutoPLANT* as communicated by Manitoba Hydro in use at the time of initiating the Work shall be used unless otherwise specified.

4.7 Autodesk ®AutoCAD MEP

4.7.1 The latest version of *Autodesk® AutoCAD MEP* as communicated by Manitoba Hydro in use at the time of initiating the work shall be used unless otherwise specified.

4.7.2 The fabricator, manufacturer or construction company shall submit the electronic *AutoCAD MEP* Project file (i.e. three dimensional model) created during the design such that it may be edited by others. In addition the fabricator, manufacturer or construction company shall submit individual drawings in hard copy and *Autodesk® AutoCAD* .dwg format that are exact replicas of the sheets generated from the *Autodesk® AutoCAD MEP* Project Model.

5.0 DRAFTING STANDARDS FOR SPECIFIC PROJECTS

Additional or revised drawing and drafting specifications related to specific projects or disciplines may be provided by Manitoba Hydro as required for specific projects.

FORM 1-3 – FUTURE PRICE ADJUSTMENT MECHANISM

Provide your responses directly under the following:

The Proponent indicates below the duration of time the proposed Unit Prices are not subject to adjustment. Also, the Proponent includes a solution and formula for future adjustments to Unit Prices:

FORM 3-1 –SCHEDULE - DELIVERY FOR EQUIPMENT DRAWINGS

Equipment drawings delivery schedule stated in weeks from receipt of Purchase Order is listed below.

For ID#	Preliminary Outline	Final Outline	Nameplate	Schematic	Wiring
1					
2					
3					
4					
5					

FORM 7-1 – LOGISTICS PLAN

Provide a complete logistics plan for each of the Auto Transformers, Shunt Reactors and Phase Shifters detailing how these Items will be delivered:

Auto-Transformers

Shunt Reactors

Phase Shifters

FORM 8-1 – MAIN MANUFACTURING FACILITY

Complete the following table regarding the main manufacturing facility to be used for performance of the Work. .

SPEC ID #'s	**Main Manufacturing Facility and Address**	**In Operation Since (Year)**
SPEC ID #1		
SPEC ID #2		
SPEC ID #3		
SPEC ID #4		
SPEC ID #5		
SPEC ID #6		
SPEC ID #7		
SPEC ID #8		
SPEC ID #9		
SPEC ID #10		
SPEC ID #11		
SPEC ID #12		
SPEC ID #13		

Others:		

FORM 9-1 - SUBCONTRACTORS

Complete the following table for Subcontractors utilized for execution of any portion of the Work during the Contract:

Subcontractor Name	Address	Portion of the Work to be Subcontracted

Subcontractors proposed and accepted shall not be changed without the prior written approval of the Purchaser.

FORM 15-1 - QUALITY CONTROL

Provide responses directly under the following questions:

1.1 Quality

(a) If the main manufacturing facility (ies) to be utilized during the performance of the Contract are certified by an internationally recognized third party (e.g., ISO9001) attach a copy of the certificate.

(b) If the main manufacturing facility (ies) is not certified, provide details of the Quality Assurance Program in place and how it may be considered an equivalent to certification.

1.2 Test Capability

(a) What, if any, are limitations of the test facility which will not allow tests, as specified to be performed? Advise how these limitations will be addressed.

FORM 17-1 – ADDITIONAL WARRANTY OFFERINGS

In addition to and without limiting the warranty specified in the Contract Documents, provide a list and details of any additional warranty that may apply to the Work and additional associated cost, if any:

FORM 19-1 – PROPOSED EQUALS

Equal articles, material or equipment, should be identified below together with information on the change in price if the equal is accepted.

The Purchaser's approval must be obtained prior to execution of a Contract and confirmed in the Contract before any equal article, material or equipment is incorporated into the Work.

The following is a list of the equal articles, materials or equipment that is proposed to substitute for those specified:

Article, Material, or Equipment		**Price Change ($ CDN or USD)**	
Specified	**Proposed**	**Increase**	**Decrease**

NOTE: Names of manufacturers of equals and catalogue numbers are stated, if applicable. All technical data and literature are appended to this Proposal.

FORM 23-1 –PREVIOUS EXPERIENCE

Provide the following information below.

The Proponent shall provide examples of directly related previous experience in the past ten (10) years for each of the ITEMs identified within the Scope of the Work that have been successfully manufactured and delivered. These ITEM examples should detail the application, customer (including references) and ratings for each.

Auto Transformers

Phase Shifters

Shunt Reactors

FORM 27-1 – COMMERCIAL COMPLIANCE

The following are proposed changes to the commercial terms contained in Part II – PROPOSED CONTRACT DOCUMENTS requested to be considered during negotiation, if any, prior to entering a Contract.

PART II SECTION	CLAUSE NO.	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

FORM 28-1 – TECHNICAL COMPLIANCE

The following are proposed changes to the Technical Requirements, Supplementary Technical Requirements contained in Part II – PROPOSED CONTRACT DOCUMENTS requested to be considered during negotiation, if any, prior to entering a Contract.

PART II SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

FORM 29-1 - MANITOBA CONTENT EVALUATION

The Proponent shall provide the estimated percentage of total proposed price(s) that they considered to be Manitoba Content: ___________%

The Proponent shall provide a detailed breakdown of Manitoba Content that would be incorporated into the Work substantiating the above percentages (inputs originating from the Province of Manitoba such as labour, materials, transportation, etc):

NOTE: Upon request, the Contractor shall provide to Manitoba Hydro records substantiating the percentage of Manitoba Content.

a) Labour by Own Workforce

COMPONENT OF THE WORK	TYPE OF LABOUR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

b) Manitoba Subcontractors

TYPE OF WORK TO BE SUBCONTRACTED	NAME AND ADDRESS OF SUBCONTRACTOR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

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

Manitoba Business Involvement (continued)

c) Purchase of Goods from Manitoba Companies

TYPE OF GOODS	NAME AND ADDRESS OF SUPPLIER	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

d) Purchase of Equipment from Manitoba Companies

TYPE OF EQUIPMENT	NAME AND ADDRESS OF SUPPLIER	TOTAL VALUE OF PURCHASE PRICE $

e) Leased Equipment/Facility from Manitoba Companies

TYPE OF EQUIPMENT	OWNER	TOTAL VALUE OF LEASE $

Provide information regarding any lease agreements such as the following:

- Length of lease
- Lease payment
- Maintenance
- Residual value

Manitoba Business Involvement (continued)

f) Other Manitoba Content:

OTHER INPUTS	DESCRIPTION	TOTAL VALUE $

FORM 30-1 COMPANY INFORMATION

This Proposal is submitted by: ______________________________
(legal company name)

hereinafter called the "Proponent", a company duly incorporated under the laws of:

____

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

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

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

The Proponent's principal office dealing with this Proposal is at:

____
(number, street)

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

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

For enquiries, the Proponent's technical and non-technical contacts are:

Technical:	Non-Technical:
Name:______________________	Name:______________________
Position:______________________	Position:______________________
Telephone:______________________	Telephone:______________________
Email:______________________	Email:______________________

FORM 31-1 SIGNING PAGE

The undersigned, having examined all of this RFP together with all addenda issued prior to the Submission Close, hereby submits this Proposal with all necessary enclosures, and hereby offers to enter into negotiation to do all the Work that is set out, described, or called for in this RFP in accordance with this Proposal.

By signing below, the Proponent:

(b) Acknowledges on our own behalf and are authorized to acknowledge on behalf of all subcontractors and suppliers participating in our Proposal that the RFP process will be governed by the terms and conditions of the RFP, and that, among other things, such terms and conditions confirm that this procurement process does not constitute a formal, legally binding ‘bidding’ process (and for greater certainty, does not give rise to any Contract A bidding process contract), and that no legal relationship or obligation regarding the procurement of any goods or services shall be created between the Proponent and Manitoba Hydro unless and until the Proponent and Manitoba Hydro sign Articles of Agreement for performance of the Work;

(c) Have submitted our pricing in accordance with the Instructions to Proponents in the RFP and we confirm that the pricing information provided is accurate;

(d) 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;

(e) Declares, represents and warrants that this Proposal is made and submitted without any corrupt, fraudulent, collusive, coercive or obstructive practices as such terms are defined in the Instructions to Proponents of this RFP; and

(f) Agrees to the terms and conditions set out in the Part 1 - Procurement Process of this RFP.

____:

[Insert Legal Name of Proponent(s) Above]

Signed By:__________________________________

I have authority to bind the Proponent

Print Name:_________________________________

Title:______________________________________

Date:______________________________________

Manitoba Hydro

Attn: Mr. Greg Melnichuk
Purchasing Department
360 Portage Ave. (2)
Winnipeg, Manitoba, Canada – R3C 2Z1
Email: gmelnichuk@hydro.mb.ca
Fax: 204-360-6130

CLARIFICATION FORM
REQUEST FOR PROPOSAL 039857 SUPPLY AND DELIVERY OF AUTO TRANSFORMERS, SHUNT REACTORS AND PHASE-SHIFTING TRANSFORMERS
Question Number:001
Date: (yy,mm,dd) 2017-03-30

Contractor Name: All proponents					
Contact Name:					
Email:		Phone:		Fax:	

Section Number and Title:	Form 18-1, Technical Data Table, ID#3		
Question:	Please confirm if the losses provided were given in per (PST) Transformer and not for the 2 transformer in series.		
Answer:			
Answered by:		Date of Response:	

PRICES FOR THE WORK

ITEMS	Description	Proposed EX-Works Unit Price without oil $	Proposed DDP Unit Price without oil $	Proposed Oil Price per unit $	Lead Time
1	Spec ID# 1: 90 MVAr 500 kV Shunt Reactor				
2	Spec ID #2: 400 MVA 500 kV Auto Transformer				
3	Spec ID #3: 300 MVA 230 kV Phase-Shifter				
4	Spec ID #4: 333 MVA 230-138 kV Auto Transformer				
5	Spec ID #5: 285 MVA 230-115kV Auto Transformer				
6	Spec ID #6: Spare Parts for Spec ID #1				
7	Spec ID #7: Spare Parts for Spec ID#2				
8	Spec ID #8: CTs Inside of Delta for Spec ID #3				
9	Spec ID #9: CTs Outside of Delta for Spec ID #3				
10	Spec ID #10: Optical CTs Inside of Delta for Spec ID# 3				
11	Spec ID #11: Optical CTs Outside of Delta for Spec ID# 3				
12	Spec ID #12: Power Flow Controller for Spec ID# 3				

ITEM	Description	Lump Sum Price $
13	Spec ID #13: Insulation Coordination Study for Spec ID# 3	

[redacted]

Indicate YES beside the currency being submitted:

CAD$

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
	Station		Dorsey HVDC	Riel HVDC	Glenboro South Transmission	Transmission North	Transmission South
	Type		Shunt Reactor	Auto-Transformer	Phase-Shifting Transformer	Auto-Transformer	Auto-Transformer
	Summary		107.1 MVAr 600 Grd Y	400 500 Grd Y - 230 Grd Y - 46	180 / 240 / 300 230 - 230	200 / 267 / 333 230 Grd Y - 138 Grd Y - 13.8	171 / 228 / 285 230 Grd Y - 115 Grd Y - 13.8

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No.	Item			Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
1	**MVA Rating**	HV	65°C Rise	MVA					
2		LV							
3		TV							
4	**Type of cooling**			-					
5	**Rated Voltage**	HV		kV					
6		LV		kV					
7		TV		kV					
	Tapchanger Descriptions								
8	DTC			-					
9	LTC			-					

Base Rating for all guarantees and performance data unless otherwise noted:	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
	MVA	**107.1**	**400**	**300**	**200**	**171**
	LV					
	°C rise	**65**	**70**	**65**	**65**	**65**
	°C	**85**	**90**	**85**	**85**	**85**

	ID # 2	ID # 3	ID # 4	ID # 5
If this is a near duplicate to a previous transformer supplied to Manitoba Hydro, enter the serial number of the previous transformer.				

	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
Main Power Transformer / Shunt Reactor Manufacturing Plant Location					

Losses

No.	Item	% Voltage	DTC Pos.	LTC Pos.		Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
10	**No-load loss:**	100 %	rated	rated	Guaranteed	kW			Enter losses for SPEC ID# 3 in adjacent worksheet		
11		110 % (120% for shunt reactor)				kW					
12		100 %	rated	- 1		kW					
13		110 %				kW					
14		100 %	rated	- 16		kW					
15		110 %				kW					
16	**Exciting current:**	100 %	rated	rated		%					
17		110 % (120% for shunt reactor)				%					
18		100 %	rated	- 1		%					
19		110 %				%					
20		100 %	rated	full buck		%					
21		110 %				%					
22	**Primary Inrush Current:**				Peak Current	pu					
23	Assume system Impedance = 0.01+j0.1%				Time Constant for decay:	s					
24					Time to decay to 1.5 pu of Rated Current:	s					
25	**Load loss:**	100 %	rated	maximum boost		kW			Enter losses for SPEC ID# 3 in adjacent worksheet		
26		100 %	rated	rated	Guaranteed	kW					
27		100 %	rated	- 1		kW					
28		100 %	rated	maximum buck		kW					
29	**Maximum load loss:**	100 %			Guaranteed	kW					
30	at worst case ONAN (ODAF) MVA which may be RCBN					MVA base					
31	at DTC tap position:					-					
32	at LTC tap position:					-					
33	**Total losses:**	100 %	rated	rated	Guaranteed	kW					
	Total Fan losses:	(for ODAF, including N+1 integral cooler)				kW					
	Total Pump losses:	(for ODAF, including N+1 integral cooler)				kW					

Impedance :

% Voltage	DTC Pos.	LTC Pos.	Units

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form				Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
	Station					Dorsey HVDC	Riel HVDC	Glenboro South Transmission	Transmission North	Transmission South
	Type					Shunt Reactor	Auto-Transformer	Phase-Shifting Transformer	Auto-Transformer	Auto-Transformer
	Summary					107.1 MVAr 600 Grd Y	400 500 Grd Y - 230 Grd Y - 46	180 / 240 / 300 230 - 230	200 / 267 / 333 230 Grd Y - 138 Grd Y - 13.8	171 / 228 / 285 230 Grd Y - 115 Grd Y - 13.8

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No.	Item					Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
34	**Positive-sequence**			maximum boost		%			Enter reactance for SPEC ID# 3 in adjacent worksheet		
35	**Reactance:**	100 %	rated	rated	Guaranteed	%					
36	**HV to LVX**			maximum buck		%					
37	**Positive-sequence**			maximum boost		%					
38	**Reactance:**	100 %	rated	rated		%					
39	**HV to TV or HV to LVX&Y**			maximum buck		%					
40	**Positive-sequence**			maximum boost		%					
41	**Reactance:**	100 %	rated	rated		%					
42	**LV to TV**			maximum buck		%					
43	**Zero-sequence**			maximum boost		%					
44	**Reactance:**	100 %	rated	rated		%					
45	**HV to LV (X)**			maximum buck		%					
46	**Zero-sequence**			maximum boost		%					
47	**Reactance:**	100 %	rated	rated		%					
48	**HV to TV or HV to LVX&Y**			maximum buck		%					
49	**Zero-sequence**			maximum boost		%					
50	**Reactance:**	100 %	rated	rated		%					
51	**LV to TV**			maximum buck		%					
	Audible Sound Level										
52	at base MVA:	100 %	rated	**worst**	Guaranteed	dB_A					
53	at maximum MVA:			**case**	Guaranteed	dB_A					

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
	Station		Dorsey HVDC	Riel HVDC	Glenboro South Transmission	Transmission North	Transmission South
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	Summary		107.1 MVAr 600 Grd Y	400 500 Grd Y - 230 Grd Y - 46	180 / 240 / 300 230 - 230	200 / 267 / 333 230 Grd Y - 138 Grd Y - 13.8	171 / 228 / 285 230 Grd Y - 115 Grd Y - 13.8

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Weights, Volumes and Dimensions :

No.	Item	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
	Weight						
54	Core and coils :	kg					
55	Tank and fittings :	kg					
56	Total assembled weight including oil :	kg					
57	**Quantity of insulating oil :**	L					
	Shipping Weight						
58	Transformer filled with oil (if applicable) :	kg					
59	Transformer filled with dry air (if applicable) :	kg					
	Shipping dimensions						
60	Total Width :	mm					
61	Total Length (parallel to line of HV bushings) :	mm					
62	Base Width :	mm					
63	Base Length :	mm					
64	Total Height :	mm					
	Projected overall dimension, including accessories						
65	Width :	mm					
66	Length (parallel to line of HV bushings) :	mm					
67	Height :	mm					
	North American Transportation Method						
68	Transformer	rail or truck					
69	Accessories	rail or truck					
	Minimum design clearances						
70	**phase to phase in air :** HV :	mm					
71	LV :	mm					
72	TV :	mm					
73	**phase to ground in air :** HV :	mm					
74	LV :	mm					
75	TV :	mm					

Coil Design :

No.	Item	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
	Winding data						
76	Are all winding conductors copper (including series transformer)?	Yes/No					

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
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No.	Arrangement of Windings and Shields from core on main core		Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
77	1st (closest to core)		-					
78	2nd	Even though all cells are yellow,	-					
79	3rd	fill-in only as many windings	-					
80	4th	as there are.	-					
81	5th		-					
82	6th (farthest from core)		-					

No.	Winding Type	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
83	HV1 or SV1 :	-					
84	HV2 or SV2 :	-					
85	HV3 or SV3 :	-					
86	LV1 or CV1 :	-					
87	LV2 or CV2 :	-					
88	TV or Delta :	-					
89	LTC or Source LTC :	-					
90	Load LTC :						
91	DTC:	-					
92	Series Transformer HV or Test Winding :	-					
93	Series Transformer LV :	-					
94	LTC Reactor or Preventive Auto :	-					
95	Current-Limiting Reactor :	-					

No.	Conductor type	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
96	HV1 or SV1 :	-					
97	HV2 or SV2 :	-					
98	HV3 or SV3 :	-					
99	LV1 or CV1 :	-					
100	LV2 or CV2 :	-					
101	TV or Delta :	-					
102	LTC or Source LTC :	-					
103	Load LTC :						
104	DTC:	-					
105	Series Transformer HV or Test Winding :	-					
106	Series Transformer LV :	-					
107	LTC Reactor or Preventive Auto :	-					
108	Current-Limiting Reactor :	-					

No.	Number of Turns	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
109	HV1 or SV1 :	-					
110	HV2 or SV2 :	-					
111	HV3 or SV3 :	-					
112	LV1 or CV1 :	-					
113	LV2 or CV2 :	-					
114	TV or Delta :	-					
115	LTC or Source LTC :	-					
116	Load LTC :						
117	DTC:	-					
118	Series Transformer HV or Test Winding :	-					
119	Series Transformer LV :	-					
120	LTC Reactor or Preventive Auto :	-					
121	Current-Limiting Reactor :	-					

No.	Maximum Number of Turns per Disk (if applicable)	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
122	HV1 or SV1 :	-					
123	HV2 or SV2 :	-					
124	HV3 or SV3 :	-					
125	LV1 or CV1 :	-					
126	LV2 or CV2 :	-					
127	TV or Delta :	-					
128	LTC or Source LTC :	-					
129	Load LTC :						
130	DTC:	-					
131	Series Transformer HV or Test Winding :	-					
132	Series Transformer LV :	-					
133	LTC Reactor or Preventive Auto :	-					
134	Current-Limiting Reactor :	-					

No.	Copper Weight per Limb	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
135	HV1 or SV1 :	kg					
136	HV2 or SV2 :	kg					
137	HV3 or SV3 :	kg					
138	LV1 or CV1 :	kg					
139	LV2 or CV2 :	kg					
140	TV or Delta :	kg					
141	LTC or Source LTC :	kg					
142	Load LTC :						
143	DTC:	kg					
144	Series Transformer HV or Test Winding :	kg					
145	Series Transformer LV :	kg					
146	LTC Reactor or Preventive Auto :	kg					
147	Current-Limiting Reactor :	kg					

No.	d.c. Resistance	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
148	HV1 or SV1 :	Ohms					
149	HV2 or SV2 :	Ohms					
150	HV3 or SV3 :	Ohms					
151	LV1 or CV1 :	Ohms					
152	LV2 or CV2 :	Ohms					

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

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No.	Item	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
153	TV or Delta :	Ohms					
154	LTC or Source LTC :	Ohms					
155	Load LTC :						
156	DTC:	Ohms					
157	Series Transformer HV or Test Winding :	Ohms					
158	Series Transformer LV :	Ohms					
159	LTC Reactor or Preventive Auto :	Ohms					
160	Current-Limiting Reactor :	Ohms					
	Conductor Insulation Diametric Thickness						
161	HV1 or SV1 :	mm					
162	HV2 or SV2 :	mm					
163	HV3 or SV3 :	mm					
164	LV1 or CV1 :	mm					
165	LV2 or CV2 :	mm					
166	TV or Delta :	mm					
167	LTC or Source LTC :	mm					
168	Load LTC :						
169	DTC:	mm					
170	Series Transformer HV or Test Winding :	mm					
171	Series Transformer LV :	mm					
172	LTC Reactor or Preventive Auto :	mm					
173	Current-Limiting Reactor :	mm					
	Conductor Manufacturer						
174	Manufacturer Option A	-					
175	Manufacturer Option B	-					
176	Manufacturer Option C	-					
	Conductor Enamel Insulation (if applicable)						
177	Manufacturer of Enamel Insulation (if not conductor manufacturer)	-					
178	Temperature Class & Maximum Temperature Limit	-					
	Conductor Paper Insulation						
179	Manufacturer of Paper or Trade name	-					
180	Thermally-Upgraded Paper	Yes/No					
181	Nitrogen Content per ASTM D-982	%					
182	Temperature Class & Maximum Temperature Limit	-					
	Crepe or Other Tape Insulation on Leads/Cables						
183	Manufacturer of Tape	-					
184	Trade name	-					
185	Thermally-Upgraded Tape	Yes/No					
186	Nitrogen Content per ASTM D-982	%					
187	Temperature Class & Maximum Temperature Limit	-					
	Pressboard or Transformerboard Insulation						
188	Manufacturer of Pressboard	-					
189	Trade name	-					
190	Temperature Class & Maximum Temperature Limit	°C					

Core Design :

No.	Item	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
	Power Transformer Core data						
191	Manufacturer of core steel :	-					
192	Type of core steel (23ZDKH85 / M-4 / etc.) :	-					
193	Thickness of individual sheets of core steel :	mm					
194	Type (core / shell) :	-					
195	Method of wound limb construction (circular or rectangular) :	-					
196	Joint type :	-					
197	Number of step-laps in step-lapped core :	-					
198	Number of limbs :	-					
199	Number of wound limbs :	-					
200	Maximum internal hotspot temperature rise above ambient :	°C					
201	Rated flux density at 100% of rated voltage :	Tesla					
202	Maximum flux density at 100% at worst-case tap position (if applicable) :	Tesla					
203	Wound limb diameter	mm					
204	Number of oil ducts in wound limb	-					
205	Core weight :	kg					
	Shunt Reactor Core Data						
206	Air-Core or Steel Core?	Air/Steel					
207	For air-core only: Three shields or One Common Shield	3/1					
208	Manufacturer of core steel :	-					
209	Type of core steel (23ZDKH85 / M-4 / etc.) :	-					
210	Thickness of individual sheets of core steel :	mm					
211	Number of limbs including outer shield :	-					
212	Number of wound limbs :	-					
213	Maximum internal hotspot temperature rise above ambient :	°C					
214	Rated flux density at 100% of rated voltage :	Tesla					
215	Maximum flux density at 100% at worst-case tap position (if applicable) :	Tesla					
216	Wound limb diameter :	mm					
217	Total height of gaps :	mm					
218	Total number of gaps :	-					
219	Core weight :	kg					

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

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No.	Item	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
220	Saturation Curve Showing Voltage and Current attached? (Required)	Yes/No					

Accessories :

No.	**Oil (delivered)**	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
221	Manufacturer of oil :	-					
222	Type of oil :	-					

Bushings Please select the appropriate bushing from the drop-down list box or supply drawing for an equivalent N.G.K. and HSP bushings built to "CAN/CSA-C88.1" to be approved at time of ordering pending drawing submit

No.	Bushing		Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
223	HV line:	Cat. No. :	-					
224	HVN:	Cat. No. :	-					
225	LV line:	Cat. No. :	-					
226	LVN or H0X0:	Cat. No. :	-					
227	TV:	Cat. No. :	-					

No.	**Cooling**	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
228	Radiator or Cooler manufacturer :	-					
229	Number of radiators or coolers :	-					
230	Number of radiator plates per radiator (leave blank if coolers):	-					
231	Length of radiator or cooler :	mm					
232	Width of radiator or cooler :	mm					

No.	**Fan Motor Schedule (if applicable)**	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
233	Manufacturer :	-					
234	Voltage :	V					
235	Full load current :	A					
236	Number of phases :	-					
237	Power rating at rated speed :	W					
238	Speed at rated output :	rpm					
239	Fan blade diameter :	mm					
240	Air flow rate per fan :	m^3 / hr					
241	Losses of each fan motor :	W					
242	Total number of fans :	-					
243	Blade enclosure is totally enclosed :	Yes/No					
244	Insulation Class is 'F' :	Yes/No					

No.	**Pump Motor Schedule (if applicable)**	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
245	Manufacturer :	-					
246	Voltage :	V					
247	Full load current :	A					
248	Number of phases :	-					
249	Power rating at rated speed :	W					
250	Speed at rated output :	rpm					
251	Pump Type :	-					
252	Pump inlet and outlet size:	mm					
253	Oil flow rate per pump :	L / min					
254	Losses of each pump motor :	W					
255	Total number of pumps :	-					
256	Type of bearings :	-					
257	Type of bearing wear indication system :	-					

No.	**De-energized Tap-changer**	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
258	Manufacturer :	-					
259	Model No. (if applicable) :	-					
260	Type :	-					
261	Rated voltage (between contacts):	kV LIL					
262	Rated current :	A					
263	Total number of steps :	-					
264	Step voltage :	%					

No.	**Load Tap-changer**	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
265	Manufacturer :	-					
266	Model No. (if applicable) :	-					
267	Tap-changer in series with and carries same current as which winding :	-					
268	Type	-					
269	Diverter bridging method :	-					
270	Rated voltage :	kV					
271	Rated current :	A					
272	Total number of steps :	-					
273	Step voltage :	%					
274	Contact life expectancy at maximum current (# of operations) :	-					
275	LTC Reactor or Series Transformer Manufacturer	-					
276	Series Transformer Type	-					
277	Series Transformer Voltage Ratio	V-V					
278	Series Transformer Core Flux Density	Tesla					

No.	**Transformer Sub-Contractors (specify if you manufacture in a different plant)**	Units	ID # 1	ID # 2	ID # 3	ID # 4	ID # 5
279	LTC Reactor (Preventive Auto) Manufacturer & Plant:	-					
280	Series Transformer Manufacturer & Plant:	-					
281	Current-limiting reactor Manufacturer & Plant:	-					

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units

Station	
Type	
Summary	

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No.					
1	**MVA Rating**	HV	65°C Rise		MVA
2		LV			
3		TV			
4	**Type of cooling**				-
5	**Rated Voltage**	HV			kV
6		LV			kV
7		TV			kV

Tapchanger Descriptions

No.		
8	DTC	-
9	LTC	-

Base Rating	**MVA**
for all guarantees and performance data	**LV**
unless otherwise noted:	**°C rise**
	°C

**If this is a near duplicate to a previous transformer supplied to Manitoba Hydr
enter the serial number of the previous transformer.**

Main Power Transformer / Shunt Reactor Manufacturing Plant Location

Losses

No.		% Voltage	DTC Pos.	LTC Pos.		Units
10	**No-load loss:**	100 %	rated	rated	Guaranteed	kW
11		110 % (120% for shunt reactor)				kW
12		100 %	rated	- 1		kW
13		110 %				kW
14		100 %	rated	- 16		kW
15		110 %				kW
16	**Exciting current:**	100 %	rated	rated		%
17		110 % (120% for shunt reactor)				%
18		100 %	rated	- 1		%
19		110 %				%
20		100 %	rated	full buck		%
21		110 %				%
22	**Primary Inrush Current:**				Peak Current	pu
23	Assume system Impedance = 0.01+j0.1%				Time Constant for decay:	s
24					Time to decay to 1.5 pu of Rated Current:	s
25	**Load loss:**	100 %	rated	maximum boost		kW
26		100 %	rated	rated	Guaranteed	kW
27		100 %	rated	- 1		kW
28		100 %	rated	maximum buck		kW
29	**Maximum load loss:**	100 %			Guaranteed	kW
30	at worst case ONAN (ODAF) MVA which may be RCBN					MVA base
31	at DTC tap position:					-
32	at LTC tap position:					-
33	**Total losses:**	100 %	rated	rated	Guaranteed	kW

Total Fan losses:	(for ODAF, including N+1 integral cooler)	kW
Total Pump losses:	(for ODAF, including N+1 integral cooler)	kW

Impedance :

% Voltage	DTC Pos.	LTC Pos.	Units

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units

Station	
Type	
Summary	

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No.						
34	**Positive-sequence**			maximum boost		%
35	**Reactance:**	100 %	rated	rated	Guaranteed	%
36	**HV to LVX**			maximum buck		%
37	**Positive-sequence**			maximum boost		%
38	**Reactance:**	100 %	rated	rated		%
39	**HV to TV or HV to LVX&Y**			maximum buck		%
40	**Positive-sequence**			maximum boost		%
41	**Reactance:**	100 %	rated	rated		%
42	**LV to TV**			maximum buck		%
43	**Zero-sequence**			maximum boost		%
44	**Reactance:**	100 %	rated	rated		%
45	**HV to LV (X)**			maximum buck		%
46	**Zero-sequence**			maximum boost		%
47	**Reactance:**	100 %	rated	rated		%
48	**HV to TV or HV to LVX&Y**			maximum buck		%
49	**Zero-sequence**			maximum boost		%
50	**Reactance:**	100 %	rated	rated		%
51	**LV to TV**			maximum buck		%

No.	Audible Sound Level					
52	at base MVA:	100 %	rated	**worst**	Guaranteed	dB_A
53	at maximum MVA:			**case**	Guaranteed	dB_A

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units
	Station	
	Type	
	Summary	

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Weights, Volumes and Dimensions :

No.	Item	Units
	Weight	
54	Core and coils :	kg
55	Tank and fittings :	kg
56	Total assembled weight including oil :	kg
57	**Quantity of insulating oil :**	L
	Shipping Weight	
58	Transformer filled with oil (if applicable) :	kg
59	Transformer filled with dry air (if applicable) :	kg
	Shipping dimensions	
60	Total Width :	mm
61	Total Length (parallel to line of HV bushings) :	mm
62	Base Width :	mm
63	Base Length :	mm
64	Total Height :	mm
	Projected overall dimension, including accessories	
65	Width :	mm
66	Length (parallel to line of HV bushings) :	mm
67	Height :	mm
	North American Transportation Method	
68	Transformer	rail or truck
69	Accessories	rail or truck

No.	Minimum design clearances		Units
70	phase to phase in air :	HV :	mm
71		LV :	mm
72		TV :	mm
73	phase to ground in air :	HV :	mm
74		LV :	mm
75		TV :	mm

Coil Design :

No.	Winding data	Units
76	Are all winding conductors copper (including series transformer)?	Yes/No

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units

Station	
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No.	Arrangement of Windings and Shields from core on main core		
77	1st (closest to core)	Even though all cells are yellow, fill-in only as many windings as there are.	-
78	2nd		-
79	3rd		-
80	4th		-
81	5th		-
82	6th (farthest from core)		-

No.	Winding Type	
83	HV1 or SV1 :	-
84	HV2 or SV2 :	-
85	HV3 or SV3 :	-
86	LV1 or CV1 :	-
87	LV2 or CV2 :	-
88	TV or Delta :	-
89	LTC or Source LTC :	-
90	Load LTC :	
91	DTC:	-
92	Series Transformer HV or Test Winding :	-
93	Series Transformer LV :	-
94	LTC Reactor or Preventive Auto :	-
95	Current-Limiting Reactor :	-

No.	Conductor type	
96	HV1 or SV1 :	-
97	HV2 or SV2 :	-
98	HV3 or SV3 :	-
99	LV1 or CV1 :	-
100	LV2 or CV2 :	-
101	TV or Delta :	-
102	LTC or Source LTC :	-
103	Load LTC :	
104	DTC:	-
105	Series Transformer HV or Test Winding :	-
106	Series Transformer LV :	-
107	LTC Reactor or Preventive Auto :	-
108	Current-Limiting Reactor :	-

No.	Number of Turns	
109	HV1 or SV1 :	-
110	HV2 or SV2 :	-
111	HV3 or SV3 :	-
112	LV1 or CV1 :	-
113	LV2 or CV2 :	-
114	TV or Delta :	-
115	LTC or Source LTC :	-
116	Load LTC :	
117	DTC:	-
118	Series Transformer HV or Test Winding :	-
119	Series Transformer LV :	-
120	LTC Reactor or Preventive Auto :	-
121	Current-Limiting Reactor :	-

No.	Maximum Number of Turns per Disk (if applicable)	
122	HV1 or SV1 :	-
123	HV2 or SV2 :	-
124	HV3 or SV3 :	-
125	LV1 or CV1 :	-
126	LV2 or CV2 :	-
127	TV or Delta :	-
128	LTC or Source LTC :	-
129	Load LTC :	
130	DTC:	-
131	Series Transformer HV or Test Winding :	-
132	Series Transformer LV :	-
133	LTC Reactor or Preventive Auto :	-
134	Current-Limiting Reactor :	-

No.	Copper Weight per Limb	
135	HV1 or SV1 :	kg
136	HV2 or SV2 :	kg
137	HV3 or SV3 :	kg
138	LV1 or CV1 :	kg
139	LV2 or CV2 :	kg
140	TV or Delta :	kg
141	LTC or Source LTC :	kg
142	Load LTC :	
143	DTC:	kg
144	Series Transformer HV or Test Winding :	kg
145	Series Transformer LV :	kg
146	LTC Reactor or Preventive Auto :	kg
147	Current-Limiting Reactor :	kg

No.	d.c. Resistance	
148	HV1 or SV1 :	Ohms
149	HV2 or SV2 :	Ohms
150	HV3 or SV3 :	Ohms
151	LV1 or CV1 :	Ohms
152	LV2 or CV2 :	Ohms

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units

Station

Type

Summary

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153	TV or Delta :	Ohms
154	LTC or Source LTC :	Ohms
155	Load LTC :	
156	DTC:	Ohms
157	Series Transformer HV or Test Winding :	Ohms
158	Series Transformer LV :	Ohms
159	LTC Reactor or Preventive Auto :	Ohms
160	Current-Limiting Reactor :	Ohms

	Conductor Insulation Diametric Thickness	
161	HV1 or SV1 :	mm
162	HV2 or SV2 :	mm
163	HV3 or SV3 :	mm
164	LV1 or CV1 :	mm
165	LV2 or CV2 :	mm
166	TV or Delta :	mm
167	LTC or Source LTC :	mm
168	Load LTC :	
169	DTC:	mm
170	Series Transformer HV or Test Winding :	mm
171	Series Transformer LV :	mm
172	LTC Reactor or Preventive Auto :	mm
173	Current-Limiting Reactor :	mm

	Conductor Manufacturer	
174	Manufacturer Option A	-
175	Manufacturer Option B	-
176	Manufacturer Option C	-

	Conductor Enamel Insulation (if applicable)	
177	Manufacturer of Enamel Insulation (if not conductor manufacturer)	-
178	Temperature Class & Maximum Temperature Limit	-

	Conductor Paper Insulation	
179	Manufacturer of Paper or Trade name	-
180	Thermally-Upgraded Paper	Yes/No
181	Nitrogen Content per ASTM D-982	%
182	Temperature Class & Maximum Temperature Limit	-

	Crepe or Other Tape Insulation on Leads/Cables	
183	Manufacturer of Tape	-
184	Trade name	-
185	Thermally-Upgraded Tape	Yes/No
186	Nitrogen Content per ASTM D-982	%
187	Temperature Class & Maximum Temperature Limit	-

	Pressboard or Transformerboard Insulation	
188	Manufacturer of Pressboard	-
189	Trade name	-
190	Temperature Class & Maximum Temperature Limit	°C

Core Design :

	Power Transformer Core data	
191	Manufacturer of core steel :	-
192	Type of core steel (23ZDKH85 / M-4 / etc.) :	-
193	Thickness of individual sheets of core steel :	mm
194	Type (core / shell) :	-
195	Method of wound limb construction (circular or rectangular) :	-
196	Joint type :	-
197	Number of step-laps in step-lapped core :	-
198	Number of limbs :	-
199	Number of wound limbs :	-
200	Maximum internal hotspot temperature rise above ambient :	°C
201	Rated flux density at 100% of rated voltage :	Tesla
202	Maximum flux density at 100% at worst-case tap position (if applicable) :	Tesla
203	Wound limb diameter	mm
204	Number of oil ducts in wound limb	-
205	Core weight :	kg

	Shunt Reactor Core Data	
206	Air-Core or Steel Core?	Air/Steel
207	For air-core only: Three shields or One Common Shield	3/1
208	Manufacturer of core steel :	-
209	Type of core steel (23ZDKH85 / M-4 / etc.) :	-
210	Thickness of individual sheets of core steel :	mm
211	Number of limbs including outer shield :	-
212	Number of wound limbs :	-
213	Maximum internal hotspot temperature rise above ambient :	°C
214	Rated flux density at 100% of rated voltage :	Tesla
215	Maximum flux density at 100% at worst-case tap position (if applicable) :	Tesla
216	Wound limb diameter :	mm
217	Total height of gaps :	mm
218	Total number of gaps :	-
219	Core weight :	kg

MHEB Power Transformer & Reactor Data Form Version 1.0.4 (2016 07 31)

No.	MHEB Power Transformer & Reactor Data Form	Units
	Station	
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No.	Item	Units
220	Saturation Curve Showing Voltage and Current attached? (Required)	Yes/No

Accessories :

No.	Item		Units
	Oil (delivered)		
221	Manufacturer of oil :		-
222	Type of oil :		-
	Bushings	Please select the appropriate bushing from the drop-down list b	
223	HV line:	Cat. No. :	-
224	HVN:	Cat. No. :	-
225	LV line:	Cat. No. :	-
226	LVN or H0X0:	Cat. No. :	-
227	TV:	Cat. No. :	-
	Cooling		
228	Radiator or Cooler manufacturer :		-
229	Number of radiators or coolers :		-
230	Number of radiator plates per radiator (leave blank if coolers):		-
231	Length of radiator or cooler :		mm
232	Width of radiator or cooler :		mm
	Fan Motor Schedule (if applicable)		
233	Manufacturer :		-
234	Voltage :		V
235	Full load current :		A
236	Number of phases :		-
237	Power rating at rated speed :		W
238	Speed at rated output :		rpm
239	Fan blade diameter :		mm
240	Air flow rate per fan :		m^3 / hr
241	Losses of each fan motor :		W
242	Total number of fans :		-
243	Blade enclosure is totally enclosed :		Yes/No
244	Insulation Class is 'F' :		Yes/No
	Pump Motor Schedule (if applicable)		
245	Manufacturer :		-
246	Voltage :		V
247	Full load current :		A
248	Number of phases :		-
249	Power rating at rated speed :		W
250	Speed at rated output :		rpm
251	Pump Type :		-
252	Pump inlet and outlet size:		mm
253	Oil flow rate per pump :		L / min
254	Losses of each pump motor :		W
255	Total number of pumps :		-
256	Type of bearings :		-
257	Type of bearing wear indication system :		-
	De-energized Tap-changer		
258	Manufacturer :		-
259	Model No. (if applicable) :		-
260	Type :		-
261	Rated voltage (between contacts):		kV LIL
262	Rated current :		A
263	Total number of steps :		-
264	Step voltage :		%
	Load Tap-changer		
265	Manufacturer :		-
266	Model No. (if applicable) :		-
267	Tap-changer in series with and carries same current as which winding :		-
268	Type		-
269	Diverter bridging method :		-
270	Rated voltage :		kV
271	Rated current :		A
272	Total number of steps :		-
273	Step voltage :		%
274	Contact life expectancy at maximum current (# of operations) :		-
275	LTC Reactor or Series Transformer Manufacturer		-
276	Series Transformer Type		-
277	Series Transformer Voltage Ratio		V-V
278	Series Transformer Core Flux Density		Tesla
	Transformer Sub-Contractors (specify if you manufacture in a different plant)		
279	LTC Reactor (Preventive Auto) Manufacturer & Plant:		-
280	Series Transformer Manufacturer & Plant:		-
281	Current-limiting reactor Manufacturer & Plant:		-

SPEC ID # 3 300 MVA, 230 kV Phase-Shifting Transformer

MHEB Power Transformer & Reactor Data Form addition V 1.0.4PST

		Losses		Excitation			Phase-Shift			Reactance							
										2-Circuit		3-Circuit T-Diagram Components					
		No-Load 100%V kW	Load 100%V 300 MVA 1 PF kW	No-Load Excitation Current 100%V %	No-Load Volts per Turn 100%V V/Turn	No-Load Flux Density 100%V Tesla	No-Load Deg.	Load Transformer 300 MVA 1 PF Deg.	Load Total 300 MVA 1 PF Deg.	Equivalent 300 MVA % Magnitude	Deg.	Source LTC 300 MVA % Magnitude	Deg.	Load LTC 300 MVA % Magnitude	Deg.	Delta (Tank ground) 300 MVA % Magnitude	Deg.
	LTC Pos.																
Full Advance	1																
	2																
	3																
	4																
	5																
	6																
	7																
	8																
	9																
	10																
	11																
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	25																
	26																
	27																
	28																
	29																
	30																
	31																
	32																
	33																
	34																
Full Retard	35																

Guaranteed Losses in kW for loss evaluation, per Remark 13 of SPEC ID# 3

Correct the entered LTC positions and phase angles entered below, to suit your design. Refer to Remark 5 of SPEC ID# 3.

Operating Point #	LTC Pos.	No-Load	Load	Fan & Pump	Phase-Shift No-Load	Phase-Shift Load Total
1	+17				+94	+80
2	+4				+12	+11.3
3	-10				-57	-60

Sum of Weighted Operating Points Cost $0

Please fill-in all taps, even if those taps might not be suitable for full or overload loading.
If LTC are +/-16 steps, leave LTC Positions 34 & 35 blank.
Guaranteed losses are per the loss evaluation criteria.

Please confirm that the phase-shifting transformer will meet the loading requirements specified in Remark 3 of SPEC ID# 3

SPEC ID # 3 300 MVA, 230 kV Phase-Shifting Transformer

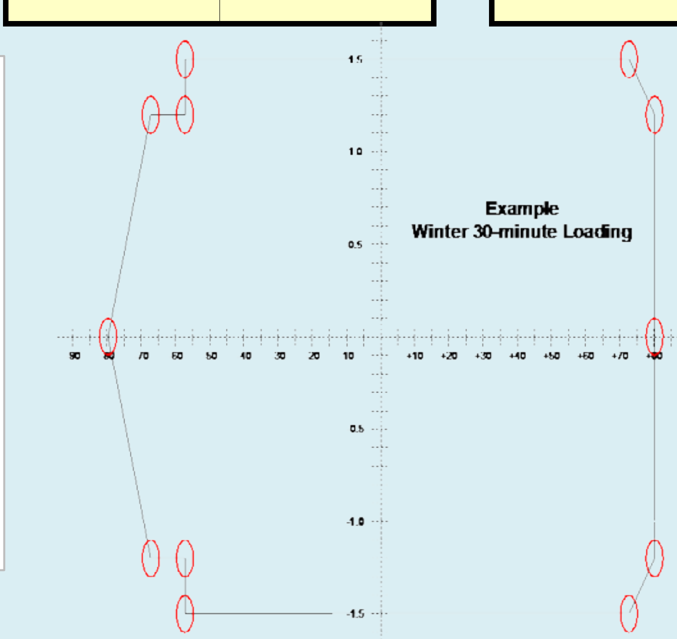
MHEB Power Transformer & Reactor Data Form addition V 1.0.4PST

Normal Loading Capability per Remark 3 of SPEC ID# 3				Extra and Overload Capability per Remark 4 of SPEC ID# 3 (Ultimate desired capability, but not required capability, is shown in parenthesis.)											
Summer Load +40°C Ambient		Winter Load 0°C Ambient		Summer Loading +35°C Ambient 0.9 PF Lag to 0.9 PF Lead						Winter Loading -15°C Ambient 0.9 PF Lag to 0.9 PF Lead					
(1.0 pu) 0.9 PF Lag to 0.9 PF Lead		(1.1875 pu) 0.9 PF Lag to 0.9 PF Lead		Normal (1.05 pu)		6-week Emergency (1.10 pu)		30-minute Emergency (1.20 pu)		Normal (1.35 pu)		6-week Emergency (1.40 pu)		30-minute Emergency (1.50 pu)	
pu	Deg.	pu	Deg.	pu	Deg.	pu	Deg.	pu	Deg.	pu	Deg.	pu	Deg.	pu	Deg.

<u>Methods of supplying this Loading Capability data:</u>

Method 1: Enter the pu load capability for each tap position.
or
Method 2: Enter the corners of the polygonal region as circled in the example to the right. Note that this example is completely arbitrary and your shape may be different.
or
Method 3: Attach polygonal graph(s), such as the example to the right, showing the capability for each loading case.

1.0 pu = 300 MVA
If a tap position has no capability, enter 0 pu.



REQUEST FOR PROPOSAL 039857

SUPPLY AND DELIVERY OF AUTO TRANSFORMERS, SHUNT REACTORS AND PHASE-SHIFTING TRANSFORMERS

PART I – PROCUREMENT PROCESS

NOVEMBER 10, 2016

REQUEST FOR PROPOSAL 039857

SUPPLY AND DELIVERY OF AUTO TRANSFORMERS, SHUNT REACTORS AND PHASE-SHIFTING TRANSFORMERS

This Request for Proposal (RFP) is comprised of two (2) Parts:

PART I – PROCUREMENT PROCESS, and

PART II – PROPOSED CONTRACT DOCUMENTS

PART I TABLE OF CONTENTS

ATTACHMENT

APPENDICES

PROPOSAL FORMS

1. INVITATION

1.1 Manitoba Hydro seeks the submission of competitive Proposals from capable original equipment manufacturers with suitable facilities, experience, references and an interest in competing for award of contracts for immediate and possible future orders for the Supply and Delivery of Equipment required to maintain and expand Manitoba Hydro's power transmission and distribution system; who are interested in performing the obligations outlined below in Section 3 – Scope of Work within the time frame referenced below in Section 4 – Schedule of the Work.

1.2 This is a non-binding procurement process.

1.3 Submission of a Proposal in response to this Invitation is not a bid or tender and shall not give rise to any Contract A, as known to Canadian laws of tender.

1.4 Neither Manitoba Hydro nor any person responding to this Invitation (a "Proponent") shall be legally bound to each other in any way unless and until Articles of Agreement are duly signed confirming that acceptable terms have been negotiated and agreed between Manitoba Hydro and its Preferred Proponent(s).

1.5 There is no period of Proposal irrevocability or any requirement for the posting of bid security.

1.6 Submitted Proposals may be withdrawn at any time by the Proponent, including after Submission Close.

2. SUBMISSION CLOSE

2.1 To be evaluated, a Proposal must be submitted at or before **Submission Close** which is:

16:00:00 hours, Manitoba local time,
February 23, 2017

through MERX (www.merx.com), preferably in .pdf electronic format, word searchable, with appropriate bookmarks and organization to allow for easy navigation.

Proposals not submitted through MERX will not be accepted.

3. SCOPE OF WORK

3.1 Manitoba Hydro seeks to identify the Proponent capable of providing the best solution for performance of the Work which requires design, manufacture, provide in-factory testing, prepare Equipment for shipment, loading, transportation and Delivery of ITEMs of Equipment to designated Manitoba Hydro Sites in accordance with the Purchaser's Requirements.

3.2 The Work is more fully described in PART II – PROPOSED CONTRACT DOCUMENTS General Requirements and Technical Requirements of this RFP.

3.3 If the Work has been divided for pricing purposes into ITEMs, such ITEMs may be purchased separately or collectively under one (1) or more contract(s) with one (1) or more successful Proponents.

3.4 Manitoba Hydro's detailed requirements for performance of the Work are set out in PART II – PROPOSED CONTRACT DOCUMENTS in the Supplementary Technical Requirements of this RFP.

3.5 The Term of each Contract awarded pursuant to this RFP shall be three (3) years with an option to extend for two (2) additional one (1) year periods.

3.6 For first time suppliers to Manitoba Hydro of the type(s) of Equipment specified in this RFP, Manitoba Hydro may limit the award to one (1) ITEM upon a successful inspection by Manitoba Hydro of their proposed manufacturing facility. The Purchaser has the option to award additional ITEMS to the Contractor upon successfully delivering the Work.

3.7 For suppliers who have supplied Equipment to Manitoba Hydro in the last five (5) years with resulting performance problems (as identified by Manitoba Hydro), Manitoba Hydro may limit the award to one (1) ITEM, if the Proponent meets the requirements of the RFP evaluation process. Performance problems include design, quality and delivery issues as identified by Manitoba Hydro. The Purchaser has the option to award additional ITEMS to the Contractor upon successfully delivering the Work.

3.8 Proponents proposing to use new manufacturing facilities shall also be subject to the requirement for a satisfactory facility inspection by Manitoba Hydro prior to any award.

3.9 During the Term of awarded Contracts, Manitoba Hydro intends to add to each Contractor's original scope of Work by placing additional future orders for equipment provided that the Contractor's performance under the Contract awarded has been satisfactory and that highly competitive pricing and Delivery dates can be agreed.

4. SCHEDULE OF THE WORK

4.1 Manitoba Hydro's required Delivery dates for each specific ITEM is indicated in the PART II – PROPOSED CONTRACT DOCUMENTS, Supplementary Technical Requirements of this RFP.

4.2 Manitoba Hydro's Evaluation Process provided in this RFP will assess Proponent responses respecting proposed pricing and potential scheduling on an ITEM by ITEM basis.

5. SITE LOCATION AND ACCESS

5.1 The Site, for purposes of Delivery will be at various Manitoba Hydro locations identified with associated access information in the Supplementary Technical Requirements of PART II – PROPOSED CONTRACT DOCUMENTS of this RFP.

6. SITE VISIT – [intentionally left blank]

7. EXAMINATION OF THE SITE AND ADDITIONAL INFORMATION - [intentionally left blank]

8. PERFORMANCE BOND [intentionally left blank]

9. MANITOBA BUSINESS INVOLVEMENT

9.1 Manitoba Hydro encourages Proponents to actively promote the participation of Manitoba Business in the Work which terms are defined as follows:

9.1.1 **"Manitoba Business"** is a business which is registered to do business in the Province of Manitoba, and the firm, or its principals, maintains their facilities, equipment and staff in Manitoba on a continuous basis.

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

10. ENVIRONMENTALLY PREFERABLE PRODUCTS

10.1 It is the desire of Manitoba Hydro to use environmentally preferable products, if practicable.

10.2 Proponents able to supply products that are environmentally preferable that meet Manitoba Hydro's performance requirements are encouraged to propose them as an alternative within their Proposal.

10.3 If such alternative product(s) can be demonstrated to be environmentally preferable when compared to that specified, Proponents are requested to provide complete details of such product(s) in the applicable Form in its Proposal, or summarized on that page and detailed in an annex to its Proposal.

11. PROPOSED USE OF 'EQUALS'

11.1.1 Whenever a component of the Work is specified in Manitoba Hydro's requirements by describing a proprietary product or by using the name of a manufacturer or vendor, the words "or Equal" shall be implied.

11.1.2 References to the component of the Work so described or named shall, accordingly, be understood as indicating the type, function, minimum standard of design, efficiency and quality required and shall not exclude any other manufacturer's product of equivalent or superior quality, design and efficiency (an "**Equal**").

11.1.3 If the Proponent wishes to propose use of an Equal instead of a specified component of the Work, the Proponent is requested to provide information in support of an Equal determination in its Proposal together with information on the change in the proposed price if the proposed Equal is accepted.

11.1.4 No unapproved Equal shall be supplied or incorporated into the Work without Manitoba Hydro's prior approval in writing.

12. OVERVIEW OF THIS NON-BINDING PROCUREMENT PROCESS

12.1 **Manitoba Hydro Requirements**

12.1.1 PART II – PROPOSED CONTRACT DOCUMENTS of this RFP includes Manitoba Hydro's standard form Articles of Agreement in draft form, Definitions and General Conditions together with Project specific General Requirements, Technical Requirements, and Supplementary Conditions (if any) for performance of the Work.

12.1.2 Manitoba Hydro seeks Proposals which respond to its stated requirements however recognizes that experienced vendors/contractors may be capable of adding value during the procurement process, if given the opportunity to attempt to do so.

12.2 **Non-Binding Process**

12.3 Submitted Proposals may be revoked by the Proponent and withdrawn at any time.

12.4 As a first step in the evaluation process, Manitoba Hydro will review submitted Proposals for compliance with mandatory submission requirements to allow Proponents to rectify such deficiencies within a limited time period as provided in Section 21 – Review and Rectification of Mandatory Requirements.

12.5 Following the Rectification process, one, some or all eligible Proponents may be invited to a confidential Interview as contemplated by Section 22 – Interviews below.

12.6 Then the written Proposals which satisfied the mandatory submission requirements will be evaluated in accordance with criteria set out in Section 23 - Evaluation Criteria below.

12.7 Manitoba Hydro may request additional evidence from one, some or all Proponents to further evaluate their capability to successfully perform the Work as provided in Section 24 – Evidence of Proponent Ability, Experience, Capital and Plant.

12.8 The top-ranked or the Preferred Proponent may be invited to commence negotiations with Manitoba Hydro as provided in Section 25 – Negotiation Process below for possible agreement on terms for a contract for performance of the Work.

12.9 Manitoba Hydro may terminate negotiations and move on to the next-ranked or then 'Preferred' Proponent until terms for a satisfactory contract can be agreed or the process cancelled.

13. PROPOSED MODIFICATIONS TO PART II DOCUMENTS

13.1 **Manitoba Hydro's General Conditions**

13.1.1 Manitoba Hydro prefers that all Proponents submit Proposals based upon the standard General Conditions included in this RFP in PART II – PROPOSED CONTRACT DOCUMENTS.

13.1.2 Where, however, a Proponent is of the view that some modification to these standard terms may enhance the Project and Manitoba Hydro's 'best solution' considerations, the Proponent may propose modification(s) to the General Conditions in its Proposal setting out the proposed wording for the change and identifying the benefit to Manitoba Hydro and/or the Project which is to result from the proposed change.

13.2 **Manitoba Hydro's General Requirements and Technical Requirements**

13.2.1 Manitoba Hydro invites Proponents to consider and propose possible solutions to establish a long term supply agreement of Auto Transformers, Shunt Reactors and Phase-Shifting Transformers.

13.3 **Treatment of Proposed Modifications**

13.3.1 Proponents shall clearly indicate in its Proposal each modification from the PART II – PROPOSED CONTRACT DOCUMENTS which is reflected in its plans and pricing submitted and which is intended to be considered by Manitoba Hydro during its evaluation process.

13.3.2 Where a Proponent has priced its Proposal on Manitoba Hydro PART II – PROPOSED CONTRACT DOCUMENTS but has 'alternatives' to suggest only in the event that it is invited to negotiate, such alternatives shall be clearly identified as such and will not be considered for evaluation purposes.

13.3.3 Every modification referred to in the Proponent's Proposal shall be identified at the appropriate location in its Proposal with the following information expressly provided:

(a) Identify the specific document(s) and section(s) of each document in PART II - PROPOSED CONTRACT DOCUMENTS which has been:

i) modified for purposes of pricing, plans, etc. included in the Proponent's Proposal; or

ii) merely listed as an 'alternative' for consideration in the event of any negotiations;

(b) Provide revised wording for each section of any document 'modified' for purposes of the Proponent's Proposal or identified as an alternative;

(c) Provide details of the rationale for each such proposed modification or identified alternative, including why and to what extent such modification or alternative is proposed to improve economies and/or enhance performance of the Work, together with the Proponent's estimates quantification of the monetary or other benefit to result for Manitoba Hydro.

14. PROPONENT REQUESTS FOR CLARIFICATION

14.1 Manitoba Hydro encourages each Proponent to submit clarification requests, questions and comments to ensure that Manitoba Hydro's requirements and intent set out in this RFP are correctly understood.

14.2 If a Proponent requires additional information or explanation concerning any lack of clarity, apparent gap, ambiguity, or possible conflict in PART I – PROCUREMENT PROCESS, in PART II – PROPOSED CONTRACT DOCUMENTS or any other data provided by Manitoba Hydro, the Proponent shall inquire of Manitoba Hydro as provided below in Section 15 – Enquiries.

14.3 If, in the opinion of Manitoba Hydro, an amendment to this RFP is required as a result of any Proponent's clarification request, question or comment, Manitoba Hydro shall issue an addendum.

15. ENQUIRIES

15.1 Proponent enquiries and requests for clarification concerning this RFP are to be submitted in writing by fax or email using the Proposal Clarification Form which is Attachment A to this PART I – PROCUREMENT PROCESS of the RFP.

15.2 Manitoba Hydro will respond to all enquiries received more than seven (7) calendar days prior to Submission Close. Enquiries received after this date may arrive too late to be duly considered or answered.

15.3 Where a Proponent seeks a clarification which involves disclosure of any confidential intellectual property or proprietary business information, Manitoba Hydro shall not release any such confidential information to other Proponents; however, Manitoba Hydro reserves the right to notify others participating in the RFP process of:

15.3.1 updates or changes to this RFP involving correction of errors identified by one or more Proponents;

15.3.2 deviation from any particular constraint or requirement set forth in this RFP granted as a result of a request for deviation that Manitoba Hydro, in its sole discretion, deems acceptable; and

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

15.4 A Proponent shall not be entitled to rely on any comment or interpretation made in response to an enquiry unless that comment or interpretation is issued as an addendum to this RFP.

16. ADDENDA

16.1 Manitoba Hydro may, at any time prior to the date of Submission Close, issue addenda changing this RFP, and all addenda shall be an integral part of this RFP.

17. JOINT VENTURES/CONSORTIA

17.1 A Proponent which is comprised of more than one legal entity (such as a joint venture or consortium of corporations) must name one (1) duly authorized contact person in its Proposal for purposes of all communications in respect of this RFP process.

17.2 Such a Proponent is to complete and submit its Proposal disclosing the proper legal name of each separate legal entity which is a member of the Proponent.

17.3 Each member of a multi member Proponent shall sign the Proposal indicating the office of the individuals who have been duly authorized to sign the Proposal on behalf of each specific member.

17.4 Where more than one legal entity combines to form a Proponent, all such entities shall undertake in the Proposal to be jointly and severally bound by the Proposal submitted and by any resulting contract.

17.5 A copy of the written agreement binding the legal entities involved in jointly and severally submitting a Proposal shall be provided to Manitoba Hydro with the Proposal.

17.6 An organizational chart shall be provided with the Proposal, detailing the Proponent's intended organizational structure for performance of the Work including the name of each member and its responsibilities in the event of award of a contract to perform the Work.

17.7 A joint venture Proposal does not give a Proponent any preference under the evaluation criteria.

18. PROPOSAL FORMS

18.1 The Proponent is requested to use the Proposal Forms included in this RFP.

18.2 Additional information forming part of the Proponent's Proposal is to be submitted in accordance with the instructions set out in the Form(s). If any Form is found to have insufficient space, the Proponent is requested to attach a sheet or sheets immediately after the applicable page.

18.3 Each Proponent is encouraged to include in its Proposal thorough and sufficient information concerning matters under consideration.

18.4 Manitoba Hydro shall own all information submitted by a Proponent in its Proposal and shall have the right to use such information for any purpose whatsoever.

18.5 Information submitted in a Proposal, other than the Proponent's pricing information, shall not be required to be treated as confidential unless otherwise agreed to in writing by a Proponent and Manitoba Hydro.

19. SIGNING OF PROPOSALS

19.1 A Proposal submitted by:

(a) an individual shall be signed by the individual in the presence of a subscribing witness;

(b) a corporation shall be signed by its duly authorized signing officer(s) in the presence of a subscribing witness or witnesses; and

(c) a partnership or joint venture shall be properly signed by each partner or joint venturer in the presence of a subscribing witnesses.

19.2 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.

19.3 Each signature shall be accompanied by a legibly printed name identifying the signatory.

19.4 Where a Proponent is or includes a First Nation Band, its Proposal shall be accompanied by an effective Band Council Resolution signed by the requisite quorum of Council authorizing submission of the Proposal on behalf of the First Nation Band.

20. SCHEDULE FOR THIS PROCUREMENT PROCESS

20.1 Manitoba Hydro intends to conduct this procurement process in accordance with the schedule set out below.

Step in the Procurement Process	Date
Enquiries	Seven (7) Calendar Days prior to Submission Close
Submission Close	Refer to Section 2.1 of Instructions to Proponents PART I – PROCUREMENT PROCESS
Technical Clarifications	Two (2) to four (4) weeks from Submission Close
Evaluation of Proposals Complete	Four (4) to six (6) weeks from Submission Close
Notice to Preferred Proponent(s)	Four (4) to six (6) weeks from Submission Close
Commencement of Negotiations with Preferred Proponent(s)	Six (6) to eight (8) weeks from Submission Close
Intended Contract Award(s) where no Manufacturing Facility Inspection Required	Eight (8) to ten (10) weeks from Submission Close

21. REVIEW AND RECTIFICATION OF MANDATORY SUBMISSION REQUIREMENTS

21.1 Following Submission Close all Proposals submitted on time shall be reviewed by the evaluation committee to determine if the mandatory submission requirements set out in these Instructions to Proponents have been satisfied.

21.2 If a Proposal fails to satisfy all mandatory submission requirements, Manitoba Hydro will issue a rectification notice to the Proponent identifying each deficiency and providing the Proponent a period of 5 calendar days (the “Rectification Period”) to correct the identified deficiencies.

21.3 If the Proponent fails to satisfy the mandatory submission requirements within the Rectification Period, its Proposal will be excluded from further consideration.

21.4 The mandatory submission requirements are as follows:

INSTRUCTIONS SECTION	MANDATORY SUBMISSION REQUIREMENT
17.1	Name of duly authorized contact person [multi-member Proponent only]
17.2	Proper legal names for each member of Proponent [multi-member Proponent only]
17.5	Provision of multi-member agreement [multi-member Proponent only]
17.6	Organizational chart for Proponent members and responsibilities [multi-member Proponent only]
19.1	Signatures

22. INTERVIEWS

22.1 The evaluation team may conduct an interview with one, some or all Proponents whose Proposal(s) fulfill(s) the mandatory requirements following any Rectification Period (an “Interview”).

22.2 Each such Proponent will be invited to make a brief presentation on its Proposal for performance of the Work in accordance with an outline which Manitoba Hydro shall provide at least seven (7) days prior to commencement of Interviews.

22.3 During each Interview, Manitoba Hydro may request that the Proponent respond to specific questions regarding its proposed plans for managing the Work and its proposed technical solution(s).

22.4 All Interviews will be conducted at Manitoba Hydro’s offices in Winnipeg, Manitoba unless otherwise indicated by Manitoba Hydro.

22.5 The result of discussions during the Interview shall be taken into account during evaluation and ranking of each Proposal.

23. EVALUATION CRITERIA

23.1 To assess with which, if any, Proponents, Manitoba Hydro may wish to make presentations attend interviews and/or commence negotiations. Proposals will be evaluated using the following criteria (in no particular order of preference). Manitoba Hydro will assess and determine, in its sole discretion, the overall best value for Manitoba Hydro in the evaluation of Proposals received.

23.2 For the purposes of evaluation, Manitoba Hydro may take into account any or all of the information received from a Proponent under or pursuant to this Request, Manitoba Hydro’s knowledge of, and past experience with, the Proponent (including Proponent’s performance on previous contracts with Manitoba Hydro, if any), and any information about the Proponent received from third parties and deemed reliable by Manitoba Hydro.

23.3 First Stage of Evaluation Process

23.4 All Proposals will be evaluated on the following and must meet all of the following criteria, in Manitoba Hydro's determination, in order to proceed to the second stage of the evaluation process:

(a) Technical Requirements

(b) The Proponent to provide examples of directly related previous experience in the past ten (10) years for each of the ITEMs identified within the Scope of the Work that have been successfully manufactured and delivered. These ITEM examples should detail the application, customer (including references) and ratings for each.

23.5 Failure to meet the above-specified criteria will result in the Proponent's Proposal from not proceeding for further evaluation.

23.6 Proposals of Proponents which meet the above criteria will proceed to the second stage of evaluation by Manitoba Hydro in accordance with the General Evaluation Criteria set out in the Subsection below:

23.7 Second Stage of Evaluation Process

(a) Total evaluated cost per ITEM. Total evaluated cost includes base pricing and loss evaluation costs, based on a defined formula provided by Manitoba Hydro.

(b) Delivery Dates

(c) Manufacturing facility and location

(d) Commercial compliance

(e) Logistics Plan

(f) Overall Design

23.8 For Proposal evaluation purposes, Manitoba Hydro will convert U.S. proposed prices on the basis of the Canadian exchange rate set by the Bank of Canada on the date of Submission Close.

23.9 **Manitoba Content**

23.9.1 All other evaluation results being reasonably equal, preference shall be given to a Proposal which maximizes Manitoba Content where the following definition shall apply:

23.9.2 **"Manitoba Content"** means manufacturing, labour, materials and/or transportation proposed to be provided by one or more Manitoba Businesses which Manitoba Hydro determines, in its sole and unfettered discretion, are likely to result in benefits that provide a positive economic impact to the Province of Manitoba.

23.9.3 See Section 9 – Manitoba Business Involvement of this RFP for definition of terms used in 22.9.2 above.

23.10 **Unbalanced Pricing in a Proposal**

23.10.1 The price proposed for each ITEM in the Proponent's Proposal shall be a reasonable price for such ITEM in the judgment of Manitoba Hydro.

23.10.2 One or more manifestly unbalanced unit prices or lump sum prices set out in a Preferred Proponent's Proposal may be challenged by Manitoba Hydro during any negotiations with a Preferred Proponent.

24. EVIDENCE OF PROPONENT ABILITY, EXPERIENCE, CAPITAL AND PLANT

24.1 Manitoba Hydro may require a Proponent to furnish evidence in addition to any provided in its Proposal to satisfy Manitoba Hydro that the Proponent has the ability, experience, capital and plant required to perform the Work successfully and to complete within the specified time.

24.2 As part of the evaluation process, Manitoba Hydro may inspect any plant and/or facilities that the Proponent proposes to use for doing the Work.

25. NEGOTIATION PROCESS

25.1 Upon completion of the evaluation process, Manitoba Hydro may invite the top-ranked or its **"Preferred Proponent"** to enter into negotiations to finalize a contract for performance of the Work.

25.2 The PART II - PROPOSED CONTRACT DOCUMENTS in this RFP form the basis for negotiations between Manitoba Hydro and the Preferred Proponent.

25.3 Any modifications or enhancements to Manitoba Hydro's requirements issued in PART II – PROPOSED CONTRACT DOCUMENTS which were included in the Preferred Proponent's Proposal or referenced for possible negotiation may be further considered.

25.4 Negotiations may include requests by Manitoba Hydro for supplementary information to verify, clarify or add to information provided by the Proponent in its Proposal or to confirm the conclusion reached in the evaluation, and may include requests by Manitoba Hydro for improved pricing or performance terms from the Preferred Proponent.

25.5 Manitoba Hydro intends to conclude negotiations with its Preferred Proponent within a period of approximately, 20 business days commencing from issuance of the invitation to enter into negotiations.

25.6 If the parties cannot conclude negotiations and finalize terms for the intended contract within the time period above, Manitoba Hydro may discontinue negotiations with the top-ranked Proponent and invite the next-best-ranked or subsequent Preferred Proponent to enter into negotiations, which process may continue until:

25.6.1 a contract for performance of the Work is successfully negotiated and executed;

25.6.2 there are no more eligible Proponents remaining; or

25.6.3 Manitoba Hydro elects to cancel this RFP process.

26. AMENDMENT OF PROPOSAL

26.1 A Proponent may amend its submitted Proposal on MERX at any time prior to Submission Close.

26.2 A Proponent may not amend its Proposal after the Submission Close except at the written request of Manitoba Hydro.

26.3 In order to advance toward a formal and binding contract during negotiations, Manitoba Hydro may issue a written request to the Preferred Proponent for specific amendment(s) to its Proposal, and if the Proponent finds the request satisfactory, shall provide the requested amendment(s) via email, fax or letter.

26.4 All amendments must be signed by the person or persons having the authority to bind the Proponent.

26.5 Manitoba Hydro shall consider each Proponent's Proposal to be the Proponent's best position for entering into negotiations and for seeking award of a contract to perform the Work.

27. WITHDRAWAL OF PROPOSAL

27.1 At any time throughout the procurement process prior to execution of Articles of Agreement, a Proponent may revoke and withdraw a submitted Proposal by either removing the Proposal from MERX if withdrawal is prior to Submission Close or by providing written notice to Manitoba Hydro if withdrawal is after Submission Close.

27.2 Written notice of withdrawal of a Proposal must be duly signed by the authorized representative of the Proponent.

27.3 Manitoba Hydro is under no obligation to return withdrawn Proposals.

28. BINDING CONTRACT

28.1 Manitoba Hydro and its Preferred Proponent shall evidence any agreement as to the final terms of a contract to perform the Work by the execution of Articles of Agreement, a draft form of which is provided in PART II - PROPOSED CONTRACT DOCUMENTS of this RFP.

28.2 Until execution of duly completed Articles of Agreement by both parties, there shall be no legal or other binding obligation created on the part of either party with respect to this non-binding RFP process or with respect to performance of the Work.

29. TERMS AND CONDITIONS OF RFP PROCESS

29.1 Defined words and phrases used in PART I – PROCUREMENT PROCESS of this RFP have the meanings ascribed to them in the body of these Instructions to Proponents (“ITP”).

29.2 Proponents shall also have regard to the Contract Definitions set out in PART II – PROPOSED CONTRACT DOCUMENTS of this RFP for defined terms relevant to performance of the Work.

29.3 All references to days or weeks in these ITP shall mean calendar days or calendar weeks, as applicable.

30. LANGUAGE

30.1 Proposals must be prepared and submitted in the English language, including any Forms and all other submissions made in response to this RFP.

30.2 All communications respecting this RFP must be conducted in fluent English, or the Proponent may be required to provide satisfactory translation services at its sole expense.

31. APPLICABLE LAWS

31.1 All matters arising out of or related to the procurement process under this RFP (including, without limitation, contracts (if any) arising here from) 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 a Proponent may be resident of or domiciled in any other province or country.

31.2 Each Proponent irrevocably submits and attorns to the exclusive jurisdiction of the Court of Queen’s Bench of Manitoba, Winnipeg Centre.

31.3 Neither *The International Sale of Goods Act, C.C.S.M. c. S11*, nor the United Nations Convention on Contracts for the International Sale of Goods referred to in that Act shall have any application to Manitoba Hydro or to persons responding to this RFP or entering into any Contract for performance of the Work.

32. CORRUPT OR FRAUDULENT PRACTICES

32.1 Manitoba Hydro has the right at any time to reject any Proposal submitted by a Proponent or terminate negotiations with a Proponent if, in Manitoba Hydro’s determination, the Proponent has engaged in any Corrupt, Fraudulent, Collusive, or Coercive Practice or has breached any laws regarding corruption or fraud. For these purposes the following defined terms shall apply:

32.1.1 **“Coercive Practice”** means impairing or harming, or threatening to impair or harm, directly or indirectly, persons or their property to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

32.1.2 **“Collusive Practice”** means an arrangement between two or more persons (including, without limitation, a Proponent and any other person) designed to achieve an improper purpose, including but not limited to the establishment of prices for the Work at artificial, non-competitive levels in the procurement process or in the negotiation and signing of the Contract.

32.1.3 **“Corrupt Practice”** means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

32.1.4 **“Fraudulent Practice”** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, Manitoba Hydro, a Proponent, or any other person, to obtain a financial or other benefit or to avoid an obligation in the procurement process, or in the negotiation and signing of the Contract.

33. ELECTRONIC FILES

33.1 Manitoba Hydro does not represent or warrant that any electronic files provided under/with this RFP are usable, are error-free, or are free of viruses or other harmful or destructive properties.

33.2 Such electronic files, and any content/part thereof, are provided on an “as is” basis, without warranty of any kind.

33.3 The entire risk as to use of and/or reliance on such electronic files is assumed by the user.

34. DELIVERY AND RECEIPT OF DOCUMENTS

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

34.1.1 the timely delivery of any information or documentation, including, without limitation, this RFP, whether by mail, by courier, by hand, by MERX, or otherwise, in connection with this RFP;

34.1.2 the timely receipt of any Proposals, revisions, amendments, notice of withdrawals, or any other information or documentation from any Proponent or potential Proponent; or

34.1.3 the working order, functioning or malfunctioning, of any electronic information system (including MERX).

35. PROPONENT EXPENSES

35.1 The Proponent shall be solely responsible for all costs or expenses incurred in relation to the preparation of its Proposal, including any additional costs incurred in respect of a Site visit and any and all costs incurred in relation to any interviews, discussions and/or negotiations held with respect to this RFP and shall have no claim against Manitoba Hydro with respect to such costs or expenses in any event.

36. PROPOSAL OWNERSHIP

36.1 Proposals, once submitted, become the property of Manitoba Hydro.

37. NO CONTRACT A - NO CLAIMS

37.1 This RFP is not intended to create and shall not create a formal, legally binding ‘bidding’ process and shall instead be governed by the law applicable to direct commercial negotiations.

37.2 For greater certainty and without limitation:

37.2.1 This RFP shall not give rise to any Contract A based upon tendering law duties or any other legal obligations arising out of any procurement process contract or collateral contract; and

37.2.2 Neither the Proponent nor Manitoba Hydro shall have the right to make any claims (in contract, tort or otherwise) against the other with respect to the outcome of this RFP process, including any decision by Manitoba Hydro to enter into a contract with a Proponent, any decision by Manitoba Hydro to not enter into a contract with a Proponent or a decision by a Proponent to withdraw its Proposal.

38. NON-BINDING PRICE ESTIMATES

38.1 While pricing information provided in Proposals will be non-binding prior to signing of Articles of Agreement, such information will be assessed during evaluation of Proposals and the ranking of Proponents.

38.2 Any inaccurate, misleading or incomplete information provided by a Proponent, including withdrawn and altered pricing, could adversely impact any such evaluation or ranking or decision by Manitoba Hydro to continue negotiations or enter into a contract with a Proponent.

39. PRIVILEGE/DISCRETION

39.1 Manitoba Hydro makes no representation or warranty that responding to this RFP will result in any negotiations or any Contract.

39.2 Manitoba Hydro is under no obligation to permit rectification of any Proposal, evaluate any Proposal, enter into any negotiations with any Proponent or other person, or to award a contract pursuant to this RFP.

39.3 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, select any Proposal, select the lowest priced Proposal, or be precluded from selecting any Proposal or other offer or for determining that it will negotiate further in respect of any Proposal submitted.

39.4 Manitoba Hydro reserves the right, and the Proponent acknowledges that Manitoba Hydro has the right, to reject any, or all, Proposals for any reason, or to select, negotiate or accept any Proposal which Manitoba Hydro in its sole unfettered discretion deems advantageous to itself with no resulting liability to any Proponent.

39.5 Manitoba Hydro reserves the right in its sole discretion to cancel this RFP for any reason whatsoever, either before or after the Submission Close and regardless of whether or not any Proposals have been submitted.

39.6 Manitoba Hydro reserves the right in its sole discretion, for any reason whatsoever, to re-issue a request for proposals or tender for all or any part of the Work referred to in this RFP, at any time, including after the date of Submission Close.

40. WAIVER

40.1 By submitting a Proposal, the Proponent acknowledges Manitoba Hydro's rights, expressly reserved under this RFP 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 decision to not select the Proposal submitted by the Proponent, whether such right or cause of action arises in contract (including fundamental breach), negligence, bad faith, or otherwise.

REQUEST FOR PROPOSAL 039857

SUPPLY AND DELIVERY OF AUTO TRANSFORMERS, SHUNT REACTORS AND PHASE-SHIFTING TRANSFORMERS

PART II – PROPOSED CONTRACT DOCUMENTS

NOVEMBER 10, 2016

REQUEST FOR PROPOSAL 039857
SUPPLY AND DELIVERY OF AUTO TRANSFORMERS, SHUNT REACTORS AND PHASE-SHIFTING TRANSFORMERS

This Request for Proposal (RFP) is comprised of two (2) Parts:

PART I – PROCUREMENT PROCESS, and

PART II – PROPOSED CONTRACT DOCUMENTS

Part II Proposed Contract Documents include:

Articles of Agreement
Contract Definitions
General Conditions
General Requirements
Technical Requirements
Supplementary Technical Requirements
Apparatus Tests and Quality Control Program Requirements

ARTICLES OF AGREEMENT 039857

ARTICLES OF AGREEMENT

These Articles of Agreement effective as of [*insert month, day and year*] (the "Effective Date") by and between:

MANITOBA HYDRO

(the "**Purchaser**")

- and -

[*insert full legal name of Contractor in* **BOLD**, *uppercase*]

(the "**Contractor**")

IN CONSIDERATION OF the mutual promises and covenants of the Parties, and other good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the Parties agree as follows:

1. CONTRACT DOCUMENTS

1.1 Upon execution of these Articles of Agreement the Parties shall be bound to perform the Contact in accordance with the terms, and conditions, obligations and Purchaser's Requirements set out in the Contract Documents listed below, all of which are intended to be complementary so that what is binding in one shall be binding as if required by all.

1.2 If there is a conflict within the Contract Documents their order of priority, from highest to lowest shall be:

1.2.1 Articles of Agreement;

1.2.2 Contract Definitions;

1.2.3 *Supplementary Conditions*;

1.2.4 General Conditions;

1.2.5 General Requirements with Appendices;

1.2.6 Supplementary Technical Requirements with Appendices;

1.2.7 Technical Requirements with Appendices;

1.2.8 Apparatus Tests and Quality Control Program Requirements;

1.2.9 Purchaser's Drawings; and

1.2.10 Contract Forms, namely:

a) Contract Form 1 – Cost of the Work;
b) Contract Form 2 – [*insert title of Form*];
c) Contract Form 3 – [*insert title of Form*], etc.
d) [*Continue to list in proper order of priority all essential parts of the Form of Tender/Proposal necessary for inclusion in the Contract at time of award*.]

2. WORK

2.1 The Contractor agrees to perform the Work required by the Contract Documents for:

[*TITLE*]

3. CONTRACT PRICE

3.1 The Purchaser agrees to pay the Contractor for due performance of the Work at the agreed lump sums for completed ITEMs in Canadian/US dollars as set out in Contract Form 1 – Cost of the Work, in accordance with terms of the Contract.

3.2 The Contractor shall refer in each invoice to the Purchaser's Purchaser Order number [*insert number*] in respect of this Contract.

4. TERM OF THE CONTRACT

4.1 The Term of the Contract shall be three (3) years.

4.2 The Purchaser may request up to two (2) one (1) year extensions of the Term.

5. JOINT AND SEVERAL OBLIGATIONS [or '**NOT USED'**]

[*Include this Article 5 only when the Contractor consists of two or more separate legal entities acting as a partnership, joint venture or consortium, etc. Include the legal name of each such member on the first page and on the signature page of these Articles of Agreement. If the Contractor is not a joint venture, etc. delete the heading and this Article altogether and insert the words "Not Used" beside Article number 5 above.*]

5.1 [*insert legal name of Contractor member #1*], [*insert legal name of Contractor member #2*] and [*insert legal name of Contractor member #3, etc.*] hereby covenant and agree that each is jointly and severally liable with the other(s) to perform all Work and to satisfy all Contractor obligations under the Contract so that the Purchaser may look to any one or more of [*insert names of each Contractor member*] for the due and proper performance of all or any of the Contractor obligations under the Contract and for the performance of every part of the Work, regardless of any intended division of the Work between/among [*insert names of each Contractor member*] as part of their contractual business arrangement.

5.2 [*insert names of each Contractor member*] hereby designate [*insert name of individual together with title and name of his/her employer*], shall be the single point of contact for the multi-member Contractor who shall be responsible to give and receive formal communications on behalf of the Contractor during the Term of the Contract. The Purchaser shall be provided with immediate notice in writing from all members of the Contractor upon revocation, any temporary or permanent amendment to this designation.

6. NOTICES IN WRITING

6.1 To be effective, a notice required to be given in writing under the Contract must be given by personal service, facsimile transmission with acknowledgement of receipt or by letter delivered by registered mail addressed to the designated contact person named below:

6.1.1 Contractor:

[*insert full legal name of Contractor*]
[*insert street address*]
[*insert city, province/state,and postal/zip code*]
[*insert country, if required*]

Attention: [*insert contact name*]
[*insert position title*]
Fax: [*insert fax number*]

6.1.2 Purchaser:

Manitoba Hydro
[*insert street address*]
[*insert city, province/state,and postal/zip code*]

Attention: [*insert contact name*]

[*insert position title*]
Fax: [*insert fax number*]

6.1.3 Engineer [or Contract Administrator]:

Manitoba Hydro
[*insert street address*]
[*insert city, province/state,and postal/zip code*]

Attention: [*insert contact name*]
[*insert position title*]
Fax: [*insert fax number*]

6.2 Designation of any of these contact persons may be amended from time to time upon written notice duly given to each of the other persons noted above.

6.3 Notice given by personal service shall be effective upon receipt.

6.4 Notice given by fax shall be effective upon confirmation of successful transmission if received within the recipient's normal working hours, or otherwise, on the next business day following receipt.

6.5 Notice by registered mail within Canada shall be deemed received 5 days after the date of posting, or 10 days after posting to an address outside of Canada.

7. PUBLIC ANNOUNCEMENTS

7.1 The Contractor shall not make use of its association with the Purchaser in respect of the Contract or the Work, for publicity or promotion or in any public announcement without the prior express written consent of the Purchaser.

8. ENTIRE AGREEMENT

8.1 The Contract constitutes the entire agreement between the Purchaser and the Contractor with respect to the Work, and supersedes all prior negotiations, representations or agreements, either written or oral relating in any manner to the Work, including procurement documents not expressly listed in Article 1 – Contact Documents above.

9. AMENDMENT

9.1 The Contract may only be amended by an agreement in writing which is signed by duly authorized representatives of each Party.

10. SURVIVAL

10.1 Those provisions of the Contract which, by their nature are deemed to have been intended parties acting reasonably to survive expiry or termination of the Contract and all other provisions of the Contract necessary to give effect thereto, shall survive the expiry or termination of all or any part of the Contract.

11. ENUREMENT

11.1 The Contract shall be binding upon, and shall enure to the benefit of the Parties and their respective permitted successors and permitted assigns.

12. COUNTERPARTS

12.1 These Articles of Agreement may be executed 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.

12.2 Counterparts may be executed either in original and faxed form and the Parties agree to adopt any signatures received by a receiving fax machine as original signatures of the Parties provided that a Party providing its signature in such manner shall promptly forward to the other Party an original signed copy of these Articles of Agreement which were so faxed.

IN WITNESS WHEREOF the Parties hereby execute these Articles of Agreement by the hands of their duly authorized representatives.

MANITOBA HYDRO:

Signed:	______________________________ Authorized Signing Representative	Signed:	______________________________ Authorized Signing Representative
Name (print):	______________________________	Name (print):	______________________________
Title (print):	______________________________	Title (print):	______________________________
Date:	______________________________	Date:	______________________________

[insert full legal name of Contractor in bold, uppercase]

Signed:	______________________________ Authorized Signing Representative	Signed:	______________________________ Authorized Signing Representative
Name (print):	______________________________	Name (print):	______________________________
Title (print):	______________________________	Title (print):	______________________________
Date:	______________________________	Date:	______________________________

CONTRACT DEFINITIONS 039857

CONTRACT DEFINITIONS

When used in the Contract Documents, the following words and phrases shall, unless the circumstances otherwise require, have the following meanings:

Actual Cost means direct expenses reasonably incurred by the Contractor in performance of its obligations under the Contract, excluding GST. Actual Cost includes RST necessarily paid by the Contractor on such direct expenses. Actual Cost does not include any indirect cost to the Contractor or Contractor's Personnel including profit, overhead or damages alleged to be consequential upon modification to the scope of Work, suspension or termination of part or all of the Contract.

Articles of Agreement, when issued by the Purchaser, means the Contract Document signed by the Purchaser and Contractor upon entering into the Contract.

Change Order means the document or documents by which the Contractor is authorized by the Engineer to proceed with an in-scope change to the Work.

Completion Certificate means the document to be issued by the Purchaser upon final completion of the Work, or a Section of the Work, by the Contractor.

Confidential Information means all information provided by the Purchaser to the Contractor in respect of the Purchaser's operation and business and the Work which is not in the public domain.

Contract means the entire agreement entered into between the Purchaser and the Contractor upon execution of the Articles of Agreement or issuance of a Purchaser Order, as applicable, for performance of the Work by the Contractor in accordance with the Contract Documents and payment by the Purchaser of the Contract Price.

Contract Administrator means the Purchaser's designate appointed to administer the Contract where the designate is not a professional engineer. The Contract Administrator shall perform the roles and responsibilities of the Engineer and the term 'Engineer' when used in the Contract Documents shall, in that event, be read down to instead say 'Contract Administrator'.

Contract Dates means those dates and durations identified in Purchaser's Requirements by which the Contractor is to achieve completion of specified components of the Work.

Contract Documents means the Articles of Agreement, these Contract Definitions, Supplementary Conditions, if any, the General Conditions, the General Requirements, Purchaser's Drawings if any, the Technical Requirements, and Contract Forms listed in the Articles of Agreement, all appendices and attachments to the foregoing documents, and amendments to any of them duly executed by both Parties as provided in the Article 9 – Amendments of the Articles of Agreement.

Contract Forms means excerpts from the Contractor's form of tender or proposal submitted in response to the Purchaser's procurement process giving rise to award of the Contract, as negotiated and modified, if at all, and accepted by the Purchaser for inclusion in the Contract.

Contract Price means the amount set out as such in Contract Form 1 – Cost of Performing the Work, and:

a) in respect of the whole of the Work, means the total price to be paid by the Purchaser to the Contractor for due performance all Work, exclusive of Goods and Services Tax (GST); and
b) in respect of any ITEM of the Work, the total price to be paid by the Purchaser to the Contractor for due provision of that ITEM of the Work, exclusive of GST.

Contract Schedule means the detailed plan, if any, for the Contractor's performance and completion of the Work. Where applicable, the detailed plan is set out in Contract Form 2 – Schedule for Performing the Work and may be adjusted from time to time in accordance with the Contract.

Contractor means the Party named as such in the Contract.

Contractor's Documents means all documents to be created by the Contractor and delivered to the Purchaser to meet the Purchaser's Requirements.

Contractor's Facilities means the premises used by the Contractor for manufacturing, assembly, testing, and preparing Equipment and other materials for Supply to the Purchaser as well as the business premises of others in the Contractor's supply chain; and **Contractor's Facility** shall have similar meaning.

Contractor's Personnel means the employees, agents, representatives, suppliers and Subcontractors of the Contractor who participate in performance of the Work.

Contractor's Records means all documents which account for the Contractor's cost of performing the Work and complying with the Purchaser's Requirements.

Contractor's Representative means the individual duly appointed representative by the Contractor pursuant to General Conditions 15 – Contractor's Representative.

Day or **day** means a calendar day.

Delivery means the packaging, loading, and transport of Equipment, apparatus and other components of the Work required of the Contractor by the Purchaser's Requirements.

Dispute Notice means the document issued by one Party to the other to commence the Dispute Resolution Processes provided at General Conditions Part X – Dispute Resolution Processes including particulars of the matter in dispute as required by General Conditions to the Contract.

Effective Date means the date when the Contract came into effect, as set out in the Articles of Agreement or Purchase Order, as applicable.

Engineer means the professional engineer appointed by the Purchaser from time to time to administer the Contract. Where the Purchaser instead designates a Contract Administrator, the Contract Documents shall be deemed to be modified to replace the term 'Engineer' with 'Contract Administrator'.

Equipment means one or more hard goods component of the Work Supplied by the Contractor in accordance with the Purchaser's Requirements.

Escalation means the provision, if any, included in the General Requirements entitling the Contractor to Contract Price adjustments based upon variations during the Term in the cost of specified commodities or other components of the Work using a fixed rate, an index or indices specified.

Extra Work Order means the document or documents by which the Contractor is authorized by the Engineer to proceed with a change to the Work that is generally within the scope of the Work such as the addition of similar, upgraded or improved items required by the Purchaser.

Final Payment means the amount determined by the Engineer to be payable by the Purchaser to the Contractor, after the Completion Certificate has issued.

General Conditions means the Contract Document which sets out general provisions for performance of the Work and administration of the Contract including procedures for payment, suspension, termination and resolution of claims and disputes.

General Requirements means the Contract Document which sets out an overview of the scope of the Work, procedures relevant to the Project and to performance of the Work such as standards, scheduling, insurance, Performance Security, Payment Security, quality assurance, reporting, change procedures and Warranty obligations of the Contractor.

GST or **Goods and Services Tax** means the value added tax payable in Canada under the federal Excise Tax Act.

ITEM (or **Item**) means an aspect of the Work described in the General Requirements in respect of which the Contractor has provided a specific Contract Price for its associated performance obligations.

Labour and Material Payment Bond means a type of Payment Security obtained by the Contractor from a third party surety company to meet the Purchaser's Requirements and stand as security to protect non-parties to the Contract from payment defaults by the Contractor in respect of their performance of aspects of the Work.

Laws mean all national, state, provincial and local government legislation, regulations and by-laws in effect from time to time in the place or places where the Contractor performs the Work.

Letter of Credit means a type of Performance Security obtained by the Contractor from its bank to meet the Purchaser's Requirements and stand as security to protect the Purchaser against the cost of Contractor defaults under the Contract.

Liquidated Damages means the agreed genuine pre-estimate of the Purchaser's losses, costs and damages likely to result from Contractor delay or failure to achieve performance requirements for specified aspects of the Work as set out in the General Requirements.

Manitoba Business is a business which is registered to do business in the Province of Manitoba, and the firm, or its principals, maintains their facilities, equipment and staff in Manitoba on a continuous basis.

Northern Indigenous shall mean a First Nations, Non-status Indian, Metis or Inuit person who has resided in Manitoba, north of the Northern Affairs Boundary (Appendix B) for a cumulative period of five years or more.

Northern Indigenous Contractor is a Northern Business (including Indigenous joint venture, partnership or corporation):
(a) which is at least 51% owned and controlled by Northern Indigenous; and
(b) if the business has six or more full-time staff, at least one-third of them are Indigenous people.

Northern Business is a Manitoba Business is located within the Northern Affairs Boundary (Appendix B).

Notice to Arbitrate means a written notice formally served by one Party on the other initiating arbitration of a dispute as contemplated by Part X of the General Conditions.

Party or **Parties** means the Purchaser, the Contractor or both of them, as the case may be.

Payment Certificate means the document to be issued by the Engineer upon review and approval of Progress Statements submitted from time to time by the Contractor as applications for payment of portions of the Contract Price.

Payment Milestone means a specified stage in performance of the Work at which the Contractor is entitled to claim payment of a specified amount for satisfactory completion of a specified part of the Work as set out in Contract Form 1 – Cost of Performing the Work.

Payment Security means a Labour & Material Payment Bond, Statutory Holdback or other form of security intended to protect non-parties to the Contract from payment defaults by the Contractor in respect to specified beneficiaries who contribute to performance of the Work.

Performance Bond means the form of security required of the Contractor and provided by a third party surety company to protect the Purchaser, on its terms, against performance defaults by the Contractor.

Performance Holdback means the percentage to be deducted from amounts of the Contract Price otherwise due and payable to the Contractor to be retained and stand as security for the benefit of the Purchaser against Contractor defaults under the Contract the unused balance of which shall be released in accordance with terms of the Contract.

Performance Security means the forms and amounts of monetary protection the Contractor is required to provide under the General Requirements to protect the Purchaser from defaults under the Contract by the Contractor.

Progress Statement means the invoice, payment application or other form approved by the Engineer in which the Contractor is entitled to request payment by the Purchaser of some or all of the unpaid balance of the Contract Price.

Purchase Order means the numbered document by which the Purchaser, directs the Contractor to manufacture, supply and deliver certain ITEMs.

Purchaser means Manitoba Hydro Electric Board (Manitoba Hydro), its successors or assigns.

Purchaser's Drawings means detailed documents issued by the Purchaser setting out Purchaser's Requirements necessary to the Contractor's performance of the Work.

Purchaser's Requirements means the contents of any one or more of the Contract Documents entitled General Requirements, Purchaser's Drawings and Technical Requirements, including all attachments and performance standards which any of them incorporates by reference.

RST or **Retail Sales Tax** means the tax due to the provincial government under The Retail Sales Tax Act (Manitoba).

Section of the Work means an ITEM or other part of the Work specified in the Purchaser's Requirements in respect of which a Completion Certificate shall be issued and a Warranty period shall commence, separate from the whole of the Work.

Site means the location(s) specified in the Purchaser's Requirements for Delivery of Items and/or for provision of Support Services.

Statutory Holdback means the 7.5% deduction which the Purchaser is required to deduct and retain and release in accordance with provisions of The Builders' Liens Act (Manitoba) when the Project or the Work is not exempted from provisions of that Act.

Subcontractor means a person or entity having a contract with the Contractor for performance of a part of the Work, including without limitation the provision of design services, testing services, transportation services, Support Services, labour, material, supplies, rental equipment, Equipment components or apparatus.

Subsidiary Obligation means a cost to the Contractor of performing work of a type required by the Contract which is specified by the Purchaser as being incidental to performance of such work so that the specific cost shall not be claimed against or paid directly by the Purchaser but shall instead be deemed to have been included by the Contractor in the Contract Price agreed.

Substantial Performance has the meaning set out in The Builders' Liens Act (Manitoba).

Supplementary Conditions means the Contract Document containing amendments to the Purchaser's standard form General Conditions (Supply Only v.1), including these Definitions, which is provided, if at all, specifically for use with this particular Contract.

Supply means all of the design, engineering, manufacture, assembly and in-factory-testing of Equipment, apparatus or other components of the Permanent Work which are to be performed by the Contractor together with provision of any software, operation and maintenance manuals and other deliverables specified in the Purchaser's Requirements; and **Supplied** and **Supplying** shall have a similar meaning.

Support Services means those ITEMS of Work to be provided by the Contractor to assist the Purchaser with off-loading, assembly, installation by others, commissioning of Equipment Supplied, provision of operation, maintenance and training instructions to Purchaser's Personnel as specified in the Purchaser's Requirements.

Technical Requirements means the Contract Document in which the Purchaser has set out the detailed scope of Work together with performance obligations of the Contractor.

Term means the fixed time period specified for the Contract, including any renewals.

Warranty means the performance obligations of Contractor which commence upon issuance of the Completion Certificate and continue for the period of time specified in the General Requirements in respect of all or part of the Work.

Work means all of the Supply obligations of the Contractor, all Support Services to be provided by the Contractor, all goods, Equipment, materials, supplies, apparatus, machinery, spare parts and other deliverables to be provided by the Contractor, all Installation and construction to be performed by the Contractor to meet the Purchaser's Requirements.

year means the calendar year at issue, consisting of 365 or 366 days, as the case may be.

NOTE: Technical terms may also be defined and abbreviations may be specified in the Technical Requirements.

GENERAL CONDITIONS 039857

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PART I - GENERAL PROVISIONS

1. DEFINED WORDS AND PHRASES

1.1 Capitalized words and phrases used in the Contract Documents have the meanings ascribed to them in the Contract Definitions, or as expressly defined elsewhere in the Contract.

2. INTERPRETATION

2.1 If an ambiguity or discrepancy is found in the Contract Documents, notice shall be immediately given to the Engineer who shall issue any necessary clarification or instruction.

2.2 Articles of Agreement 1.2 or the Purchase Order, as applicable, sets out the priority to be given to the Contract Documents in the event of a conflict between or among any of them.

2.3 In the event that an inconsistency or discrepancy within the Contract Documents cannot be resolved on the basis of the priority of documents provided as above, the higher standard or specification as determined by the Engineer shall apply.

3. LANGUAGE, DIMENSIONS AND WEIGHTS

3.1 All oral and written communications required by the Contract shall only be in English. Any requirement for translation of Contractor communications into proper English shall be at the cost of the Contractor.

3.2 The design documents and the Work shall be executed in the system(s) of measurement specified in the Purchaser's Requirements.

3.3 Weights shall, unless otherwise expressly specified in the Purchaser's Requirements, be shown in kilograms and metric tonnes.

4. ERRORS IN CONTRACT DOCUMENTS

4.1 If a Party becomes aware of an error, omission or defect of a technical nature in a Contract Document, the Party shall promptly give notice of the error or defect to the Engineer and to the other Party.

4.2 If the Work includes design obligations and the Contractor suffers delay and/or incurs cost as a result of an error in the Purchaser's Requirements which a contractor well experienced in performing similar work exercising due care would not have earlier discovered to avoid the delay and/or cost suffered, the Contractor shall be entitled to give notice to the Engineer of a claim for time extension and/or adjustment to the Contract Price in accordance with General Conditions 35 – Contractor Claims.

5. INTELLECTUAL PROPERTY

5.1 All Contractor's Documents shall become the exclusive property of the Purchaser upon their making.

5.2 The Contractor represents and warrants that it owns all intellectual property rights in the Work or has right to grant to the Purchaser the licenses and any other rights in and to the Work. If the intellectual property rights are or will be owned by a third party, the Contractor represents and warrants that it has the right to sublicense to the Purchaser or that it will obtain for the Purchaser a license from the third party.

5.3 Ownership of any proprietary information or intellectual property contained in the Contractor's Documents shall remain with the Contractor.

5.4 The Contractor hereby grants the Purchaser an irrevocable, perpetual, free and royalty free, non-transferable, limited license to use, copy, publish and to allow third parties to use, the Contractor's Documents and all proprietary information contained in the Contractor's Documents for the purpose of completing, operating, maintaining, modifying, and repairing Equipment and other components of the Work supplied by the Contractor.

5.5 The Contractor shall include the following notation on all Contractor's Documents either directly or by reference:

[insert Contractor's Name] – (the "Contractor") hereby licenses Manitoba Hydro to use, copy and to allow third parties to use this document, and all proprietary information contained in this document for the purpose of completing, operating, maintaining, modifying, and repairing components and/or all of the Work provided by the Contractor."

5.6 The Contractor shall deliver to the Purchaser all software (in object code format only) that is required for the installation, operation and maintenance of the Work Supplied by the Contractor.

5.7 The Contractor hereby grants to the Purchaser a perpetual, fully paid-up, non-exclusive, transferable, royalty free, limited license to use and copy Contractor's software provided for the Purchaser's internal business purposes in respect of the installation, operation and maintenance of Equipment and other components of the Work Supplied by the Contractor.

5.8 The Contractor shall pay all royalties when due under or in respect of patents or other intellectual property rights pertaining to the Equipment or other components of the Work Supplied by the Contractor.

6. PURCHASER'S CONFIDENTIAL INFORMATION

6.1 The Purchaser owns and operates public utility assets which may be vulnerable to threat and damage and involve certain proprietary interests necessary to include as Confidential Information in the Purchaser's Requirements.

6.2 The Contractor and all Contractor's Personnel shall:

6.2.1 treat as confidential all information provided by the Purchaser in respect of its operations and the Work which is not in the public domain;

6.2.2 not use or disclose to any person or permit any person to use or disclose any Confidential Information without prior written permission from the Purchaser;

6.2.3 comply with any reasonable directions given by the Engineer or the Purchaser with respect to safeguarding or ensuring protection of the Confidential Information;

6.2.4 not directly or indirectly threaten to or in fact destroy, invalidate, or otherwise harm any Confidential Information or other property owned or controlled by the Purchaser;

6.2.5 ensure that all Contractor's Facilities used to access, copy, transmit or store Confidential Information shall be sufficiently secure to protect against unauthorized distribution or access to Confidential Information;

6.2.6 notify the Purchaser in writing immediately upon becoming aware of any threatened or actual unauthorized distribution or access to Confidential Information, and in any such event, take preventive and/or remedial actions that the Purchaser may reasonably require; and

6.2.7 from time to time upon request by the Purchaser or Engineer, acting reasonably, take actions required of Contractor and Contractor's Personnel to ensure compliance with this General Conditions 6.

7. ASSIGNMENT OF RIGHTS AND OBLIGATIONS

7.1 The Contractor shall not, without the prior written consent of the Purchaser, assign the Contract in whole or in part to any other person. The Purchaser may for any reason, in its sole discretion, withhold consent to any Contractor proposal for assignment. Any assignment for which the Purchaser's consent is granted shall not relieve the Contractor from any of its obligations under the Contract.

7.2 The Contractor hereby agrees that the Purchaser shall have the right at any time to assign the Contract, in whole or in part including the Warranty to any third party without consent or prior notice to the Contractor.

The Purchaser shall advise the Contractor in writing within ten (10) days of the occurrence of any such assignment.

PART II - ADMINISTRATION OF THE CONTRACT

8. THE ENGINEER

8.1 The Purchaser has appointed the Engineer to administer the Contract. On written notice to the Contractor, the Purchaser may at any time replace the Engineer. The Engineer may be an employee of the Purchaser.

8.2 The Engineer shall not amend the Contract.

8.3 The Engineer may exercise the authority that is attributable to the Engineer as specified in or necessarily to be implied from the Contract. Whenever the Engineer exercises a specified authority for which the Purchaser's approval is required under policies internal to the Purchaser, then (for purposes of the Contract) the Purchaser shall be deemed to have given approval.

8.4 Except as otherwise stated in these General Conditions:

8.4.1 whenever carrying out duties or exercising authority, specified in or implied from the Contract, the Engineer shall be deemed to act for the Purchaser;

8.4.2 the Engineer has no authority to relieve either Party of any duties, obligations or responsibilities under the Contract; and

8.4.3 any approval, acceptance, check, certificate, consent, examination, inspection, instruction, notice, proposal, request, review, 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.

8.5 The Engineer may delegate some or all of their authority to one or more individuals and shall notify the Contractor providing details as to the nature and extent of the delegation.

8.6 Unless the Parties otherwise agree, the Engineer shall not delegate the authority to determine any matter under General Conditions 8.8 – Determination of Claims.

8.6.1 any failure to disapprove any Work provided shall not constitute approval, and shall therefore not prejudice the right of the Engineer to reject the Work or a Section of the Work; and

8.7 The Contractor shall comply with written instructions given by the Engineer, on any matter related to the Contract. T.

8.8 **Determination of Claims**

8.9 Whenever these General Conditions provide that the Engineer shall proceed in accordance with this General Conditions 8.8 - Determination of Claims, the Engineer shall first consult with each Party seeking to reach agreement. If agreement is not achieved, the Engineer shall make a fair determination in accordance with the Contract, having due regard to all relevant circumstances.

8.10 The Engineer shall give notice in writing to both Parties of each agreement or determination made, with supporting particulars.

8.11 Each Party shall give effect to each agreement or determination unless and until revised under Part X of these General Conditions.

9. RECORDS

9.1 The Contractor shall:

9.1.1 keep full and detailed records necessary for the proper administration of the Contract and performance of the Work including, as the case may be, reports, schedules, books, accounts, correspondence, instructions, drawings, receipts, vouchers, memoranda, and records of labour force, Contractor's Plant, hours worked and rates required to properly appraise the progress of the Work;

9.1.2 provide to the Engineer with copies of any records when requested, other than those involving profits, expenses, or costs associated with sums payable on a lump sum basis under the Contract or to the composition of lump sum amounts;

9.1.3 provide the Engineer with reasonable access to any premises and to inspect and/or audit records, and permit copies to be made, provided such rights of review and copy shall not extend to audit of profits, expenses or costs associated with sums payable under the Contract or to the composition of lump sum amounts; and

9.1.4 preserve records related to performance of the Work for a period of not less than six (6) years from the date the Completion Certificate issues or such other longer period of time as may be required by the Laws.

10. NON-WAIVER OF RIGHTS

10.1 No action nor want of action on the part of either Party to exercise a right or remedy conferred upon either of them under the Contract shall be deemed to be a waiver on the part of that Party of any right or remedy available under the Contract.

10.2 No failure by either Party to require strict compliance by the other Party with any term or condition of the Contract shall constitute either an estoppel or waiver, nor otherwise prejudice the right of the opposing Party to claim the benefit of strict compliance.

PART III - EXECUTION OF THE WORK

11. CONTRACTOR'S GENERAL OBLIGATIONS

11.1 The Contractor shall completely perform the Work including, without limitation, the Supply and Delivery of the Work, within the timeframe(s) specified in the General Requirements and in accordance with the Purchaser's Requirements and shall remedy any defects in the Work in accordance with these General Conditions.

11.2 The Contractor shall ensure that all Equipment, materials or other goods Supplied and all Delivery and Support Services meet the Purchaser's Requirements and are performed in a competent, good and skillful manner.

11.3 The Contractor shall fully and completely perform all of its covenants and obligations under the Contract.

11.4 The Contractor shall promptly apply to the Engineer for any explanation which the Contractor may require as to the meaning or intent of any provision in the Contract Documents.

11.5 The Contractor represents and warrants that it possesses the expertise, skills, Personnel and Contractor's Facilities necessary to properly perform all aspects of the Work and complete the Contract in accordance with the Purchaser's Requirements.

12. PERFORMANCE AND PAYMENT SECURITY

12.1 The Contractor shall provide and maintain in effect all forms and amounts of Performance Security and Payment Security for the periods of time specified in the General Requirements.

12.2 The Contractor shall ensure that any third parties providing any such security shall meet the Purchaser's Requirements.

12.3 Claims by third party beneficiaries against any Payment Security provided under the Contract shall proceed in accordance with the terms of the specific form of security.

12.4 Subject to the terms of each type of Performance Security called for in the General Requirements, the Purchaser shall be entitled to recover against the Performance Security amounts to which the Purchaser is entitled under the Contract in the event of:

12.4.1 failure by the Contractor to extend the validity of any Performance Security specified in the General Requirements, in which event the Purchaser may claim the full amount of the Performance Security;

12.4.2 failure by the Contractor to pay the Purchaser an amount due as either agreed by the Contractor or determined under General Conditions – 8.8 Determination of Claims within 30 days after the agreement or determination;

12.4.3 failure by the Contractor to remedy a default or provide a reasonable plan to the Engineer for remedying the default within fourteen (14) days after receiving the Engineer's notice requiring the default to be remedied; or

12.4.4 any circumstance which entitles the Purchaser to termination under General Conditions 41-Termination for Breach of Contract, irrespective of whether notice of termination has been given.

12.5 The Purchaser shall indemnify and hold the Contractor harmless against and from all damages, losses and expenses (including reasonable legal costs) resulting from a recovery made against available Performance Security to the extent that the Purchaser is finally determined not to have been entitled to effect such recovery.

12.6 The Purchaser shall return the unused balance of the Performance Security to the Contractor as provided in the General Requirements.

13. SUBCONTRACTS

13.1 The Contractor shall not subcontract the whole of the Work.

13.2 The Contractor shall bind each Subcontractor to carry out all the provisions of the Contract applicable to the part or parts of the Work subcontracted, and each Subcontractor shall agree with the Contractor that all work performed by the Subcontractor shall be subject in all respects to applicable provisions of the Contract.

13.3 The Contractor shall not, without the prior approval in writing from the Purchaser, make a subcontract with any individual, firm or corporation for performance of any portion of the Work and the Contractor shall not remove a Subcontractor designated in the Contract Documents without timely notice and receipt of the Purchaser's written approval.

13.4 Any approval of a Subcontractor given by the Purchaser shall not relieve the Contractor from any obligation or liability for the full and complete performance of the Work in accordance with the Contract.

13.5 All Work performed by a Subcontractor shall be deemed to be performed by the Contractor. Personnel of a Subcontractor shall be deemed to be part of the Contractor's work force as Contractor's Personnel.

13.6 All claims against a Subcontractor, whether for wages, materials, damages, or otherwise shall be deemed by the Purchaser to be claims against the Contractor.

13.7 On request, the Contractor shall furnish the Engineer with duplicate copies of all written agreements with Subcontractors in respect of the Work.

14. WORK SAFETY

14.1 The Contractor shall comply with all Laws respecting workplace safety, wherever Work is performed.

15. MATERIALS, CONTRACTOR'S FACILITIES AND PERSONNEL

15.1 All materials necessary for manufacture of any Equipment and performance of the Work shall be new and all work performed and materials supplied pursuant to the Contract shall be of the specified quality, or otherwise of suitable quality as determined by the Engineer.

15.2 In all cases where work, material or Equipment of "approved" type or make is specified, the Engineer's approval in writing must be obtained before such work is begun, material ordered or Equipment is shipped.

16. INTERFERENCE BY OTHERS

16.1 Where any part of the Work depends for its proper or timely execution upon work to be done by others, the Contractor shall promptly notify the Engineer in writing of any actual or pending delay caused by others and of any errors, omissions or defects in the work of others which may result in increased cost or delay to the Contractor's proper performance of the Work.

16.2 Failure of the Contractor to give prompt notice of actual or apprehended interference by others and any prejudice resulting to the Purchaser from late notice shall be taken into consideration in the event that the Contractor subsequently submits a claim for extension of time or for adjustment of the Contract Price in respect of interference by others.

17. INSPECTION, DELIVERY AND ACCEPTANCE

17.1 The Work shall be subject to inspection and acceptance by the Engineer. Inspection and acceptance of the Work by the Engineer does not relieve the Contractor of its responsibility for defects or other failures to meet the requirements of the Contract. The Engineer will have the right to reject any work that is not in accordance with the requirements of the Contract and require its correction or replacement at the Contractor's expense.

17.2 The Contractor must provide the Engineer access to all locations where any part of the Work is being performed at any time during working hours. The Engineer may make examinations and such tests of the Work as they may think fit. The Contractor must provide all assistance and facilities, test pieces, samples and documentation that the Engineer may reasonably require for the carrying out of the inspection.

17.3 The Contractor shall perform all inspections and tests described in the Purchaser's Requirements.

17.4 Waiver by the Purchaser of any right of inspection or testing shall not relieve the Contractor from its full responsibility and liability for the quality, character, proper operation and performance of every aspect of the Equipment Supplied or any other Work performed, nor prejudice nor adversely affect rights of the Purchaser under the Contract including those set forth in General Conditions 36 – Contractor's Liability, 40 – Contractor's Default or 41 – Termination for Breach of Contract.

17.5 The Contractor shall prepare the Work for shipping as required by the Purchaser's Requirements and shall deliver the Work to the Site in the manner and on the Contract Date(s) specified in the applicable Purchase Order. Delivery of the Work shall be deemed complete upon delivery and acceptance of all manuals, instructions, reports and other documents required under the Contract.

17.6 The Purchaser shall inspect all ITEMs immediately upon Delivery and shall notify the Contractor of any damage to the packaging or the Work. The Engineer shall inspect the Work within 30 days of delivery and shall accept or reject the ITEMS in accordance with the Contract.

17.7 Upon acceptance of an ITEM, the Engineer shall certify payment for all or part of the amount claimed in the Progress Statement.

17.8 Upon delivery of all parts of the Work, the Engineer shall recommend and the Purchaser may issue a Completion Certificate for the Work.

18. FAULTY OR DEFECTIVE WORK

18.1 Prior to issue of the Completion Certificate, if, in the opinion of the Engineer, any component of the completed Work including any Equipment Supplied fails to comply with the Purchaser's Requirements, or if any tests indicate the existence of a failure, fault or defect in the Work performed or Equipment Supplied, the Engineer shall give the Contractor notice in writing together with particulars of such failure, fault or defect, and the Contractor shall, at the Contractor's expense, promptly re- execute or make good the faulty or defective Work or alter it to comply with the Purchaser's Requirements.

18.2 All tests or re-tests of rectified Work required by the Engineer or requested by the Contractor shall be carried out in the manner provided by the Contract Documents, if specified, or as may otherwise be approved by the Engineer.

18.3 If, after notification by the Engineer, the Contractor defaults or delays in diligently commencing, continuing and completing the making good the faulty or defective Work to comply with the Purchaser's Requirements, then the Purchaser may, on written notice to the Contractor, perform the remedial work or cause others to do so in any manner and by any means which the Engineer considers expedient or advisable.

18.4 The Contractor shall be liable for all remedial costs, charges and expenses reasonably incurred by the Purchaser and the Purchaser may immediately deduct the Purchaser's duly certified, invoiced amount for remedial work performed from amounts otherwise due to the Contractor or from available Performance Security, without need for the prior agreement of the Contractor or any determination by the Engineer.

18.5 The Contractor may dispute the amount of remedial costs recovered by the Purchaser in accordance with Part X of these General Conditions.

19. TITLE AND RISK OF LOSS

19.1 The Contractor warrants that it has good and marketable title to the Equipment, free and clear of any and all liens, restrictions, reservations, encumbrances or claims of any kind and that it will defend the Purchaser's title to the Equipment.

19.2 Risk of loss shall pass to the Purchaser upon acceptance of the Work. Items rejected by the Purchaser shall remain at the risk of the Contractor.

19.3 Title and all other property rights in and to all tangible personal property, and in and to all parts of tangible personal property forming part of an Item, shall pass to the Purchaser free and clear of all encumbrances, when Final Payment is made.

20. GENERAL DUTY TO MITIGATE

20.1 The Contractor shall use all reasonable efforts and all due diligence to mitigate and reduce the risk and extent to which Contractor may claim extensions of time and adjustments to the Contract Price.

20.2 The Contractor shall not be entitled to determinations or awards for time extensions or adjustments to the Contract Price that the Contractor could have mitigated against, reduced or avoided by the exercise of all reasonable efforts and all due diligence.

20.3 The Engineer may request and the Contractor shall promptly submit a detailed description supported by such documentation as the Engineer may require, setting out the measures and steps taken by the Contractor, if any, to mitigate the fact or the extent of a claim in compliance with this general duty to mitigate.

PART IV - PAYMENT FOR THE WORK

21. CONTRACT PRICE COMPONENTS

21.1 The components of the Contract Price are set out in Contract Form 1 – Cost of Performing the Work.

21.2 The cost to the Contractor of all Subsidiary Obligations shall, absent a clear, express provision to the contrary set out elsewhere in the Contract Documents, be deemed to be included in the Contract Price, such as:

21.2.1 customs duties;

21.2.2 surcharges;

21.2.3 premiums for insurance provided by the Contractor;

21.2.4 fees for permits and licences to be obtained by the Contractor;

21.2.5 royalty fees;

21.3 Canadian Goods and Services Tax (GST) is not included in the Contract Price.

21.4 Manitoba retail sales tax (RST) shall be treated as set out in Contract Form 1 – Cost of Performing the Work.

22. GOODS AND SERVICES TAX (GST)

22.1 The Contractor shall show GST as a separate amount payable in each Progress Statement issued together with the Contractor's GST registration number obtained under the *Excise Tax Act* (Canada).

22.2 The Purchaser is required to pay GST on the Contract Price.

23. OUT-OF-PROVINCE CONTRACTOR

23.1 Provisions of *The Tax Administration and Miscellaneous Taxes Act* (Manitoba) and *The Retail Sales Tax Act* (Manitoba) apply to any Contractor based outside of Manitoba with no permanent place of business in Manitoba.

23.2 The Purchaser must comply with requirements under the *Income Tax Act* (Canada) to deduct and remit withholding taxes where the Contractor is a non-resident of Canada.

24. DIRECT PAYMENTS BY PURCHASER

24.1 In the event that the Contractor fails to promptly paying any assessment, premium, tax, fee or compensation due to any person in respect of the Contractor's performance of the Work and obligations under the Contract, the Purchaser may, proceeding reasonably, elect to directly make payment to a person entitled to such payment.

24.2 The Contractor shall be liable for all direct payments reasonably made by the Purchaser on its behalf and the Purchaser may immediately deduct the Purchaser's duly certified, invoiced amount for direct payments made from amounts otherwise due to the Contractor or from available Performance Security, without need for the prior agreement of the Contractor or any determination by the Engineer.

24.3 The Contractor is entitled to dispute the reasonableness of the Purchaser's direct payment and recovery in accordance with Part X of these General Conditions.

25. PROGRESS STATEMENT

25.1 The Contractor shall submit a Progress Statement to the Engineer at the end of each month, or as otherwise specified in the Purchaser's Requirements or agreed with the Purchaser, as the Work progresses requesting payment for Work completed including under any Extra Work Orders, and/or for Payment Milestones achieved during the month.

25.2 The form of the Progress Statement shall be approved by the Engineer and the Contractor shall provide written evidence to substantiate the value of Work performed together with such additional documentation as the Engineer may require to evaluate each Progress Statement.

25.3 Subject to General Condition 25.4, not later than fourteen (14) days after receipt of a Progress Statement accompanied by all requested information, the Engineer shall issue a certificate for payment to the Purchaser in the amount claimed in the Progress Statement or in such other amount as the Engineer certifies is properly due to the Contractor.

25.4 If, in the opinion of the Engineer, Work included in a Progress Statement has not been completed, is deficient, or unsuitable, unnecessary or the cost claimed was improperly incurred, the Engineer may refuse to certify payment for all or part of the amount claimed in the Progress Statement.

25.5 Upon any amendment to a Progress Statement, the Engineer shall advise the Contractor in writing providing reasons for the amendments for each amount of the Contractor's Progress Statement denied.

25.6 No certificate of payment issued by the Engineer shall be deemed to be a final verification of quantities or quality or constitute acceptance of the associated Work claimed by the Contractor to be completed.

26. PROGRESS PAYMENT

26.1 Unless otherwise specified in the Purchaser's Requirements or agreed between the Parties, the Purchaser will make payment to the Contractor of amounts certified for payment by the Engineer within thirty (30) days of receipt of the certificate for payment less:

26.1.1 any Performance Holdback required to be deducted under the General Requirements;

26.1.2 any Statutory Holdback required to be deducted and retained;

26.1.3 any Liquidated Damages due from the Contractor;

26.1.4 any amount agreed by the Contractor or determined by the Engineer to be owing from the Contractor to the Purchaser; and

26.1.5 any amount(s) which the Purchaser is entitled to immediately deduct pursuant to an express provision of these General Conditions.

27. RELEASE OF PERFORMANCE SECURITY

27.1 Unless otherwise expressly provided in the General Requirements, unused portions of Performance Security provided by the Contractor shall be released to the Contractor within thirty (30) days of the issue of a Completion Certificate for the Work.

28. DELAYED PAYMENT

28.1 Should either Party fail to make any payment to the other when due under terms of the Contract including upon award by the arbitrator, monthly compounded interest at the rate of one and one half percent (1.5%) per annum above the prime business loan rate quoted from time to time by the Royal Bank of Canada shall be due and payable to the payee from date due to actual receipt of payment.

PART V - COMPLETION OF THE WORK

29. COMPLETION CERTIFICATE

29.1 The Purchaser shall specify in the Purchaser's Requirements whether any Section of the Work may be certified complete prior to completion of the whole of the Work.

29.2 As soon as the Engineer determines that the Work or a Section of the Work has been completely performed, the Engineer shall recommend and the Purchaser may issue a Completion Certificate to the Contractor for the Work.

PART VI - WARRANTY OBLIGATIONS

30. WARRANTY WORK, TIME PERIODS AND DEFAULTS

30.1 Warranty periods shall commence the day after a Completion Certificate issues

30.2 When more than one Section of Work is included in the Contract, more than one Warranty period may apply in which case the Warranty period for each Section shall commence on the date a Completion Certificate issues for that Section.

30.3 If, within the Warranty period(s) specified in the General Requirements, the Work or any part of the Work ceases to meet the Purchaser's Requirements, becomes broken or defective for any reason , including, without limitation, due to faulty or improper design, materials, workmanship, manufacture, fabrication, testing, shipment or delivery, then, upon notification in writing from the Engineer, the Contractor shall promptly make good every such breakage, defect or failure at the sole cost of the Contractor (including without limitation, transportation, removal, repair, replacement and installation costs).

30.4 If specified in the General Requirements, the Warranty period for Work or any part of the Work made good by the Contractor may be extended for a further period from the date when the remedial work is completed.

30.5 If, after notification is provided to the Contractor, the Contractor makes default or delays in diligently commencing, continuing and satisfactorily completing required Warranty work, then the Purchaser, having first given reasonable written notice to the Contractor, may proceed to rectify or have others rectify the Work, and invoice the Contractor for the Purchaser's resulting costs.

30.6 The Contractor shall be liable for all Purchaser's costs reasonably incurred to rectify the Work under Warranty and the Purchaser may immediately deduct the Purchaser's duly certified, invoiced amount for Warranty work performed from amounts otherwise due to the Contractor or from available Performance Security, without need for the prior agreement of the Contractor or any determination by the Engineer.

30.7 The Contractor may dispute the amount of Warranty rectification costs recovered by the Purchaser in accordance with Part X of these General Conditions.

30.8 The Contractor shall ensure that all manufacturer, supplier and Subcontractor warranties provided or obtained in relation to the Work are duly assigned and provided to the Purchaser, without need for further action or expense by the Purchaser.

PART VII - RISK AND RESPONSIBILITY

31. DELAYED PURCHASER'S DRAWINGS OR INSTRUCTIONS

31.1 The Contractor shall give notice to the Engineer whenever the Work is likely to be delayed or disrupted if a necessary drawing or instruction is not issued to the Contractor within a reasonable time stated. The notice shall include details of the nature and extent of delay apprehended by the Contractor and the Contractor's intended mitigation plan.

31.2 If the Engineer fails to issue the requested drawing or instruction within a reasonable time, and despite its mitigation efforts, the Contractor suffers delay and/or incurs costs as a result, the Contractor shall be entitled to claim extension of time and/or adjustment to the Contract Price under General Conditions 35 - Contractor Claims.

31.3 To the extent that failure by the Engineer to issue the requested drawing or instruction was caused by any error or delay by the Contractor, including time for submission of any Contractor's Documents, and to the extent that the Contractor failed to take reasonable mitigation measures, relief for the Contractor's claim shall be reduced or denied.

32. OWNERSHIP OF EQUIPMENT AND MATERIALS

32.1 Unless otherwise provided in the Contract, the Work or any part of the Work belongs to the Purchaser after delivery and acceptance in accordance with General Condition 18 - Inspection, Delivery and Acceptance.

32.2 The Contractor is responsible for loss or damage to the Work or any part of the Work until it is delivered to the Purchaser in accordance with the Contract. Where the Work or any part of the Work is returned to the Contractor under the Contract, the Contractor is responsible for loss or damage to the Work from the time the Work leaves the Site.

32.3 Transfer of ownership and risk of loss and damage to the Purchaser shall not relieve the Contract from any obligation under the Contract.

33. PURCHASER CAUSED DELAY

33.1 If the Contractor suffers delay and/or incurs additional costs as a result of:

33.1.1 an Extra Work Order issued by the Engineer in absence of agreement by the Contractor;

33.1.2 negligence or default on the part of the Purchaser;

33.1.3 negligence or default on the part of an other contractor; or

33.1.4 deviation from the Contract or temporary suspension of the Work by direction of the Engineer,

then the Contractor may make a claim for time extension and/or adjustment to the Contract Price in accordance with General Conditions 35 – Contractor Claims.

33.2 To the extent that the Contractor fails to take reasonable mitigation measures, relief for the Contractor's claim shall be reduced or denied.

34. REQUESTS FOR EXTENSIONS OF TIME

34.1 The Contractor shall be entitled to claim an extension of time for completion of the Work if achievement of a Contract Date including completion of the whole of the Work is or will be delayed by reason of an unforeseeable event beyond the control of either Party, including:

34.1.1 legal strikes or walkouts other than those involving Contractor's Personnel;

34.1.2 unpreventable accident;

34.1.3 terrorism, war or delay caused by war;

34.1.4 vandalism or malicious mischief;

34.1.5 riot or civil commotion;

34.1.6 acts of God;

34.1.7 lawful orders of civil or military authorities; or

34.1.8 unforeseeable inclemency of weather.

34.2 If such an event does not cause the Purchaser to, of its own initiative, adjust Contract Date(s) to relieve the Contractor, and the Contractor believes the event calls for relief in the form of an extension of time, and/or, in circumstances where the event occurred in Canada, adjustment to the Contract Price for costs associated with the delay, then the Contractor may make a claim in accordance with General Conditions 35-Contractor Claims.

34.3 To the extent that the Contractor fails to act promptly or to take reasonable mitigation measures, relief for the Contractor's claim shall be reduced or denied.

35. CONTRACTOR CLAIMS

35.1 **Notice of Intent to Claim**

35.2 If the Contractor deems itself to be entitled under a provision of the Contract to additional costs to perform the Work or to an extension of the time required to perform the Work, the Contractor shall give written notice of intent to claim in the form of a letter to the Engineer.

35.3 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.

35.4 If the Contractor fails to give written notice of a claim within the period of seven (7) days, the Contractor shall not be entitled to any adjustment to the Contract Price or to any adjustment to the Contract Schedule, and the Purchaser shall be discharged from all liability in connection with the claim.

35.5 **Claim Documentation**

35.6 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:

35.6.1 a description of the event or circumstance

35.6.2 the date(s) upon which the event or circumstance is said to have occurred; and

35.6.3 the date on which the event or circumstance first came to the attention of the Contractor.

35.7 Within fourteen (14) days after the Contractor has given a written notice of intent to claim, the Contractor shall prepare and update its notice and submit with the following additional information:

35.7.1 the claimed impact of the event or circumstance on the Contract Schedule and/or costs with all substantiating and supporting documentation reasonably available;

35.7.2 all clauses of the Contract relied upon by the Contractor;

35.7.3 details of the Contractor's mitigation efforts; and

35.7.4 any proposed resolution.

35.8 The Contractor shall also provide the Engineer with such further information and records as the Engineer may request.

35.9 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.

35.10 The Contractor shall control, track and fully document each claim submitted and all alleged impacts on performance of the Work from the 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.

35.11 Each Party shall take reasonable steps to mitigate adverse impacts arising from the event(s) giving rise to each Contractor's claim submitted.

35.12 The Engineer shall proceed in accordance with General Conditions 8.8 - Determination of Claims to promptly reject untimely claims submitted or, when a claim is submitted in accordance with requirements above, to first seek agreement of the Parties or, failing agreement, to determine each viable Contractor's claim received.

36. CONTRACTOR'S LIABILITY

36.1 **Indemnification**

36.2 To the extent attributable to or arising out of any breach of the Contract by the Contractor, or any negligent acts, errors or omissions or willful misconduct of the Contractor or Contractor's Personnel in the performance of the Work, including during the Warranty period, the Contractor shall indemnify and save the Purchaser harmless from and against any and all losses, costs, damages or expenses, which the Purchaser may suffer or be put to arising from any action, cause of action, suit, claim, liability, debt or demand which may be brought or made against the Purchaser by any third party, in respect of:

36.2.1 bodily injury, sickness, disease or death, of any person whosoever;

36.2.2 damage to or loss of any property, real or personal, including the Work;

36.2.3 alleged or actual non-compliance with environmental legislation or any other Laws.

36.3 **Labour and Materials**

36.4 The Contractor shall dispose promptly of any notice of claim for a builders' lien or trust claim received by the Purchaser, assume the defense of and shall indemnify and save harmless the Purchaser from and against all assessments, suits, claims and demands which may be brought or made by any individual, firm or corporation against the Purchaser for the value or price of work, services or materials furnished to or by the Contractor under the Contract.

37. INDIRECT DAMAGES

37.1 Neither Party shall be liable to the other Party for loss of use of any Work, loss of profit, loss of any contract, losses due to damage to reputation or for any indirect or consequential loss or damage which may be suffered by the other Party in connection with the Contract other than:

37.1.1 liability in respect of the indemnities described in General Condition 36 – Contractor' Liability; and

37.1.2 liability in any case of fraud, deliberate default or reckless misconduct by the defaulting Party.

38. ROYALTIES, INFRINGEMENT AND INDEMNIFICATION

38.1 The Contractor shall fully indemnify and save harmless the Purchaser from and against any and all actions, claims, demands, costs, charges and expenses arising under any third party patent or other intellectual property right including but not limited to a trade secret, copyright, trade mark or industrial design incurred by reason of an alleged infringement by the Contractor in performance of the Work, whether the claimed right is foreign or domestic, in respect of any components of the Work Supplied by the Contractor and by the Purchaser's subsequent use and operation of the Work for the purpose(s) set out in the Contract, but such indemnity shall not cover any use of the Work for purposes not reasonably inferred from the Contract.

38.2 The Purchaser shall promptly notify the Contractor of any infringement claim arising, consider with the Contractor the likely outcome of the claim, and the Purchaser shall then specify the timing, a reasonable amount and the form of security which the Contractor shall provide to protect the Purchaser from all loss, cost and damage which might arise from the claim.

38.3 The Purchaser shall not, unless and until the Contractor has failed to provide the requested security and taken over the conduct of the defence, negotiations or litigation, make any admission which might prejudice disposition of the claim.

38.4 Upon providing the Purchaser with the security requested, the Contractor shall, at its own expense, take conduct of the defence and any negotiations for the settlement of the claim, and any resulting litigation.

38.5 The Purchaser shall, at the request and sole cost of the Contractor, provide reasonable assistance for the purpose of contesting any such claim or action.

38.6 In the event that Equipment or other component of the Work Supplied by the Contractor is determined to constitute an infringement and its use enjoined, the Contractor shall either:

38.6.1 secure for the Purchaser the right to continue using the Equipment or other component of the Work by dismissal or suspension of the injunction, by procuring for the Purchaser a license, or other user permit, or shall,

38.6.2 at the Contractor's own expense:

(a) replace the infringing component of the Work with non-infringing components of the Work;

(b) modify the infringing component of the Work so that it becomes non-infringing, or

(c) remove the infringing Item and refund the Contract Price paid by the Purchaser for the Item.

39. IMPORTS

39.1 The Contractor shall be the importer of all non-Canadian goods and services required for performance of the Work.

PART VIII - DEFAULT AND TERMINATION

40. CONTRACTOR'S DEFAULT

40.1 If the Contractor:

40.1.1 abandons performance of the Work;

40.1.2 becomes bankrupt or insolvent or makes an assignment for the general benefit of creditors;

40.1.3 permits any execution to be levied on the Contractor's real or personal property or on any portion of the Work;

40.1.4 assigns or subcontracts the Contract other than in accordance with terms of the Contract;

40.1.5 fails to perform the Work in accordance with the Purchaser's Requirements;

40.1.6 fails to perform the Work within the time or times specified in the Contract;

40.1.7 refuses or neglects to follow the instructions of the Engineer;

40.1.8 fails to meet any of the Purchaser's Requirements within a reasonable time where no specific time is specified;

40.1.9 refuses or neglects to use appropriate measures to protect the Work from damage;

40.1.10 is careless or incompetent in the execution of the Work;

40.1.11 delays performance of the Work or any part of the Work unnecessarily or unreasonably; or

40.1.12 is in default of any other of its covenants or obligations in, or arising from the Contract Documents including any failure to provide or maintain any required Performance Security;

then the Purchaser may, at its option, and without prejudice to any other rights or remedies:

(a) at the Contractor's expense, obtain suitable replacement Item(s) at such price or prices as the Purchaser deems appropriate; and/or

(b) give notice of intention to terminate the Contract as provided in General Condition 41 – Termination for Breach of Contract.

41. TERMINATION FOR BREACH OF CONTRACT

41.1 If the Contractor defaults as set forth in General Conditions 40.1.1 through 40.1.6 above, the Purchaser may immediately terminate the Contract upon written notice to the Contractor.

41.2 Upon such notice, the Contractor shall discontinue performing the Work and shall have no further claim for payment in respect of Work done or material furnished to the date of termination.

41.3 If the Contractor defaults in any manner set forth in General Condition 40 – Contractor's Default paragraphs 40.1.7 through 40.1.13 above, the Engineer may give written notice of the specific default(s) to the Contractor, advising of the Purchaser's intent to terminate the Contract if the defaults are not promptly corrected by the Contractor.

41.4 If, within ten (10) days of receipt of such notice, the Contractor fails to remedy or take steps to remedy the default(s) to the satisfaction of the Engineer, the Purchaser, may, without prejudice to any other rights or remedies, by further written notice to the Contractor, terminate the Contract.

41.5 Following termination of the Contract, the Purchaser shall not be bound to make any further payment to the Contractor until the Work has been fully completed.

41.6 The Contractor shall be liable to the Purchaser for all loss, cost, damages, and expense which the Purchaser reasonably incurs on account of the Contractor's default and the subsequent termination of the Contract.

41.7 When the Work has been fully completed, the Purchaser shall certify the amount incurred by reason of the Contractor's default and resulting termination of the Contract. If the total incurred, when added to the monies paid to the Contractor to the date of termination:

41.7.1 are less than the balance of the Contract Price which would have been payable to the Contractor upon due completion of the Work, the surplus shall be paid to the Contractor; or

41.7.2 if the total exceeds the balance of the Contract Price which would have been payable to the Contractor upon due completion of the Work, the difference shall be a debt due and payable to the Purchaser by the Contractor.

41.7.3 Upon completion of the Work the Purchaser may immediately deduct the Purchaser's duly certified, invoiced amount for such costs from any unpaid balance of the Contract Price or from available Performance Security, without need for the prior agreement of the Contractor or any determination by the Engineer.

41.7.4 The Contractor may dispute the grounds for termination, or the Purchaser' costs invoiced and/or recovered as above in accordance with Part X of these General Conditions PROVIDED HOWEVER that the Contractor shall serve any such Notice of Dispute within fourteen (14) days of receiving notice of the

Purchaser's costs to complete or shall be deemed to have forever released the Purchaser from any requirement to arbitrate disputes arising under this Contract, whereupon the Purchaser shall be at liberty to pursue judgment in any court with jurisdiction to facilitate timely collection of amounts due from the Contractor or from its exigible assets.

42. TERMINATION FOR CONVENIENCE

42.1 The Purchaser may at any time, in its sole discretion and for its own convenience, provide a written notice to the Contractor immediately terminating the Contract, in whole or in part.

42.2 Upon termination for convenience the Purchaser shall be under no obligation to the Contractor other than to pay:

42.2.1 such compensation as the Contractor is entitled to receive for Work performed up to the date of termination; and

42.2.2 the cost of reasonable expenses incurred by the Contractor to wind down its performance under the Contract.

42.3 Any payment by the Purchaser upon termination for convenience shall be conditional upon the Contractor delivering and transferring possession and ownership to the Purchaser of all Contractor's Documents, material, and Equipment under the control of the Contractor as of the termination date.

42.4 The Contractor shall submit to the Purchaser vouchers, certificates, timesheets, invoices and any other supporting documentation reasonably requested by the Engineer showing the Actual Cost of expenses properly committed or incurred by the Contractor to the date of termination.

42.5 Termination of the Contract in part, with respect to any component of the Work, shall not terminate or otherwise affect the Contract remaining.

42.6 There may be more than one (1) partial termination of the Contract.

42.7 The Purchaser's liability shall be limited to provisions set out in this General Condition 42 with no liability nor any obligation to compensate the Contractor for any claims (including third party claims, lost profit, lost opportunity or any other form of consequential damages), cost, loss, expense, or damage howsoever incurred by the Contractor as a result of termination for convenience.

43. TERMINATION BY CONTRACTOR

43.1 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 in excess of sixty (60) days, then the Contractor may give written notice to the Purchaser to make such payment within thirty (30) days of receipt by the Purchaser of any such notice.

43.2 Upon receipt of any such delayed payment notice, the Purchaser shall take diligent steps to promptly pay claimed outstanding amounts which are, in fact, overdue and not in dispute by the Purchaser.

43.3 If the Purchaser does not cure the default within thirty (30) days from the date of receipt of the Contractor's notice, or serve upon the Contractor a written notice within that time disputing that the claimed amount(s) are overdue, the Contractor may, by further written notice to the Purchaser terminate the Contract and pursue its remedies permitted under terms of the Contract.

PART IX - GOVERNING LAWS

44. LAWS OF MANITOBA

44.1 The Contract shall be governed by the laws in effect from time to time in the Province of Manitoba, 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 or domiciled in another country or Canadian province or territory.

44.2 Neither *The International Sale of Goods Act* (Manitoba) nor the United Nations Convention on Contracts for the International Sale of Goods referred to in that Act shall have any application to the Parties or to any of their dealings under the Contract.

45. ATTORNMENT

45.1 Subject to their agreement to rely upon alternative methods for resolution of disputes arising under the Contract as provided in Part X of these General Conditions, and to the exception set out in General Conditions 41.7.4 upon conditions following Termination for Breach of Contract, the Parties hereby irrevocably attorn to the exclusive jurisdiction of the Manitoba Court of Queen's Bench, Winnipeg Centre.

46. OBSERVANCE OF THE LAWS

46.1 The Contractor a shall comply with all Laws relevant to performance of the Work, wherever Work is being performed and, without limiting the generality of the foregoing, in particular Laws described in the General Requirements.

47. CORRUPTION AND FRAUD

47.1 The Contractor declares and undertakes in relation to the Contract that it:

47.1.1 has not acted and will not act unfairly or dishonestly so as to cause loss to the Purchaser or deprive the Purchaser of its rights;

47.1.2 has not offered, given, demanded or accepted any bribe or other improper benefit or advantage to any person and will not do so;

47.1.3 has not provided false, inaccurate or misleading information to any person and will not do so;

47.1.4 has not authorized, acquiesced or turned a blind eye to any form of corruption and will not do so;

47.1.5 did not collaborate, directly or indirectly, with any person in competition for this or other contracts with the Purchaser during the procurement process;

47.1.6 will not, in respect of any design services to be provided under the Contract, deliberately, knowingly, with willful blindness or recklessness, provide or approve a design which will provide an improper benefit or advantage to any person or which is in excess of the Purchaser's requirements and has not been fully disclosed and approved by the Purchaser;

47.1.7 will not deliberately, knowingly or with willful blindness or recklessness, carry out, instruct, authorize, condone or be a party to provision of work, materials, equipment or services not of a quality and quantity required under the Contract; or

47.1.8 will not conceal defective work, material, Equipment or services.

47.2 The Contractor shall ensure that all Contractor Personnel comply with the Contractor's commitments under this General Condition.

PART X - DISPUTE RESOLUTION PROCESSES

48. ALTERNATIVE TO JUDICIAL PROCEEDINGS

48.1 Any dispute arising between the Parties under the Contract shall be resolved in accordance with the dispute resolution processes set out in this General Condition 50 as an alternative to civil court proceedings.

48.2 Unless both Parties otherwise agree in writing, the dispute resolution process shall proceed as follows:

48.2.1 either Party may deliver a Dispute Notice in writing to the other, with a copy to the Engineer;

48.2.2 the Parties shall then attempt to resolve the dispute through direct negotiations at one or more settlement meetings involving representatives of each Party involving increasing levels of management as contemplated by General Condition 52 – Amicable Settlement, below.

48.2.3 upon failure of the Parties to reach an amicable settlement of all aspects of the dispute, either Party may commence final and binding arbitration by delivering to the other Party a Notice to Arbitrate as provided in Section 53.2 below.

49. EXCHANGE OF PARTICULARS ON PARTY POSITIONS

49.1 In accordance with Notices in Writing provisions in the Articles of Agreement, the initiating Party shall deliver a Dispute Notice to the other Party setting out the details of the dispute and referring to terms in the Contract alleged to support the position advanced by the initiating Party.

49.2 Within fifteen (15) days of receipt of a Dispute Notice, the responding Party shall deliver its reply setting out its position on the matter in dispute together with any counter allegations and including specific reference to the terms of the Contract alleged to support the responding Party's position taken.

50. AMICABLE SETTLEMENT

50.1 The Purchaser and the Contractor shall make all reasonable efforts to resolve the 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.

50.2 In the event that Party representatives designated in the Contract for notice purposes, or their delegates, fail to resolve a dispute within thirty (30) days from delivery of the Dispute Notice by the initiating Party, the dispute shall be considered by the Purchaser and an equivalent member of the Contractor's executive.

50.3 If the Purchaser and Contractor executives fail to resolve the dispute, the last attempt at amicable negotiations shall involve the Vice President of the Purchaser responsible for the Work and the equivalent senior executive of the Contractor.

50.4 The Parties shall set the schedule for their settlement meetings and shall continue to negotiate as long as both Parties consider an amicable settlement may be possible to achieve.

51. FINAL AND BINDING ARBITRATION

51.1 If the dispute has not been resolved within a reasonable time by amicable negotiations, or within such period of time as the Purchaser and the Contractor may have agreed, the dispute shall be abandoned by the initiating Party, with timely notice to the other Party, or shall be finally resolved by binding

51.2 Arbitration proceedings shall be commenced by either Party serving upon the other a written Notice to Arbitrate in accordance with the most current version of the Purchaser's Rules for Arbitration available at http://www.hydro.mb.ca/selling_to_mh/selling_index.shtml?WT.mc_id=2030

52. APPOINTMENT OF ARBITRATOR

52.1 The Contractor and the Purchaser shall attempt to agree upon the appointment of a single arbitrator.

52.2 If the Contractor and the Purchaser are unable to agree on the choice of a single arbitrator within the time provided in the Rules for Arbitration, either the Contractor or the Purchaser may apply to the Court of Queen's Bench of Manitoba, Winnipeg Centre, for judicial appointment of a single arbitrator as contemplated by the Rules.

53. AUTHORITY OF THE ARBITRATOR

53.1 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.

54. VENUE

54.1 Arbitration proceedings shall be conducted at Winnipeg, Manitoba.

55. PROCEEDINGS

55.1 The arbitrator shall, as soon as possible, set the schedule for conduct of the arbitration, examine the matter(s) in dispute, hear evidence and argument from both the Contractor and the Purchaser, and issue an award in writing.

55.2 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.

56. RULES AND STATUTE TO APPLY

56.1 To the extent and in the manner provided, the Purchaser's Rules of Arbitration and provisions of *The Arbitration Act of Manitoba,* C.C.S.M. c. A120 shall apply.

57. COSTS

57.1 The cost of arbitration shall be assessed and apportioned between the Contractor and the Purchaser in such manner as the arbitrator may determine.

58. PAYMENTS WHERE AMOUNT IN DISPUTE

58.1 Where the amount of any payment required to be made under the Contract is in dispute, the Party required to make the payment or entitled to set off shall pay or deduct such portion of the payment that is not, in good faith, in dispute.

59. PERFORMANCE OBLIGATIONS DURING DISPUTE

59.1 The Contractor shall not suspend, delay or interfere with progress of the Work because of dissatisfaction with a determination of the Engineer nor because of any dispute during any of the notice or negotiation periods set out in this Section, nor during any arbitration proceedings.

60. EQUITABLE RELIEF

60.1 Nothing in this General Condition Part X shall prevent, or be deemed to prevent, either Party from seeking and/or lawfully obtaining interlocutory or permanent injunctive relief from any court of competent jurisdiction to restrain any anticipated, present or continuing breach of a provision of the Contract with respect to confidentiality, intellectual property or other similar breach where a Party, acting reasonably, is of the view that such breach will cause irreparable harm to it which cannot be adequately compensated for in damages.

GENERAL REQUIREMENTS 039857

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GENERAL REQUIREMENTS

PART 1 – SCOPE OF THE WORK

1. **SCOPE OF THE WORK**

1.1 The Contractor shall design, manufacture, provide in-factory testing, prepare Equipment for shipment, load, transport and Deliver the agreed ITEMs of Equipment to the Purchaser on or before the agreed Contract date as specified in a Purchase Order, the Technical Requirements and Supplemental Technical Requirements.

1.2 The Equipment may include one or more of the following ITEMs:

1.2.1 Spec ID# 1: 90 MVAr 550 kV Shunt Reactor

Spec ID #2: 400 MVA 500-230-46 kV Auto Transformer

Spec ID #3: 300 MVA 230 kV Phase-Shifter

Spec ID #4: 333 MVA 230-138-13.8 kV Auto Transformer

Spec ID #5: 285 MVA 230-115-13.8 kV Auto Transformer

Spec ID #6: Spare Parts for Spec ID #1

Spec ID #7: Spare Parts for Spec ID#2

Spec ID #8: CTs Inside of Delta for Spec ID #3

Spec ID #9: CTs Outside of Delta for Spec ID #3

Spec ID #10: Optical CTs Inside of Delta for Spec ID# 3

Spec ID #11: Optical CTs Outside of Delta for Spec ID# 3

Spec ID #12: Power Flow Controller for Spec ID# 3

Spec ID #13: Insulation Coordination Study for Spec ID# 3

1.3 The (list of) ITEM(s) to be Supplied and Delivered and compensation agreed under this Contract shall be as set out in Contract Form 1-1.

1.4 The Purchaser will endeavour to procure needed ITEMs from the Contractor. However, nothing in the Contract prevents the Purchaser, including without limitation in circumstances where the Contractor is unable to provide the Purchaser with needed ITEMs within an acceptable timeframe, from contracting with any other person or entity for the purchase of.

PART 2 – COST OF PERFORMING THE WORK

2. **CONTRACT FORM 1-1 – COST OF PERFORMING THE WORK**

2.1 The Contract Price is set out in Contract Form 1-1.

3. **PROGRESS STATEMENTS**

3.1 As contemplated by Section 25 PROGRESS STATEMENT of the General Conditions, this General Requirement varies the Purchaser's requirement for submission of Progress Statements so that the Contractor shall instead submit a Progress Statement to the Engineer at or after the time of Delivery an Item.

3.2 This General Requirement varies Section 25.3 of the General Conditions requiring that the Engineer issue a certificate for payment within 14 days of receipt of a Progress Statement so that the Engineer shall, subject to General Condition 18 – Faulty or Defective Work, issue a certificate for payment to the Purchaser not later than 30 days after receipt of a Progress Statement.

3.3 **PROGRESS PAYMENT**

3.4 As contemplated by General Condition 26.1, this General Requirement varies the Purchaser's standard thirty (30) day payment term, so that payments under this Contract shall instead be made fifteen (45) days from the Purchaser's receipt of a certificate for payment from the Engineer.

3.4.1 any Performance Holdback required to be deducted under the General Requirements;

3.4.2 any Liquidated Damages due from the Contractor;

3.4.3 any amount agreed by the Contractor or determined by the Engineer to be owing from the Contractor to the Purchaser; and

3.4.4 any amount(s) which the Purchaser is entitled to immediately deduct pursuant to an express provision of the General Conditions or the General Requirements.

4. **ADJUSTMENTS TO PRICES**

4.1 All prices agreed and set out in Contract Form 1-1 may be subject to adjustment in accordance with terms of the Contract.

5. **ESCALATION**

5.1 The price adjustment methodology set out in Contract Form 1-3 provides for escalation of any prices proposed by the Contractor and accepted by the Purchaser in the Contract.

6. **LIQUIDATED DAMAGES**

6.1 If the Contractor fails to fully complete all Work required in respect of an ITEM of the Work, on or before the Contract Date for that ITEM of the Work, then the Contractor shall pay to the Purchaser Liquidated Damages, which are a genuine pre-estimate of the Purchaser's loss and damage in each such case and are not a penalty, in an amount calculated as 0.5% of the Contract Price of the ITEM for each day such Work is not complete up to a maximum of 15% of the Contract Price of the ITEM.

6.2 The Engineer will certify the amount of Liquidated Damages payable, which shall thereupon become a debt due from the Contractor to the Purchaser.

6.3 Liquidated Damages shall be deducted from the Contract Price payable to the Contractor pursuant to the Contract, and if there are insufficient monies payable by the Purchaser to the Contractor to cover the amount of the Liquidated Damages, then the difference shall be a debt due and payable by the Contractor to the Purchaser.

6.4 Liquidated Damages are not an exclusive remedy.

PART 3 – PURCHASER'S SCHEDULE

7. **TERM OF THE CONTRACT AND OPTION TO EXTEND**

7.1 The Term of the Contract shall be three (3) years with a Purchaser's option to extend the Term by two additional one (1) year periods for a maximum possible Term of five (5) years.

7.2 Should the Purchaser elect to extend the Term of Contract, notice will be given to the Contractor at least 90 days prior to expiry of the current Term.

8. **CONTRACT DATES**

8.1 The Contract Date for an ITEM shall be determined by the Purchaser in accordance with the Contractor's standard lead time for the ITEM described in Contract Form 1-1 and shall be specified in the applicable Purchase Order;

The Contractor shall deliver each ITEM in accordance with the Contract Date specified in the applicable Purchase Order.

PART 4 – SITE LOCATIONS

9. **SITE LOCATIONS**

9.1 The Site, for purposes of Delivery will be at Manitoba Hydro locations described in the Supplementary Technical Requirements or such location identified by the Purchaser in a Purchase Order.

PART 5 – STANDARDS AND QUALITY CONTROL

10. **COMPLIANCE WITH STANDARDS**

10.1 All materials, Equipment and other deliverables furnished by the Contractor shall comply with the applicable provisions of the standards of the Canadian Standards Association (CSA) or of the Canadian General Standards Board (CGSB) and where no such standards exist, materials, Equipment and other deliverables shall comply with the applicable provisions of the standard specifications of the American Society for Testing and Materials (ASTM).

10.2 All conditions of Canadian Standards Association (CSA) and the American National Standards Institute (ANSI), latest revisions, shall apply unless superseded or modified herein.

10.3 If CSA and ANSI contradict, CSA takes precedence over ANSI.

PART 6 – INSPECTIONS AND TESTING

11. **INSPECTION AND TESTING**

11.1 Any special tests which the Purchaser requires are set forth in the Technical Requirements and the Supplementary Technical Requirements. The Purchaser intends to inspect the Contractor's Facilities prior to the start of manufacturing.

11.2 The Purchaser intends to inspect the Equipment at the Contractor's Facilities prior to Delivery.

11.3 The Purchaser will inspect, test and commission the Equipment prior to any Completion Certificate being issued.

PART 7 – DELIVERY AND STORAGE OF EQUIPMENT

12. **PACKAGING**

12.1 Contractor shall package the Equipment for shipping as required by the Technical Requirements and in the manner necessary to protect the Equipment from outdoor conditions.

12.2 The Contractor shall prepare the Work for shipment in such a manner as to protect it from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation and loading.

13. **NOTICES FOR DELIVERY**

13.1 The Contractor shall notify the Engineer of Delivery of Equipment as required by Section 50.1 of the Technical Requirements.

14. **TRANSPORTATION OF DANGEROUS GOODS**

14.1 When transporting dangerous goods in Manitoba, the Contractor shall comply with the *Transportation of Dangerous Goods Act*, R.S.C. 1985, c. T19, and T*he Dangerous Goods Handling and Transportation Act*, R.S.M. 1987, c. D12.

14.2 The Contractor shall ensure that each shipment complies with any provincial legislation regarding the transportation of dangerous goods for each province through which the shipment must pass.

15. **WORKPLACE HAZARDOUS MATERIAL INFORMATION SYSTEM**

15.1 The Contractor shall comply with the *Workplace Hazardous Material Information System (WHMIS) requirements and The Workplace Safety and Health Act*, R.S.M. 1987, c. W210, and all regulations thereunder, for all products that contain hazardous material.

15.2 The Contractor shall supply one Material Safety Data Sheet (MSDS) with the shipment for each hazardous material contained in the shipment. One copy of the MSDS shall be forwarded to the Engineer.

15.3 Warning labels which comply with WHMIS format are required on all containers of hazardous materials. The above WHMIS requirements apply to all storage batteries, electrolytes, greases used with batteries and lead covered battery terminals and connectors.

16. **ENVIRONMENTAL CONTAMINANTS**

16.1 The Work must not contain or employ any Polychlorinated Biphenyls (PCBs) at a concentration greater than 1 mg/kg or any other substance which is a known environmental contaminant or hazard.

PART 8 – – INTENTIONALLY LEFT BLANK

PART 9 – INTENTIONALLY LEFT BLANK

PART 10 – INTENTIONALLY LEFT BLANK

PART 11 – CHANGES IN THE WORK AND PRICE

17. **DETERMINATION OF CONTRACT DATES**

17.1 The Purchaser shall determine the Contract Date in accordance with the standard lead times described in Contract Form 1-1.

17.2 The Purchaser may request modification to the standard lead time for an ITEM described in [insert contract form which contains standard lead times to allow for Delivery on an expedited basis

17.3 The Contractor shall, within seven (7) days, advise the Purchaser of its ability to meet the Purchaser's request, any adjustment sought to the Contract Price or other terms for making such a change. If acceptable to the Purchaser, the Purchaser may issue a Purchase Order which shall include the Contract Date and any adjustments to the Contract Price as agreed.

18. **CLARIFICATIONS AND CHANGES TO THE WORK**

18.1 The Purchaser may request changes to the Work, including additions, deletions, variations and extras to the Work, by issuing a Change Order or an Extra Work Order.

18.2 Upon receipt of a Change Order or an Extra Work Order, the Contractor shall present, in a form acceptable to the Engineer, a proposal containing any additions, deletions, variations or extras to the Work.

18.3 If the Purchaser and the Contractor agree, the change in the Work shall be documented as follows:

18.4 An Extra Work Order which adds to the ITEMS listed in General Requirement 1 – SCOPE OF THE WORK must be signed by both the Purchaser and the Contractor and shall be deemed to amend the Contract.

18.5 A Change Order intended to modify the obligations or requirements applicable to all of the Work must be signed by both the Purchaser and the Contractor and shall be deemed to amend the Contract; and

18.6 A Change Order which modifies the obligations or requirements applicable to the purchase of a specific ITEM shall be signed by the Engineer and referenced in the applicable Purchase Order and shall not be deemed to amend the Contract, except with respect to the performance of the Work described in the Purchase Order.

PART 12 –COMPLETION CERTIFICATE AND WARRANTY REQUIREMENTS

19. **WARRANTY**

19.1 The warranty period shall be thirty six (36) months.

19.2 If the Contractor is required to make good any part of the Work as provided in this Section and PART VI – WARRANTY OBLIGATIONS of the General Conditions, then such part of the Work made good shall be subject to all the provisions of this Section and PART VI – WARRANTY OBLIGATIONS of the General Conditions for a further period of 12 months from the date when the same has been made good as aforesaid provided that no such extension of the Warranty period shall extend beyond 48 months from the original date of commencement of the Warranty Period.

PART 13 –PERFORMANCE SECURITY

20. **PERFORMANCE HOLDBACK**

20.1 An amount equal to 15% of the Contract Price for each ITEM of Equipment shall be deducted from each payment otherwise due to the Contractor and retained as security for the proper performance of that ITEM of Work by the Contractor and, subject to any amounts deducted to compensate the Purchaser for Contractor defaults, the balance, if any, shall be released in accordance with the Final Payment section of the General Conditions.

PART 14 – INTENTIONALLY LEFT BLANK

PART 15 –INSURANCE

21. **CONTRACTOR'S INSURANCE REQUIREMENTS**

21.1 The Contractor shall provide, maintain and pay for the insurance coverage listed below. The Contractor shall supply the Purchaser with a certified copy of the required policy of insurance and all renewals thereof. A Certificate of Insurance which specifies all terms and conditions of required coverage may be submitted in place of the policy. All documentation must be submitted to the Purchaser prior to the commencement of the Work.

21.2 All required insurance policies shall be endorsed to provide the Purchaser with not less than 30 days' written notice in advance of cancellation, change or amendment restricting coverage, and shall show the Purchaser as an Additional Insured.

21.3 The Contractor shall be responsible for any deductible amounts under the insurance policies except where such amounts are expressly excluded from the Contractor's responsibility. Should a loss be sustained, the Contractor shall act on behalf of both the Purchaser and the Contractor for the purpose of adjusting the amount of loss with the insurance companies.

21.4 **General Liability Insurance**

21.5 General Liability Insurance shall provide coverage to a limit of not less than $5,000,000 (CAD) inclusive, per occurrence, for bodily injury, death, and damage to property including loss of use of damaged property.

21.6 The Purchaser shall be named as Additional Insured.

TECHNICAL REQUIREMENTS 039857

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TECHNICAL REQUIREMENTS

1 GENERAL

These Technical Requirements apply to:
(a) transmission station shunt reactors,
(b) transmission station grounding transformers,
(c) distribution station power transformers,
(d) transmisssion station power transformers
(e) HVDC station power transformer (not converter transformers), and
(f) generator step-up (GSU) transformers.

In cases where the generator step-up (GSU) transformer or HVDC station power transformer requirements differ from the others, a table is presented showing the differences.

For GSU Transformers	For All Others

For HVDC Station	For All Others

2 DUTY

2.1 Mechanical

The Equipment specified herein will be installed outdoors and will be used for service as specified in the Supplementary Technical Requirements on various portions of the Purchaser's system having the following characteristics.

The Equipment described herein shall be suitable in every way for continuous service in Manitoba and the conditions under which it will operate are to be considered throughout.

The Equipment shall be outdoor type and shall be suitable for continuous service in ambient temperatures ranging from -50ºC to +40ºC and winds up to 145 km/h. Icing conditions and blowing snow will also be encountered.

Attention shall be paid to the prevention of condensation on the inside of terminal junction boxes.

All specific ratings, the cooling system, tap-changer options and special requirements shall be in accordance with the Supplementary Technical Requirements.

All conditions of Canadian Standards Association (CSA) and the American National Standards Institute (ANSI), latest revisions, shall apply unless superseded or modified herein. If CSA and ANSI contradict, CSA takes precedence over ANSI.

NOTE: The Equipment, complete with associated accessories, will be installed and placed in service by the Purchaser.

2.2 Electrical

The system frequency is normally 60 Hz but equipment ratings must apply for the frequency range of 55 to 62 Hz. System grounding and Lightning Impulse Level (LIL) ratings are as follows:

System Voltage	Type of Grounding	Impulse kV LIL	Chopped Wave kV LIL	Switching kV SIL
500 kV Wye	Effective	1675	1845	1390
230 kV Wye	Effective	900	990	745
138 kV Wye	Effective	650	715	540
124 kV Wye	Effective	650	715	540
115 kV Wye	Effective	550	605	455
*69 kV Wye	Effective	350	385	N/A
66 kV Delta	Impedance	350	385	N/A
33 kV Delta	Impedance	200	220	N/A
24.94 kV Wye	Effective	150	165	N/A
24.0 kV Delta	Ungrounded	150	165	N/A
24.0 kV Wye	Effective	150	165	N/A
13.8 kV Delta	Ungrounded	110	121	N/A
12.47 kV Wye	Effective	110	121	N/A
8.32 kV Wye	Effective	95	105	N/A
*6.9 kV Delta	Ungrounded	95	105	N/A

System Voltage	Type of Grounding	Impulse kV LIL	Chopped Wave kV LIL	Switching kV SIL
*4.16 kV Delta	Ungrounded	75	83	N/A
4.16 kV Wye	Effective	75	83	N/A

* Generator Step-Up transformers only

3 EQUIPMENT STANDARDS

All Equipment shall be designed, manufactured and tested generally in accordance with the laws and regulations of Manitoba and the latest editions of the following standards, except where specifically directed otherwise.

3.1 Bushings

CAN/CSA-C88.1
Power Trans former and Reactor Bushings

ANSI C57.19.101
IEEE Trial-Use Guide for Loading Power Apparatus Bushings

3.2 Canadian Electrical Code

CSA C22.1
Canadian Electrical Code, Part I Safety Standard for Electrical Installations

3.3 Connectors

CSA C57
Electric Power Connectors for Use in Overhead Line Conductors

CEMA / EEMAC 1Y-2
Standard For Bushing Stud Connector & Aluminum Adapters

NEMA CC-1
Electric Power Connection for Substations

ANSI C119.4
Connectors for Use Between Aluminum-to-Aluminum and Aluminum-to-Copper Conductors Designed for Normal Operation at or Below 93°C and Copper-to-Copper Conductors Designed for Normal Operation at or Below 100°C

3.4 Instrument Transformers

CAN/CSA-C60044
Instrument Transformers

3.5 Electromagnetic Interference

CSA C108.1.2 M
Electromagnetic Interference Measuring Instrument - ANSI Type

CSA CAN3 C108.3.1 M
Limits and Measurement Methods of Electromagnetic Noise from AC Power Systems, 0.1 5-30 MHz

3.6 Galvanising

CAN/CSA G164 M
Hot Dip Galvanizing of Irregularly Shaped Articles

3.7 Oil

CAN/CSA C50
Insulating Oil, Electrical for Transformers and Switches

3.8 Paint

EEMAC Y1-2
Performance Specification for Finishing Systems for Outdoor Electrical Equipment

3.9 Revenue Metering

Measurement Canada S-E-07
Specifications for the Approval of Measuring Instrument Transformers

3.10 Transformers and Reactors

CAN/CSA C88 M90
Power Transformers and Reactors

ANSI / IEEE C57.XX
IEEE Standard General Requirements for Liquid-Immersed Distribution Power and Regulating Transformers et al

3.11 Transformer Overloads

ANSI C57.91
IEEE Guide for Loading MineraI-Oil-Immersed Transformers

4 REFERENCE MVA

The MVA referenced in these Technical Requirements will always refer to the maximum nameplate MVA.

5 INTERFERENCE

All Equipment shall be designed and constructed so as not to cause interference with radio and television reception or telephone communication circuits, in accordance with good modern practice and generally as defined in CSA C108.3.1-M.

6 LOADING - Non-GSU Only

For GSU Transformers	For All Others
This section does not apply to GSU transformers.	This section does apply.

This section combines the low-ambient normal loading and the overloading requirements for power transformers. Normal loading is defined as producing a maximum 120°C hotspot temperature. Overloading or emergency loading produces a hotspot temperature in excess of 120°C.

All transformers, including accessories and load-tap-changing equipment shall be capable of overloading in accordance with ANSI C57.91. Overloading shall be limited only by the core and coils, not by any accessories such as bushings, tap changers, tank or clamping structure. Leads should be designed to not be a limiting factor if at all possible.

If the core and coils are not the limiting factor, a statement shall be included in the instruction manual and on the nameplate. The manual shall also explain the limitation and the reason for it.

Transformers shall also meet the following overloading requirements depending on the type of station.

If the station type is not specified in the Supplementary Technical Requirements, the HV voltage is 66 kV or less, and the top MVA is not greater than 30 MVA, then use the Distribution Station Loading rules. Otherwise use the Terminal Station Loading requirements.

These capabilities are not required for cold starts of the transformer except for mobile transformers which may be used for de-icing of transmission lines.

Reduced capacity below normal (RCBN) applies during overloading.

Each chart below is referenced by a report number. This number shall be included on the Equipment nameplate with the statement:

This transformer is suitable for Distribution/Terminal Station Loading per the Report ___________.

Distribution Station Loading Report is EDPD-W01-08 .

Transmission Station Loading Report is SPD 2006/01 .

T_A, in the tables below, is the ambient temperature during the peak load and can be considered constant. It may or may not be the maximum ambient temperature but the hotspot temperature rise shall be determined for this condition.

Some of the “Normal” formulae below exceed 1.0 p.u. at 30°C average ambient and 40°C maximum ambient. This is just a characteristic of the formula. Transformer capability does not need to exceed 1.0 p.u. at 40°C maximum ambient. The ambient temperature range of interest for the formula is shown in the table.

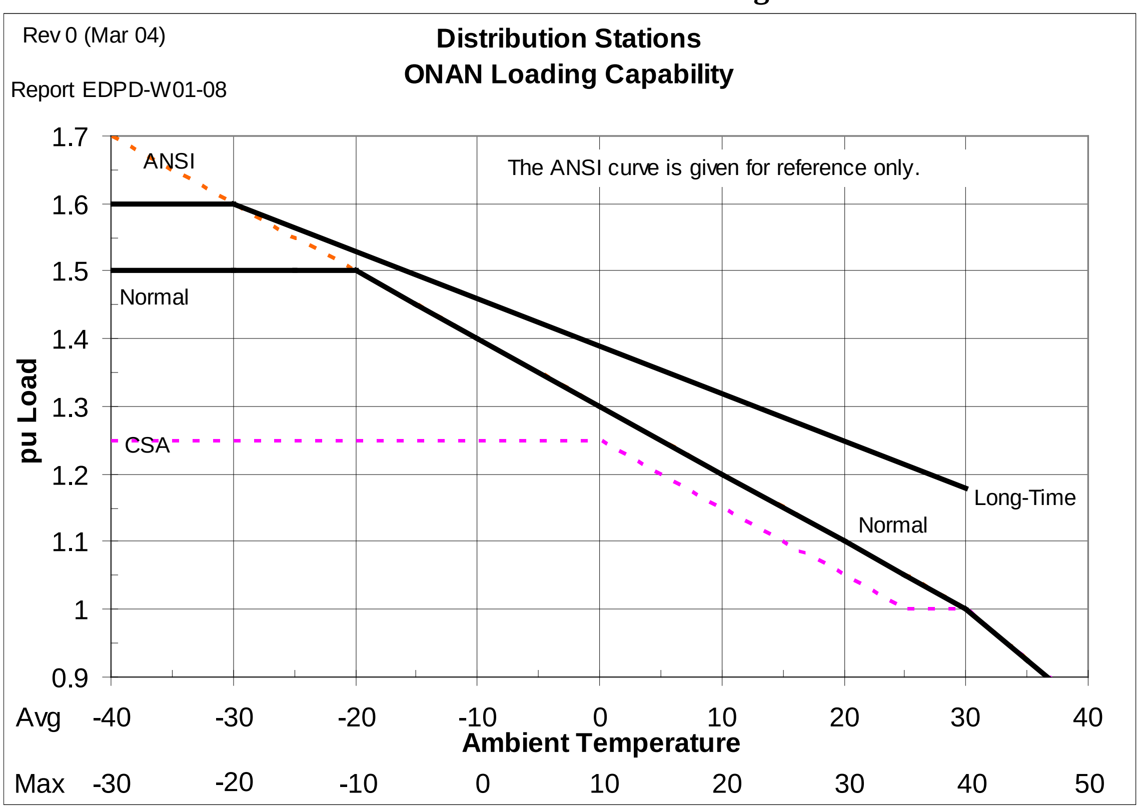
6.1 Distribution Station Loading

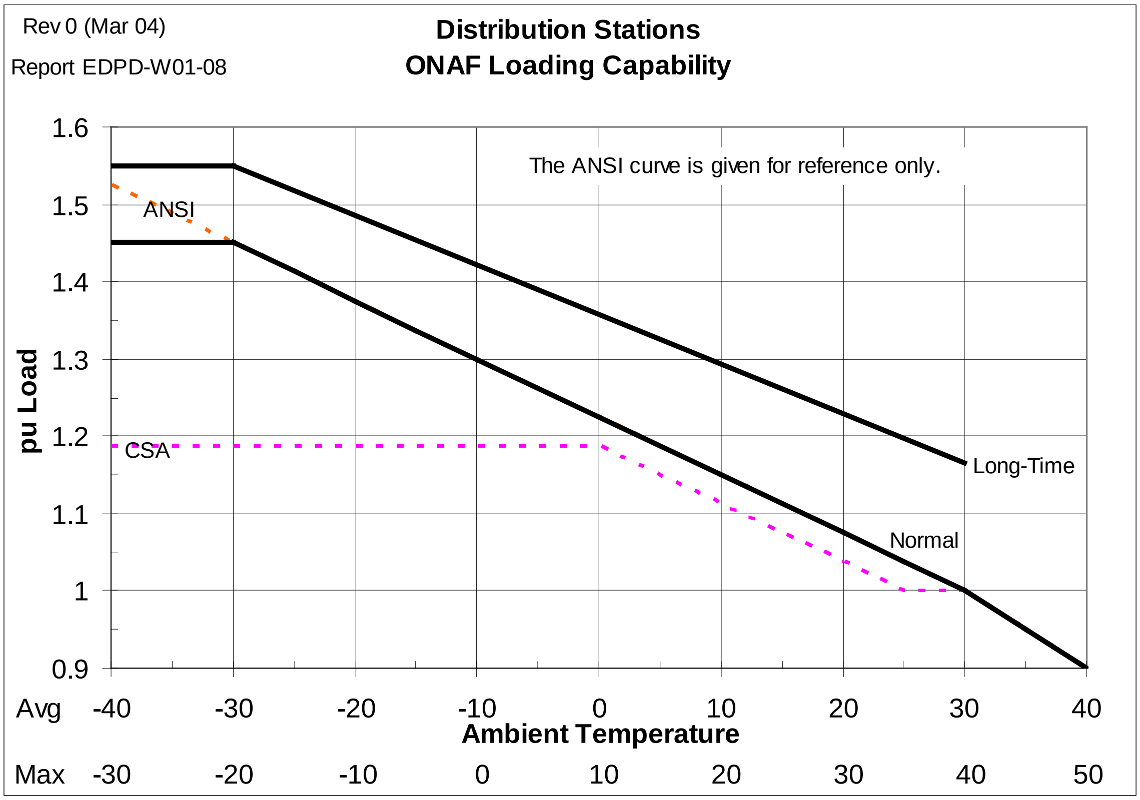
The distribution station loads below apply for both temperature sensitive and insensitive loads.

The ONAN loads below apply not only to single rating ONAN transformers but also to multiple rated transformers with an ONAN rating. This is intended to cover the possibility of station service failure. These ONAN loads are not required for transformers where fans or pumps are always required to be active such as with integral coolers.

Type of Load	Duration	Frequency	Hotspot Temperature Limit °C	Constant Ambient Temperature °C	p.u. Load	
					ONAN	ONAF
Normal	continuous	daily	120	-20	1.5	1.45
				0	1.4	1.30
				+30	1.1	1.08
			ONAN =	$1.00 + 0.0100 \times (40 - T_A)$		
			ONAF =	$1.00 + 0.0075 \times (40 - T_A)$		
Long-Time Emergency	6 weeks	3 times in lifetime	140	-20	1.60	1.55
				0	1.47	1.43
				+30	1.25	1.23
			ONAN =	$1.18 + 0.0070 \times (40 - T_A)$		
			ONAF =	$1.17 + 0.0064 \times (40 - T_A)$		
Short-Time Emergency	30 minutes	Once in lifetime	180	+30	2.00	2.00

Distribution Station Loading





6.2 Terminal Station Loading

6.2.1 Loading for Transformers below 100 MVA

All terminal station transformers below 100 MVA shall be capable of supplying 2.0 p.u. of the maximum MVA rating for 30 minutes as a short-time emergency load. This is only required at a winter ambient of -30°C or less with a steady-state pre-load of 0.60 p.u. The hotspot temperature limit is 180°C.

The Contractor shall also provide a loading study, based on the final test results, to determine the maximum allowable overloads based on the following combinations of conditions:

p.u. MVA Pre-Load	Overload MVA	Duration hours	Constant Ambient Temperature °C	Hotspot Limit °C
1.0	?	0.5	-30, -20, -10, 0, 10, 20, 25, 30, 35, 40	180
0.8	?	0.5	-30, -20, -10, 0, 10, 20, 25, 30, 35, 40	180
0.6	?	0.5	-30, -20, -10, 0, 10, 20, 25, 30, 35, 40	180

6.2.2 Loading for All Terminal Station Transformers

The Contractor shall also provide a loading study for all terminal station transformers, based on the final test results, to determine the maximum allowable overloads based on the following conditions:

p.u. MVA Pre-Load	Overload MVA	Duration hours	Constant Ambient Temperature ºC	Hotspot Limit ºC
1.0	?	0.5, 1, 2, 4, 8, continuous	-30, -20, -10, 0, 10, 20, 25, 30, 35, 40	120, 140
0.8	?	0.5, 1, 2, 4, 8, continuous	-30, -20, -10, 0, 10, 20, 25, 30, 35, 40	120, 140
0.6	?	0.5, 1, 2, 4, 8, continuous	-30, -20, -10, 0, 10, 20, 25, 30, 35, 40	120, 140

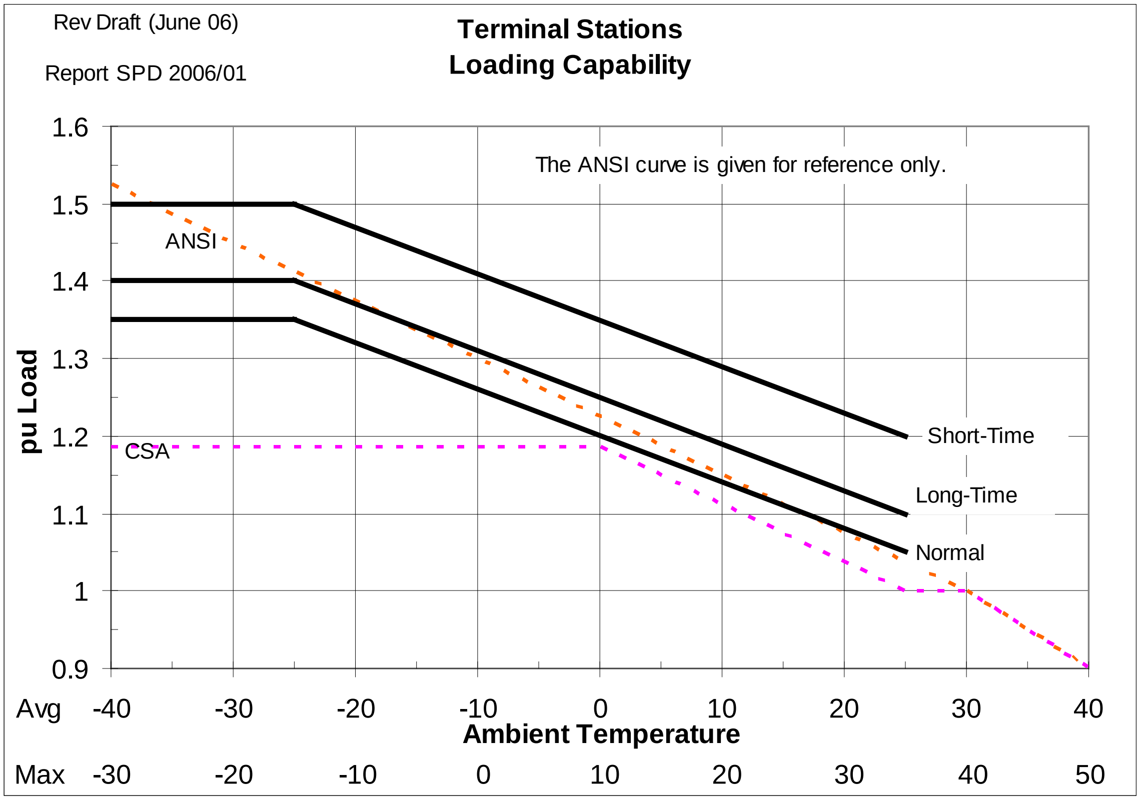
The overload limit for oil temperature is 110°C. If any of these conditions cannot be met, the Contractor shall state so and specify the reason for the limitation. This overload study shall be included in the final test report.

If requested in the Supplementary Technical Requirements, additional loading tests shall be done as described in the Apparatus Tests and Quality Assurance Program Requirements.

6.2.3 Normal Terminal Station Capability

Type of Load	Duration	Frequency	Hotspot Temperature Limit °C	Constant Ambient Temperature °C	p.u. Load
Normal	Continuous	Daily	120	-15	1.35
				+35	1.05
				$1.02 + 0.006 \times (40 - T_A)$	
Long-Time Emergency	6 weeks	3 times in lifetime	130	-15	1.40
				+35	1.10
				$1.07 + 0.006 \times (40 - T_A)$	
Short-Time Emergency	30 minutes	Once per year	140	-15	1.50
				+35	1.20
				$1.17 + 0.006 \times (40 - T_A)$	

Terminal Station Loading



7 SHORT CIRCUIT CAPABILITY

Transformers shall be designed and constructed to be capable of withstanding the mechanical and thermal stresses produced by standard external short circuit tests as defined in IEEE Standard C57.12.90.

7.1 System Impedance

Transformers must be designed to withstand any type of fault with infinite bus on all terminals unless otherwise specified in the Supplementary Technical Requirements.

Tertiary terminals when connected externally must be considered a source. When the source is specified as a reactor or capacitor bank, the TV system impedance may be determined as follows at the HV ONAN MVA base:

$$X_{\text{TV System}} = \frac{\text{base MVA for fault calculations}}{\text{TV maximum ONAF MVA} \ \times \ \text{pu continuous overvoltage}} \quad \text{pu}$$

7.2 Pre-Fault Operating Voltage

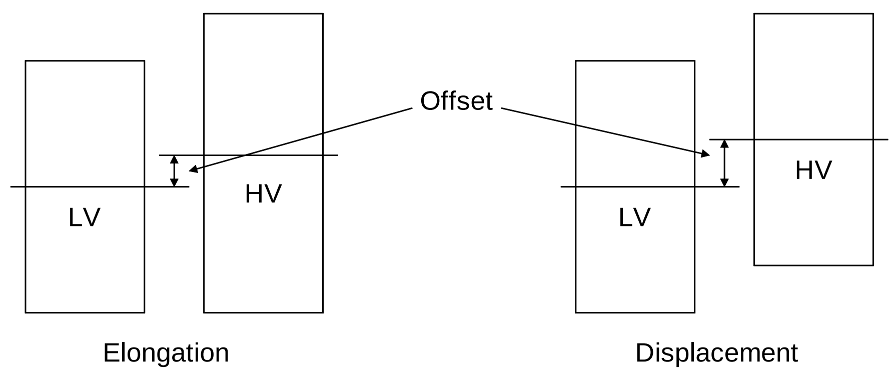
The pre-fault operating voltage is 110% unless otherwise specified in the Supplementary Technical Requirements. The 110% is overridden by a higher maximum continuous or steady-state operating voltage as specified in any manner in the Supplementary Technical Requirements.

7.3 Winding Design

If self-bonding conductors are used inside a winding, the bond must not soften during any type of fault based on the short-circuit temperature rise calculation in ANSI C57.12.00.

Self-supporting coil design is encouraged but conductor must still be fully supported back to the core.

All Equipment shall be capable of withstanding the forces and stresses generated with a 0.5% coil height elongation offset between major coils or a 0.3% coil height displacement offset between major coils. This is required regardless of coil orientation or arrangement (e.g. two parallel halves).



8 WINDINGS

8.1 Winding Design

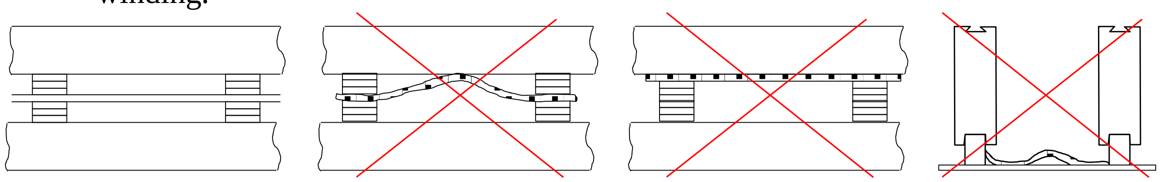
All windings shall be constructed with copper conductor. Design and construction of the main transformer and series transformer (if applicable) windings shall be circular concentric type.

Coil ends 350 kV LIL or higher must have stress rings.

All coils, including helical coils, must have at least one spacer or other pressboard between disks. Layer windings with conductor on conductor are not acceptable without the approval of the Purchaser.

The use of clackband in windings is not acceptable. Clackband is paper-taped pressboard blocks to create axial cooling ducts within windings. This is due to short circuit and cooling concerns such as lack of support back to the core, slippage of clackband blocking oil flow and looseness of disk windings wound with clackband.

When oil flow washers are used to create zig-zag oil movement through the coils, the washers shall be of sufficient thickness so as not to deform as shown in the sketches below. They also shall not be placed against the winding conductor. The axial cooling space between the winding conductor radial build surface and the oil flow washer shall be similar to the average axial space provided throughout the winding.



Conductor splices shall only be performed on the outside diameter of the windings and limited to as few as necessary by the winding type and/or available conductor length that can be supplied. All conductor splices shall be brazed. All splices must be strand-to-strand. These strands must be insulated from each other.

Resistance measurements on winding terminals of different phases shall not differ by more than 1%, unless approved by the Purchaser. The purpose of this is to balance the lead lengths and/or make the lead length resistance insignificant. Do not connect the furthest coil phase to the furthest LTC phase. Maintain a-b-c or c-b-a orientation on the tap head. Do not run leads back and forth unnecessarily. For example, do not bring the LV leads out on on HV side, run around past the LTC to the LV side bushings, and then run the LV side leads back to the LTC or link board.

All LTC and DTC voltage steps shall be theoretically equal in magnitude and stated as such on the nameplate unless specified otherwise in the Supplementary Technical Requirements. This is not intended to exclude variable-induction designs but rather to ensure every attempt is made to meet the limit of 0.5% ratio error on all LTC and DTC tap position combinations. The Purchaser does not necessarily know which transformers will be paralleled in the future and must ensure that the ratio difference between transformers be less than 0.5% from theoretical or less than 1% measured between transformers.

All winding leads must be sized such that the temperature rise of the leads shall not exceed that of the winding to which they are associated with.

On transformers above 95 MVA, the arrangement of the tapping leads shall be such that on any tap, particularly at the maximum current tap, the magnetic field from various leads are cancelled or at least minimized so as not to affect the surrounding metal parts and hence prevent circulating currents and undue gassing. Such an arrangement may occur when each tapping section consists of a full length winding and the tapping leads loop from bottom to top to connect the sections in series. In such a winding, it shall be a two layer winding.

8.2 Winding Conductor

Continuously transposed cable (CTC) and other multi-stranded enamelled conductor shall be free of inter-strand shorts after the winding is complete. The conductor shall be checked for inter-strand shorts prior to the removal of the winding from the winding lathe, and again during clamping of the individual coils. CTC shall always include the separator between the two stacks. Small CTC, where the separator won't fit, is not acceptable due to concerns about strand tilting.

The use of netting-tape CTC is not allowed without the approval of the Purchaser. All conductor must be paper insulated, except for the strands of CTC which must be enamelled. The CTC cable, as a whole, must be paper insulated. The minimum paper insulation amount for any winding conductor is 3 layers wall (6 layers diametric), to allow for damage during winding. All conductor paper insulation shall have at least one extra layer of insulation than the Contractor's dielectrically required amount, to allow for damage.

All windings manufactured using CTC with epoxy enamel overcoat shall have a sample of the cable taken from each reel used to wind the coils. All of those samples shall accompany their respective winding during the heating process used to bond the conductors together. After the bonding process has been completed each sample shall be

For HVDC Station	For All Others
sent to the Purchaser to verify that the bonding is according to the conductor specification.	analyzed by the Contactor's Quality Assurance to verify that the bonding is according to the conductor specification.

The use of wide strap conductor greater than 15 mm (0.6 inches) wide is not allowed in power transformers, shunt reactors and series transformers. It is allowed for tap changer reactors (preventive auto).

Enamelled conductor, including twin, CTC, etc., shall use enamel with a temperature class above 140°C.

8.3 Winding Assembly

All windings, winding leads and conductor connections shall be adequately supported to withstand operational and shipment vibration and short circuit forces. The use of Terylene cord for tying cables and leads should be limited to where the short-circuit forces are negligible. Tie-wraps are not acceptable. Pressboard cleating is required at lead exits and long cable runs. Internal drawings showing support structures shall be provided for the Purchaser's review and comments. These drawings will be treated as confidential and will not be shared with third parties.

Fibreglass studs and nuts are preferred for assembling pressboard support components. If Nylon studs and nuts are used, they shall be at least 16 mm (5/8") in diameter. Every effort shall be made to align holes in the supports to avoid placing undue pressure on the studs. In either case, if the support carries a heavy load such as tap leads or tap switches, steel bolts shall be used at the base of the support where the support connects to a steel member.

All winding leads must be sized such that the temperature rise of the leads shall not exceed that of the winding to which they are associated with.

8.4 Shields

Any interwinding or winding to core shield(s) associated with the core and coil assembly shall be capable of withstanding a test potential of 2500 V ac or dc. Magnetic shields, electro-static shields, where supplied, shall be electrically connected separately to ground and accessible for testing external to the tank cover, in the same manner as the core and clamp grounds and enclosed in the same NEMA 4 water tight box with a lamacoid or stainless steel anodized nameplate.

8.5 Spring-Damper Clamping System (Dashpots)

Equipment greater than 30 MVA shall be provided with a spring-damper clamping system. The spring-damper clamping system shall ensure the designed clamping pressure is maintained on the coils through the life of the transformer and restrict axial coil movement during external short circuit faults. There shall be a minimum of four dampers. The design of this system is subject to the Purchaser's approval.

9 CORE AND CLAMP

9.1 Material

The core shall be manufactured of high permeability, non-ageing, cold-rolled grain oriented sheet steel laminations having smooth, insulated surfaces. The core shall be of mitred construction with the steel properly stacked and all insulation designed so that no detrimental changes in physical or electrical properties will occur during the life of the transformers.

9.2 Design

The average flux density in the core shall not exceed 1.7 Tesla at 100% voltage on any tap position. This also applies to series transformers. The average flux density in the core shall not exceed 1.65 Tesla at 100% voltage on any de-energised tap position and on neutral LTC tap position.

The core design shall be such that the maximum exciting current at 110% of the rated voltage for rated tap position, will not exceed 1% of the rated current based on the ONAN MVA rating. This also applies to series transformer core itself at the series transformer ONAN MVA base and at the tap extremes.

In addition to this limit, the excitation current at 110% of the rated voltage shall not exceed the following limits. This table applies for any de-energised tap position and for neutral tap on the LTC.

Voltage Class	Maximum Excitation Current in Amps at 110% Voltage
15	10.7
25	10.3
33	9.5
66	7.6
115	6.4
138	6.5
230	5.1

Transformers must be tested under no-load conditions at 115% voltage.

Transformers shall be suitable for operation at 110% voltage, under full-load, for 30 minutes.

9.3 Grounding

The core of the main transformer, series transformer (if applicable) and tap changer-reactor (if applicable) shall be grounded at one point by means of a strap extending past the clamping zone, usually near the centre of the core yoke and a No. 6 AWG lead shall be brought through the tank cover via an oil tight bushing into a NEMA type 4 watertight box where it shall be grounded to the tank cover through a 500 ohm, minimum 25 W, wire-wound resistor. Each transformer and each reactor shall have its own core ground bushing and resistor.

All cores must be isolated from the tank and the clamping structure, prior to grounding. For tap-changer-reactors, the top and bottom core yokes must be bonded.

The core clamps of each of the main transformer, series transformer (if applicable), and tap-changer-reactor (if applicable) shall be grounded at one point and a No. 6 AWG lead shall be brought through the tank cover via an oil-tight bushing into a NEMA type 4 watertight box where it shall be grounded to the tank cover. Each transformer and each reactor clamping structure shall have its own clamp ground bushing.

For HVDC Station	For All Others
If the bushing is a threaded stud, it shall be a minimum of 10mm in diameter.	N/A

Both the internal lead and the external lead shall be double crimped with an approved type connectors and a proper full stroke crimp tool and die.

The clamps shall be isolated from the core and the tank. If the Contractor's standard practice is not to isolate the core from the clamping structure, it is subject to the Purchaser's approval as evidenced by Contract Form 28-1 Technical Compliance of the Contract which requires a complete description of the clamping structure and a bonding diagram.

The NEMA type 4 watertight box shall be seated with a cover using no more than two fasteners to allow for easy access. The core bolt and ground insulation of the core(s) and clamp(s) shall be capable of withstanding a test potential of 2500 V ac or dc for 1 minute.

The boxes shall be labelled externally using lamacoid nameplates or approved equal. Labelling shall be clear so that if two boxes are supplied, each box is fully labelled as Main, series, reactor etc. and core/clamp as necessary.

9.4 Bonding

It is preferred that the clamping structure be designed so as to block circulating currents from flowing in the clamping structure. It is also preferred that the windings and leads be so arranged to minimize the core circulating current.

If it is the manufacturer's standard practice to allow large circulating currents in the clamping structure, then the clamping structure members shall be solidly bonded with copper at all joints in the structure. These copper bonding points shall be readily accessible inside the tank. This shall include joints between clamps, between clamps and crossbars, and between clamps and tie-plates or tie-rods. The Purchaser reserves the right to approve all such designs.

A bonding diagram is required to show the bond connections between the clamping structure members such as the clamps, tie-rods, tie-plates, flitch plates, core bolts, and any other members that share a common bond with the clamp ground. This diagram shall identify the fixed and removable bonding links so that the clamping structure's insulation may be tested by opening the links. A diagram is required for each of the main transformer, shunt reactor, series transformer (if applicable) and tap-changer-reactor (if applicable). This diagram shall be provided in the instruction manual. For transformers rated above 115 MVA, it shall also be provided as an anodized stainless steel plate mounted to the transformer, near the rating plate.

9.5 Core Bolts

Core-bolts are not allowed.

9.6 Bracing

The core and windings shall be suitably braced within the tank to prevent displacement or distortion during transportation or abnormal electrical conditions in service. All cores shall be suitably braced and blocked to control and limit waving and folding over of the core steel. Cores with large unsupported gaps between the clamps and the core are not acceptable.

On transformers rated 95 MVA or greater, the top and bottom yokes shall be supported with additional core blocks and insulated bands to prevent flaring of the core steel outside the core clamping pressure area. Suitable lifting attachments shall be provided for untanking the core and coils with a minimum of headroom. The design and placement of lifting points shall be such as to preclude distortion of the core or damage to the core-bolt insulation, under lifting stresses.

Permanent metal banding around the core is not acceptable.

10 OIL

Petro Canada Luminol TRi shall be used, meeting the following requirements.

The oil used shall be pure mineral oil and will be subject to approval by the Purchaser. The oil shall be clean and free of moisture, acid or other matter likely to injure its insulating properties. The oil shall have a moisture content of less than 5.0 ppm. The oil shall be in accordance with CAN/CSA-C50, Class A, Type II and in addition:

(a) The viscosity shall not be greater than 2500 cSt at -40°C when tested in accordance with ASTM D445. The charged viscometer is to be maintained at -40°C ±3°C for at least 15 hours prior to the test being made. No more than 2 mL of sample shall pass the capillary between first chilling the sample and the start of the timed elution. The viscosity value to be reported is the first measurement obtained.

(b) The oxidation stability test as performed in accordance with ASTM D2440 for 164 hours shall yield a sludge weight not greater than 0.03% and a neutralisation number not greater than 0.1 mg KOH/g.

(c) The gassing tendency shall be less than -2 µL/min at 80°C when tested in accordance with ASTM D2300 Method B.

(d) There shall be less than 1 mg/kg of PCB material in the oil, when measured in accordance with ASTM D4059.

(e) Subject to the conditions of ASTM D3487, Table 1, Footnote D, the oil shall have a dielectric strength of not less than 58 kV when tested according to ASTM D1816 using a 2 mm electrode spacing.

(f) No oxidation resisting additive to be used other than DBP/DBPC without the full written vetting with the Purchaser.

(g) Furan and furan-masking compounds shall be less than the equivalent of 3 ppb of 2-furfuraldehyde.

(h) Use of any low temperature viscosity improver/additive shall be identified and brought to the Purchaser's attention. Such components shall not be more volatile or more vulnerable to oxidation than the base oil. Such components shall effectively survive the oil processing conditions specified in ASTM D3487 3.2 Note 1, and during oxidation according to ASTM D2440 164 hours. Proof of this survival shall be either an assay by means to be suggested by the Contractor, or by the oil retaining its original -40C viscosity during the specified D2440 oxidation and high temperature degasification.

The maximum specific gravity of the oil used shall be chosen to ensure that ice will not float on the oil at any temperature the oil may attain with an ambient temperature of -50°C in the de-energised equipment.

Sufficient oil to fill the transformer to the proper operating level shall be supplied by the Contractor, however, the Purchaser reserves the right to supply reclaimed oil which meets or exceeds the requirements of CAN/CSA-C50 in lieu of purchasing the first filling. The Contractor shall provide the corresponding monetary reduction and written confirmation of warranty validity.

11 BUSHINGS

11.1 Types

Bushings shall conform to CAN/CSA-C88.1. Bushing choice is subject to Purchaser's approval so it is recommended to do this immediately after the contract is awarded. Approved bushings are shown in the list below. For bushings not listed below, a bushing outline drawing is required for approval.

Solid dielectric core or composite bushings are acceptable provided that:

(a) they are only used at 72.5 kV and below;

(b) they do not replace a bushing that could have been draw lead;

(c) they have a capacitance tap;

(d) the transformer design with this bushing allows for direct replacement by an ABB oil-filled bushing (turret diameters, CT, gas seal, bottom connector) with no re-work required;

(e) a drawing of the bushing is provided at the approval stage.

Where a solid dielectric core (SDC) or oil-filled bushing is indicated as being satisfactory, it is left to the discretion of the Contractor to select either the listed dry or oil-filled bushing type.

Draw lead bushings are always required when practical. Bottom connected bushings are used when necessary for the current rating. This means, in some cases, that the neutral bushing will be different than the line bushing.

When practical, choosing the neutral bushing to be the same as the line bushings is encouraged, provided that this doesn't change the bushing from a draw-lead to a bottom connected bushing. This is intended to reduce the number of spare bushings required. Typically, this will occur on low voltage terminals where the line is 150 kV LIL and the neutral is 110 kV LIL. This does not require testing the transformer neutral at the higher impulse level.

The outline drawing of the bushing and instruction manual shall indicate the minimum depth of thread contact required for the draw lead into the draw rod when fitting the bushing. The bushing draw rod to draw lead connection shall be such that both the male and female fittings have the same cross sectional area.

The top bushing terminal shall be part of the bushing draw rod and no connection will be allowed from a top terminal cap to the draw rod. The top terminal of the draw rod exit from the bushing tube shall have a minimum of two O-rings to prevent any moisture from entering the transformer via internal bushing tube.

Porcelain bushing colour shall be grey.

Bushings must be suitable for overloading at 110ºC top oil temperature without leaking oil.

Voltage Class	Ampere Rating	Draw Lead or Bottom Connected	ABB Catalogue #			
15 kV	400	Draw	015 G 0400	BA	or	CA
	1200	Bottom	015 G 1200	DA	or	FA
	2000	Bottom	015 G 2000	GA	or	HA
	4000	Bottom	015 G 4000	LA	or	MA
27.5 kV	400	Draw	028 G 0400	BA	or	CA
	1200	Bottom	028 G 1200	DA	or	FA
	2000	Bottom	028 G 2000	GA	or	HA
	3000	Bottom	028 G 3000	JA	or	KA
	4000	Bottom	028 G 4000	LA	or	MA
35 kV	400	Bottom	035 G 0400	BA	or	CA
	1200	Bottom	035 G 1200	DA	or	FA
	2000	Bottom	035 G 2000	GA	or	HA
72.5 kV	400	Draw	072 G 0400	BA	or	CA
	1200	Bottom	072 G 1200	FA		
	2000	Bottom	072 G 2000	GA	or	HA
123 kV	600	Draw	123 G 0600	AA		
	1200	Bottom	123 G 1200	BA		
	2000	Bottom	123 G 2000	CA		
145 kV	600	Draw	145 G 0600	AA		
	1200	Bottom	145 G 1200	BA		
245 kV	600	Draw	245 G 0600	LK		
	1200	Bottom	245 G 1200	MK		

NOTES:

All bushings must conform with CAN/CSA-C88.1 Standard.

All bushings must have capacitance taps.

All bushings shall be Grey Munsell 5BG 7.0/0.4.

Final approval as per drawing submittal.

Draw lead bushing shall be used whenever possible.

Bushings must be suitable for dry switching surge test level of the transformer.

Equivalent ECI (Hubbell), N.G.K., PCORE (Lapp) and HSP bushings built to "CAN/CSA-C88.1" to be approved at time of ordering pending drawing submittal.

List of Approved Transformer Oil-Filled Bushings

11.2 Arrangement

Bushings shall be located on the tank cover, however, other arrangements if required by the Contractor's design may be accepted subject to the Purchaser's approval.

The preferred arrangement of bushings, unless specified otherwise, shall be such that the HV and LV line bushings H2 and X2 respectively shall be located on the same centreline.

Minimum phase-to-phase spacing of 500 mm shall be used on units with LIL of 170 kV or lower.

Bushings shall be located so as to provide a vertical clearance of 2440 mm minimum between the transformer base and the bottom of the porcelain.

11.3 Connections

Where draw lead bushings are supplied separate from the transformer, the ends of the transformer leads shall be taped (not soldered) to prevent strand separation. Where internal connections to bushings studs have to be made during field assembly, as many connector parts as possible shall be made captive to prevent these from falling into the tank.

Neutral draw lead/rod bushings shall also be connected such that it may be removed and replaced without lowering the oil in the tank and exposing any cellulose insulation.

For HVDC Station	For All Others
The level at which the oil can be lowered, without exposing any cellulose insulation shall be indicated on the outline drawing and the manufacturer shall apply a unique permanent identified marking on all applicable bushing turrets and/or tank.	N/A

Bushings that require corona shields shall only use a one piece corona shield that allows for the removal of the bushing, from the transformer, with the corona shield attached. All bushing shield shall be designed to prevent installation of the shield incorrectly, for example upside down.

Particular attention shall be given to bushing and tank cover flange details and these shall be shown on the Contractor’s transformer outline drawing, or alternatively, a note may be added to the transformer outline drawing to indicate that the transformer is designed to permit interchangeability between the transformer bushings supplied and the applicable standard bushing described by CAN/CSA-C88.1, including bottom end connection, as carried in the Purchaser's spare stock.

11.4 Mounting & Lifting

Provision must be made for bolts for securing bushings onto the transformer cover flange. Inaccessible welded studs or blind tapped holes are not acceptable.

The Contractor shall ensure that the bushing flange is grounded and not floating due to poor contact with painted surfaces.

O-ring and machined O-ring groves are the preferred bushing flange mounting method. Alternatively, if a gasket stop is located on the inside of the bushing mounting flange bolt circle, then an additional gasket stop must be located outside of the bolt circle, to fully support the bolted area of the bushing flange. However, for ABB bushings, this only applies at 115 kV and above. For ABB 66 kV and below, the odd shape of the flange would cause the outer gasket stop to either not support the flange, or extend past the edge of the flange allowing the collection of water.

Provision shall be made for bleeding air from the highest point of the bushing turret.

Bushings rated 115 kV and above shall be provided with lifting eyes in the support flange.

11.5 Interchangeability

If using bushings other than ABB oil-filled from the table, the Contractor shall ensure that the turret openings and bushing CTs are suitable for use with the standard bushing listed in the table above. The Contractor shall also make every effort to size the gas seal for both makes of bushings.

NOTE: The maximum internal diameter of some ABB bushings are larger than the equivalent bushing.

11.6 Nameplate

The insulation power factor and the capacitance shall be measured between the high voltage conductor and the test tap (C1) and between the test tap and ground (C2). These capacitances together with the temperature corrected values of insulation power factor to 20ºC shall be recorded on the nameplate of each bushing along with the reference temperature of 20ºC.

11.7 Site Glass

360˚ site glasses are preferred. When these are not available, oil filled bushings shall be provided with prismatic-type (fish eye) liquid level indication. The lens shall face outward from the transformer tank to facilitate viewing from the ground below. The test tap shall be located on the bushings diagonally opposite to the lens to facilitate safe test tap access from the top of the transformer tank.

11.8 Testing of SDC or Composite Bushings

If SDC or composite bushings are specified in the Supplementary Technical Requirements, the Contractor shall specify the following partial discharge requirements when ordering composite bushings.

PD @ 1.5 Uy to be less than 10 pC
PD @ 2 Uy to be less than 100 pC
PD @ 1 min. dry withstand to be less than 200 pC

Oil-filled bushings are naturally capable of meeting these requirements.

12 BUSHING CONNECTORS

All bushings shall be equipped with solderless, 4-bolt, plated cable clamp connectors in accordance with EEMAC 1Y-2. Connectors shall be hot-dipped tinned, suitable for copper or aluminium conductors and shall be capable of carrying full current rating without exceeding the allowable temperature rise above ambient for the bushing supplied.

Connectors for current ratings up to 1000 A shall be suitable for a cable range of No. 1/0 AWG to 1250 MCM stranded conductor, unless otherwise specified in the Supplementary Technical Requirements.

Connectors for voltages 115 kV and above shall be streamlined and corona-free design.

13 CURRENT TRANSFORMERS

Current transformers shall be supplied where specified in the Supplementary Technical Requirements.

13.1 Characteristics

Upon completion of the current transformer design, the Contractor shall supply the Purchaser with excitation curves and available relaying and/or metering accuracies and continuous rating factors at 30ºC on all ratios.

Continuous current rating factors for all bushing-type current transformers shall be stated on the nameplate and shall not be less than two times the rated current.

13.2 Metering

Where a current transformer is specified with a metering accuracy, the ratio and phase angle characteristics shall be within the accuracy specified by Measurement Canada, an Agency of Industry Canada Measures Canada, Un Organisme d'Industrie Canada (MCIC). Documented approval shall be provided for all taps complying with revenue metering requirements. This applies to all metering current transformers unless otherwise specified in the Supplementary Technical Requirements.

13.3 Accessibility

When bushing type current transformers are supplied, line bushings shall be removable without removing the current transformers. Current transformers in the main tank shall be accessible and removable/replaceable through the bushing turret without lowering the oil in the main tank to a level at which either the winding or core is exposed.

13.4 Wiring and Connections

Oil tight bushings or approved equal shall be used for taking current transformer secondary leads through the tank cover or turret. Bushing studs shall be locked to prevent movement when tightening external lead connectors. Bushing studs shall contain 3 nuts, both on the internal and external ends. Outer terminals of these bushings shall be enclosed in a weatherproof junction box from which the secondary leads shall be taken to a terminal block in the control cabinet or control box. The weatherproof junction box for the outer terminals shall be accessible from the transformer cover.

For HVDC Station	For All Others
The junction box shall be sealed with the use of no more than two fasteners to ensure a suitable seal.	N/A

Current transformers shall be supplied with sufficient secondary lead lengths to terminate directly on CT junction blocks, without splices.Bolted joints in current transformer leads are not acceptable. The lead length shall allow for the removal of the CT junction box from the mounting flange of a minimum of 150 mm, with the leads attached. The CT secondary shall have crimp style terminal ring lugs. The lugs shall be terminated on threaded internal studs for the CT secondary bushings and allow removal of the CT secondary leads. Terminal lug crimp joints shall be made with approved type connectors and proper full stroke crimp tool and die.

Current transformer leads inside the tank shall be ‘ETFE’ type, DuPont TEFZEL or approved equal and shall not be less than No. 10 AWG stranded. Insulation used shall be impervious to oil and shall not contaminate the oil, and shall not deteriorate through contact with oil over the range of operating temperatures. The Contractor shall submit documentation confirming the requirements of the current transformer leads when subjected to oil. Tie-wraps shall not be used to tie the leads inside the tank.

13.5 CT Test Loop

For HVDC Station	For All Others
A test loop shall be provided for all current transformers in any given bushing turret. The test loop shall consist of a single turn with a minimum cross sectional area of 80mm² taken through the "window" of all the current transformers of a given turret, and shall be terminated on oil tight 5 kV – 200A bushings located on the turret wall. The test loop bushings shall be located under the same weatherproof junction box as the outer secondary terminals for the CTs. The CT secondary leads and the leads of the test loop shall be permanently identified, on the inside and outside of their respective bushings , as per the nameplate. The 5kV test loop bushings shall be permanently identified for polarity on the inside and outside of these bushings. The CT shall be tested for polarity from both the bushings and the test loop. The test loop shall be rated to carry 400 Amps for 30 seconds, a 1 minute de-energized period, and a second period of 30 seconds at 400 Amps, without any permanent damage to the test loop or test loop bushings.	Not required.

13.6 CT Packing

Bushing CTs shall have pressboard packing placed between stacked CTs and also between the CTs and the support and clamping plates to protect them from rubbing against each other.

13.7 Samples

A sample of the current transformer lead wiring shall be submitted by the Contractor to the Purchaser for testing as described in Section 43 MATERIALS TO BE SUBMITTED FOR SAMPLING of the Technical Requirements.

Approval of the sample wiring shall apply only to the sampled batch and shall not be construed as a blanket approval of the material. Subsequent samples from different batches shall be submitted separately to the Purchaser for testing and approval.

Once the material has been approved by the Purchaser, the Contractor shall allocate sufficient materials as required for exclusive use for the Work.

13.8 Removal for Shipping

Bushing CTs shall not be removed for shipment, nor shall the CTs require rewiring upon delivery.

14 LOAD TAP-CHANGERS (LTC)

The most modern design and construction shall be used in the manufacture of the tap-changer, so as to provide smooth, shockless operation during a tap-change.

The Purchaser shall accept the use of either a resistive or reactive type tap changing system. The Contractor shall propose the type of gear that is most advantageous to their design thereby providing the Purchaser the best suitable system for any given transformer. Tap-changer selection shall be subject to the Purchaser's approval.

14.1 LTC Load Capability

The tap-changer shall have current carrying capacity consistent with the specified transformer forced cooled rating(s), including at low ambient temperature, and with the associated transformer short time overload ratings in accordance with the Technical Requirements and, if applicable, the Supplementary Technical Requirements. The tap-changer shall not limit the overload capability of the transformer.

14.2 Preferred Tap-Changers

The use of vacuum tap-changers is preferred over non-vacuum types. The use of tap-changers with the selectors mounted in an external tank is generally preferred over internal tank tap-changers. Therefore, the first preferred tap-changer is the Reinhausen RMV II. However, the use of the ABB UZ tap-changer is equally acceptable.

The needless use of series booster transformers is discouraged when other means are available.

Refer to the table below, for the preferred tap-changers to be used with each type of transformer. This table is not meant to be a requirement, but rather a guideline. However, the choice of tap-changer may be a factor in the evaluation of the bid. The suitability of the tap-changer model for the specific application should override this table.

The order of a list within a specific option (e.g., 3rd Option) is not intended as an order of preference.

NOTES for table:

ST: Series Booster Transformer
When practical, an auto series booster transformer is preferred.

Asea Brown Boveri types: UZ, UC, VUC

Maschinenfabrik Reinhausen types: VV, VR, R, M, RMV II

Maschinenfabrik Reinhausen VM type just became available at the time of this RFP. The VM is preferred over the M tap changer.

The RMV short cabinet is required. The long cabinet is not acceptable because it will sit in the snow.

Tap Voltage	MVA	LTC Type 1st Preference	LTC Type 2nd Preference	LTC Type 3rd Preference
4.16 kVY	7.5 / 10 / 12.5	RMV II	UZ with ST	VV or VR or R or M with ST
	9 / 12 / 15	UZ with ST	VV with ST	RMV II or VR or R or M with ST
	10 / 13.3 / 16.7	UZ with ST	VV with ST	RMV II or VR or R or M with ST
	18 / 24 / 30	UZ with ST	VV with ST	RMV II or VR or R or M with ST
12.47 kVY	7.5 / 10 / 12.5	RMV II	UC or VR or R or M	
	9 / 12 / 15	RMV II	UC or VR or R or M	
	10 / 13.3 / 16.7	RMV II	UC or VR or R or M	
	18 / 24 / 30	RMV II	UC or VR or R or M	
	36 / 48 / 60	UZ with ST	VV with ST	RMV II or VR or R or M with ST
24.94	7.5 / 10 / 12.5	UZ	RMV II	VV
	9 / 12 / 15	UZ	RMV II	VV
	18 / 24 / 30	RMV II	UC or VR or R or M	
	36 / 48 / 60	RMV II	UC or VR or R or M	
12.47 kVY x 24.94 kVY +/-10% in both connections	7.5 / 10 / 12.5	UZ with ST	VV with ST	RMV II or VR or R or M with ST
	9 / 12 / 15	UZ with ST	VV with ST	RMV II or VR or R or M with ST
	18 / 24 / 30	UZ with ST	VV with ST	RMV II or VR or R or M with ST
	36 / 48 / 60	UZ with ST	VV with ST	RMV II or VR or R or M with ST
12.47 kVY x 24.94 kVY +/-20% at 12.47 kV +/-10% at 24.94 kV	7.5 / 10 / 12.5	RMV II	VR	R or M or UC
	9 / 12 / 15	RMV II	VR	R or M or UC
	18 / 24 / 30	RMV II	VR	R or M or UC
	36 / 48 / 60	UZ with ST	VV with ST	RMV II or VR or R or M with ST
114.3 kV - 24.0 kVY	7.5 / 10 / 12.5	UZ	RMV II or VV	VR or R or M or UC or VUC
	9 / 12 / 15	UZ	RMV II or VV	VR or R or M or UC or VUC
	18 / 24 / 30	RMV II	VR	R or M or UC or VUC
	36 / 48 / 60	RMV II	UZ with ST	VV or VR or R or M with ST
	69 / 92 / 115	UZ with ST	VV with ST	RMV II or VR or R or M with ST
66 kV - 24.0 kV	7.5 / 10 / 12.5	UZ	RMV II or VV	VR or R or M or UC or VUC
	9 / 12 / 15	UZ	RMV II or VV	VR or R or M or UC or VUC
	18 / 24 / 30	RMV II	UC or VUC	VR or R or M
	36 / 48 / 60	RMV II	UZ with ST	VR or R or M
114.3 kVY - 66 kV	7.5 / 10 / 12.5	UZ	VV or VR	R or M or UC or VUC
	9 / 12 / 15	UZ	VV or VR	R or M or UC or VUC
	18 / 24 / 30	UZ	VV or VR	R or M or UC or VUC
	36 / 48 / 60	UZ	VV or VR	R or M or UC or VUC
	57 / 76 / 95	VR	UC or VUC or R or M	
	75 / 100 / 125	VR	UC or VUC or R or M	
	84 / 112 / 140	VR	UC or VUC or R or M	
230 kVY - 66 kV	18 / 24 / 30	VV or VR or RMV II	UC or VUC or R or M	
	36 / 48 / 60	VV or VR or RMV II	UC or VUC or R or M	
	57 / 76 / 95	VV or VR or RMV II	UC or VUC or R or M	
	84 / 112 / 140	VR or RMV II	UC or VUC or R or M	
230 kVY - 115 kVY	75 / 100 / 125	VR	R or UC or VUC	
	84 / 112 / 140	VR	R or UC or VUC	
	171 / 228 / 285	R or UC or VUC		
230 kVY - 138 kVY	75 / 100 / 125	VR	R or UC or VUC	
	84 / 112 / 140	VR	R or UC or VUC	
	171 / 228 / 285	VR	R or UC or VUC	
500 kVY - 230 kVY	240 / 320 / 400	VR	UC or VUC or R	

Preferred Tap Changers

14.3 LTC Reactors (Preventive Autos)

Reactor windings are preferred to be round, but may be rectangular on circuits up to 33 kV class. For 66 kV class, the reactor windings must be circular. For power transformers rated 30 MVA ONAN and above, reactor windings must be circular.

Rectangular reactor windings must be interwound providing equal reactance, rather than concentrically wound.

The reactor unit and lead supports must be of robust construction. The rating of the reactor shall be adequately sized to leave a margin of safety so that it does not become the weak link within the circuit. This includes the overloading requirements in the Technical Requirements.

The reactor shall be stand-alone tested for at least ratio, DC resistance on each coil, and magnetizing current at 100% voltage, prior to being mated with the main transformer windings. Reactors manufactured and tested outside of the main transformer manufacturing facility must be re-tested in the main transformer manufacturing facility.

14.4 LTC Series Booster Transformer

The Purchaser strongly prefers the use of Reinhausen RMV II reactive tap changers, or resistive tap changers without series booster transformers. However, the Purchaser acknowledges that the use of series booster transformers cannot always be avoided and will accept them in certain instances. Specifically, it is acceptable when the current is too large to allow the use of the Reinhausen RMV or an in-tank tap changer, or large enough that a resistive tap changer becomes exceedingly expensive, such as with current splitting. It is also acceptable when a re-connectable tapped winding requires equal percentage variation in the different connections. There may also be other unforeseen reasons that may be acceptable to the Purchaser, such as excessive lead size on a very small transformer. The reason the Purchaser prefers to avoid series booster transformers is the inaccessibility for condition monitoring and problem diagnosis. In that regard, when used, auto-connected series transformers are preferred.

The use of a series booster transformer is subject to the Purchaser’s approval.

If acceptable to the Purchaser, the series booster unit and lead supports must be of robust construction paralleling that of a power transformer. Evidence of short circuit withstand capabilities must be demonstrated along with suitability of application.

As the series transformer makes up an integral part of the unit assembly, LIL insulation levels shall be one step higher than the minimum necessary levels. The rating of the series transformer shall be adequately sized to leave a margin of safety so that it does not become the weak link within the circuit. This includes the overloading requirements in the Technical Requirements. All windings shall be circular and constructed of copper. The use of a distribution style series booster transformer is not acceptable to the Purchaser.

The series transformer must be fully tested as a stand-alone transformer before being mounted into the main assembly. Test bushings shall be used to access any buried circuits within the LTC winding and series transformer schematics.

14.5 Definition of Raise and Lower

The definition of raise and lower depends solely on the assignment of primary and secondary circuit labels. It does not depend on which circuit the LTC is installed.

Raise always means to raise the secondary or output voltage.

Likewise, lower always means to lower the secondary or output voltage.

Raise is always associated with LTC movement towards the maximum plus (+) tap position number, and lower is always associated with LTC movement towards the maximum minus (-) tap position number.

The CSA standard, CAN/CSA C88-M90 adds the following definitions:

> “The tap-changer positions shall be numbered such that increasing the tap position number will reduce the turns ratio.”
>
> “Turns ratio (of a transformer) - the ratio of the number of turns in the high-voltage winding to that in the low-voltage winding.”

Conditions for a Raise Operation towards maximum plus (+) tap position number							
		Turns		Turns Ratio			
Operation	LTC Location	Primary N_P	Secondary N_S	Primary $\frac{N_P}{N_S}$	CSA $\frac{N_{HV}}{N_{LV}}$	Secondary Voltage V_s	Core Flux Density
Step-Down	HV	↓		↓	↓	↑	↑
	LV		↑	↓	↓	↑	↓
Step-Up	HV		↑	↓	↑ *	↑	↓
	LV	↓		↓	↑ *	↑	↑

* Step-up operation does not meet the CSA definition of turns ratio versus tap position numbering.

Symbols:

p	primary (input)
s	secondary (output)
↓	decreasing
↑	increasing

14.6 LTC Control Cabinet

The control cabinet shall be weatherproof, equipped with hinged doors suitable for padlocking and door stops and supplied with thermostatically controlled heaters. The thermostat shall be located so that an even distribution of heat shall be obtained throughout the control cabinet, without the use of fans, to eliminate extreme heating of temperatures on the wiring and control devices. Special precautions shall be taken to minimize vibration of this compartment.

To keep the cabinet out of the snow, the bottom of the LTC control cabinet shall be at least 915 mm above the transformer base; any other height shall be subject to Purchaser’s approval.

A conduit connection of 2" or larger, containing all necessary wiring between the main transformer control cabinet and the load-tap-changer control cabinet shall be provided by the Contractor.

14.7 Operation Below -40ºC

Where operation of a tap-changer at -40ºC or lower is not possible, a special low temperature cut-out to prevent electrical operation, including a set of contacts for remote alarm, and also a warning plate to prevent manual operation when the tap changer is energised, shall be provided. Alternatively, a suitable heating system shall be provided to permit tap changer operation down to -50ºC.

A low temperature cut-off switch set at -40ºC to disable the tap-changer control circuit shall be provided in the tap-changer compartment(s). It shall be either:

> the standard switch supplied by the tap changer manufacturer and subject to the Purchaser's approval

or

> a Honeywell UDC 1000 Controller(Model # DC1001-1-1-1-0-0-0-0- DIN rail mount), DIN rail socket (Model # 81446391-001) and 100 ohm platinum RTD, 3 inch insertion (Model # R11-D100A3-004. 0-69-0006 00).

NOTE: Reinhausen tap changers, including the VR, VM and VV, when used with PetroCanada Luminol Tri oil, do not require lockout above -40 ºC. The viscosity of this oil is suitable for tap changer operation down to -40 ºC. Specify the use of PetroCanada Luminol Tri oil when ordering the tap changer with a -40 ºC cut-off.

14.8 LTC with the Selectors Mounted Inside the Main Transformer Tank

The Jansen principle shall preferably be used in the design and construction of the load-tap-changing equipment. The equipment components causing arcing shall be housed in tank compartments segregated from the main tank.

Tap gear selection shall be made so as to provide a life expectancy of 500,000 operations for the contacts.

The tank cover shall have a manhole (bell flange) large enough to remove the tap-changer complete with selector switch without de-tanking the transformer unit. This manhole shall be piped for gas collection.

Each diverter compartment shall be provided with:

(a) a pipe connector to a separate conservator; and
(b) a 1" drain valve brought down to a suitable location 1200 mm above grade.

For HVDC Station	
The tap changer conservator tank shall be at a lower elevation than the main conservator tank such that if oil leaks between the diverter oil vessel and the main tank, oil will flow into the diverter vessel and not vice versa. It is preferred that the tap changer conservator tank be located on the outer edge of the tank band to allow a clear view of the oil level gauge and ease of plumbing of the drain / fill / breather lines.	

For GSU Transformers	For All Others
Same as HVDC Station	The tap-changer conservator may be a separate tank or a separate section of the main transformer conservator.

The tap changer conservator tank shall be oversized to allow for annual oil sampling, considering the amount expelled from the pipework to take a proper sample, so the volume shall be approximately equal to the volume of the diverter.

It shall have the same oil valves and accessories applied to it as required by the main tank conservator. All fill/drain valves shall be brought down to a suitable location 1200 mm above grade. The 1" drain shall be arranged so as to permit the contaminated oil in the conservator to be drained while the transformer is energized.

Each diverter compartment head cover shall be provided with an approved pressure-relief device and an inspection window from which the tap-changer position is visible. The top of the head cover shall not be higher than the bushing steel flanges. The diverter switch chamber shall be supplied with surge relay type RS 2000 (by Maschinenfabrik Reinhausen) or approved equivalent.

For HVDC Station	For All Others
The surge relay shall have a minimum of three (3) NO contacts.	The surge relay shall have a minimum of one (1) NO contact.

For HVDC Station	For All Others
A Messko LMPRD part# 685-OM15VM2BOZM two DPDT switches shall be provided. Refer to 25 PRESSURE-RELIEF DEVICE for more details.	A Qualitrol LPRD shall be provided. Refer to 25 PRESSURE-RELIEF DEVICE for more details.

A pressure equalisation loop with a shut-off valve shall be provided between the main tank and the tap-changer diverter compartment for vacuum filling. A 1" indicating type equalizing valve between the tap-changer compartment(s) and the main tank shall be provided for field use. The purpose of this is to simplify vacuum oil filling. This shall be assembled with solid pipe between the diverter flange and the cover flange of the LTC. This assembly shall be as small as possible so as not to create an undue tripping hazard for personnel walking on the cover. A warning plate shall be located near the equalizing valve to indicate that the valve must be closed when the unit is operational.

With the shut-off valve closed, mixing between the oils in the main tank and the diverter compartment shall not be permitted.

A Messko (Maschinnenfabrik Reinhausen) MtraB dehydrating breather shall be supplied as described in section 20.5.5 Breathers.

All drive shafts shall be covered with protective guards. For ABB tap changers with the plastic drive shaft cover, replace the plastic cover with an aluminum shield because the plastic one cracks with UV exposure.

The arrangement and support of tap leads at the tap changer selector shall be in such a manner to allow the tap changer head, which is attached to the diverter compartment, to be lifted to facilitate changing of the O-ring between the tap changer and the main tank, in the event of a leak. The maximum height to allow the O-ring to be changed is to be determined by the manufacturer and a lamacoid nameplate shall be placed next to the tap changer head indicting the maximum allowable height that the tap changer head may be lifted, using a load cell to monitor the stress on the tap changer head.

14.9 LTC with the Selectors Mounted in a Separate Tank

14.9.1 Compartments and Pressure Test

All tap-changer tank compartments shall be provided with access openings and cover plates.

The tap-changing mechanism shall be mounted in an oil filled tank compartment on the end wall of the transformer and shall be segregated from the main transformer tank. The tap-changer compartment may be divided into oil tight sections housing the arcing and non-arcing components of the tap-changer respectively. The interconnecting tank section, tap-changer components, gaskets and other required parts shall be capable of withstanding both a pressure of 83 kPa or full vacuum in both directions. The tap-changer compartment(s) shall be pressure and vacuum tested in both directions prior to mounting on the transformer. After the tap-changer is mounted on the transformer, it shall be pressure tested between the main tank and the tap-changer compartment(s) to check the integrity of the oil seal between the main tank and the tap-changer compartment(s). This test shall be conducted by applying a pressure of 50kPa to the main tank and the main tank must be filled with oil. The duration of the pressure test shall be 16 hours for hot oil (above 60ºC). The pressure test shall be done after all factory tests are completed. All internal tap-changer components shall be examined for deficiencies or excess wear at the same time the tap changer is open for the pressure test.

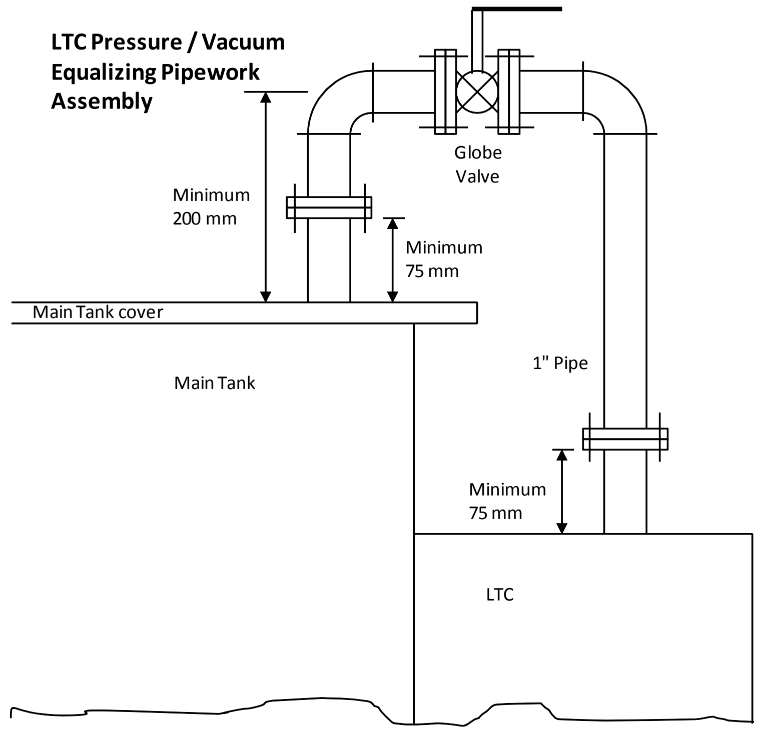
The tap-changer tank shall be welded to the main tank. Bolted tanks are not acceptable.

14.9.2 Valves

Each oil-filled tap-changer compartment(s) shall be provided with 1" drain and filter press connections equipped with indicating type valves and brass plugs, and weatherproof open type breathers.

14.9.3 LTC Equalizing Pipework and Valve

A 1" indicating type equalizing valve between the tap-changer compartment(s) and the main tank shall be provided for field use as per the sketch below. The purpose of this is to simplify vacuum oil filling. The pipework must be through the cover of the main tank, and not through the side wall. A warning plate shall be located near the equalizing valve to indicate that the valve must be closed when the unit is operational.



14.9.4 Pressure Relief Device

The tap-changer compartment(s) shall be equipped with a pressure-relief device as specified in Section 25 PRESSURE-RELIEF DEVICE of the Technical Requirements. The trip contact shall be wired into a terminal block in the main control cabinet of the transformer.

14.9.5 Fast Gas Pressure Device

The tap-changer compartment(s) shall be equipped with a fast gas pressure device such as the Beta pressure relay, RS 2002 or approved equal. The fast gas pressure device shall be set at a pressure level in accordance with the manufacturer's instruction taking into account the ambient temperature requirements. The trip contact shall be normally open hand reset type and wired into a terminal block in the main control cabinet of the transformer.

For HVDC Station	For All Others
The device shall have a minimum of three (3) NO contacts.	The device shall have a minimum of one (1) NO contact.

14.9.6 With Conservator

For further requirements to this subsection, refer to Technical Requirements sections:
(a) 20 CONSERVATOR TANK and
(b) 21 CRITICAL OIL LEVEL TRIP

The tap-changer compartment(s) shall be kept under a small static head of oil and shall be designed to allow oil expansion inside the compartment(s). This may be achieved by providing space at the top of the tap-changer compartment(s) or by connecting to a conservator tank.

For HVDC Station	For All Others
The tap changer conservator tank shall be at a lower elevation than the main conservator tank such that if oil leaks between the diverter oil vessel and the main tank, oil will flow into the diverter vessel and not vice versa. It is preferred that the tap changer conservator tank be located on the outer edge of the tank band to allow a clear view of the oil level gauge and ease of plumbing of the drain / fill / breather lines.	The tap-changer conservator may be a separate tank or a separate section of the main transformer conservator.

The tap changer conservator tank shall be oversized to allow for annual oil sampling, considering the amount expelled from the pipework to take a proper sample, so the volume shall be approximately equal to the volume of the diverter.

It shall have the same oil valves and accessories applied to it as required by the main tank conservator. All fill/drain valves shall be brought down to a suitable location 1200 mm above grade. The 1" drain shall be arranged so as to permit the contaminated oil in the conservator to be drained while the transformer is energised. If an electronic temperature monitor is provided, the oil level gauge shall have a potentiometer output for use by the electronic temperature monitor.

If a silica-gel breather is required by the tap changer manufacturer, a Messko (Maschinnenfabrik Reinhausen) MtraB dehydrating breather shall be supplied as described in section 20.5.5 Breathers.

14.9.7 Without Conservator

If a conservator is not provided, a magnetic dial type oil level gauge visible from the ground shall be provided on the tap-changer compartment(s). The gauge shall be equipped with normally open alarm contact that closes on low oil and wired into a terminal block in the main control cabinet of the transformer. The gauge shall also have a trip contact for critical low oil level.

(a) Breathing LTC Tank
On breathing tap-changer tanks without a conservator, the air space above the oil shall be equipped with a silica-gel breather. A Messko (Maschinnenfabrik Reinhausen) MtraB dehydrating breather shall be supplied as described in section 20.5.5 Breathers.

(b) Sealed LTC Tank
Sealed tap-changer tanks that don't breathe require a pressure/vacuum bleeder device complete with pressure-vacuum gauge, Qualitrol or approved equal.

A 1/4" bleeder valve shall be installed between the pressure/vacuum device and the LTC tank to allow manual relief of pressure/vacuum during set-up of the transformer for operation. The bleeder valve shall be located at a height where it can be reached easily. The control on the bleeder device shall be set at a pressure level in accordance with the manufacturer's instruction taking into account the ambient temperature requirements.

14.9.8 Heater

If possible, an immersion heater shall not be used; otherwise a suitable sized immersion type electric element heater shall be provided in the tap-changer oil compartment(s) for operation below -20ºC. In addition to the operating thermostat for this heater, it shall have a high temperature cut-off device set at 0ºC.

14.9.9 Vacuum Bottles

Tap-changers incorporating vacuum bottles for switching or diverter contacts shall include in the control a current sensing circuit to block the electrical and hand crank operation of the tap-changer if the vacuum bottles are open. Alternatively, a proven fibre optic system will be considered, subject to approval by the Purchaser. The vacuum bottles shall be fail proof to the closed position and that a means of readily measuring the contact wear be provided. An alarm contact indicating the failure of the vacuum bottle shall also be provided and wired into a terminal block in the main control cabinet of the transformer. A warning plate shall be provided close to the hand crank position stating that the tap-changer must not be operated when there is an alarm indicating vacuum bottle failure.

For Reinhausen RMV tap changers, the Vacuum Interrupter Module (VIM) card shall utilize the latest version software which includes allowance for 33 tapchanges under zero current.

14.9.10 Control Cabinet

An air-filled compartment housing the control equipment shall be mounted immediately below the on-load-tap-changer or alternative position approved by the Purchaser.

The new larger Reinhausen RMV control cabinet is not acceptable because it will sit in the snow. The old smaller cabinet is required.

14.10 Accessories and Controls Supplied by LTC Manufacturer

14.10.1 Motor

A 60 Hz motor of type and design approved for the duty shall be used to operate the driving mechanism. This motor will be supplied from the Purchaser's external station service supply. The motor voltage and number of phases are specified in the Supplementary Technical Requirements.

14.10.2 Position Indicator

A tap-changer position indicator shall be driven directly from the tap selector shaft to show the operating position of the tap-changer and the limits, upper and lower, of its permitted operation. The indicator shall be located at such height as to be easily read by a person standing at ground level.

The tap-changer dial indicator shall have tap positions numbered from plus one (+1) and minus one (-1) upwards corresponding to 'raise' and 'lower' of the output voltage with respect to the neutral (N) position.

14.10.3 Counter

An operations counter, visible from outside the cabinet, shall be provided to count the number of tap-changer operations.

14.10.4 Drag Pointers

Hand reset drag pointers shall be fitted to the position indicator to indicate the range over which the tap-changer has operated in service.

14.10.5 Hand Crank

A separate hand control by means of a removable crank, or otherwise, together with necessary gearing, shall be provided to ensure an easy and quick manual movement of the tap-changing gear when necessary. Interlocking shall be provided to open the tap-changer motor supply and control circuits when operating the tap-changer manually.

14.10.6 Cabinet Light

A cabinet light, associated switch, and a standard NEMA, 125 V, 15 A, 1 phase, 3-wire duplex convenience outlet, with a ground fault circuit interrupter shall be provided.

14.10.7 Cabinet Heater

A 120 V ac anti-condensation heater in the control cabinet.

14.10.8 Wiring

Refer to section 32 CONTROL WIRING as a general guide.

14.10.9 Neutral Indication

In addition to the visual indication of the position indicator, the Contractor shall provide a set of electrical contacts suitable for 125 V dc which will only close when the tap-changer is in the neutral position for the purpose of interlocking with the Purchaser's associated circuit breakers. These contacts shall be wired to a terminal block for connection to the Purchaser's external cabling.

14.10.10 Remote Indication

Remote indication of the complete range of tap positions shall be provided using three methods: cam switches, the discrete resistance method and a BCD transmitter.

(a) Switches
Auxiliary switches shall provide remote indication for the complete range of tap positions.

(b) Discrete Resistance
The system shall include a potentiometer position transmitter (50 ohms per step), 4 to 20 mA transducer and remote tap position indicator. The transducer shall be CEWE DR135, or approved equal. The indicator shall be CEWE CL96, 4-20 mA, or approved equal. Two such systems shall be supplied, with both tap position indicators being mounted on a swing panel in the transformer's control cabinet. One of these indicators may be mounted high up the panel because it may eventually be mounted in the station's building. The other must be mounted near the raise and lower controls. The tap-changer remote control and indication terminations shall be located within the main control cabinet of the transformer.

(c) BCD Transmitter

One BCD transmitter for tap position indication shall be provided, with access from the transformer's control cabinet.

14.10.11 Full Boost and Full Buck Indication

Two sets of dry contact shall be used to provide full boost and full buck indication when the tap-changer is on supervisory control. These contacts are to be shown in the control schematics and wiring diagrams, and be wired to terminal blocks. They shall be grouped together with the other spare contacts.

14.10.12 NERC Cyber Security Door Contact

LTC motor drive door opening shall actuate an an additional dry contact for NERC cyber-security purposes. This contact shall be wired back to the main transformer control cabinet.

For Reinhausen RMV II tap changer, order the 'Door Ajar Relay' option. For Reinhausen in-tank LTC, order with an auxiliary circuit "Door Open" contact.

For ABB, it is an available option.

14.10.13 Active Tap Change Indication

The LTC shall include a contact which indicates when either a raise or lower operation is occurring. Alternatively, this can be two contacts such as raise / lower activation contacts, or'd together. E.g. Reinhausen optional switch# 127 or 191 or equivalent.

14.10.14 Voltage Failure

For HVDC Station	For All Others
There shall be three (3) 120 VAC control voltage monitoring relays for the tap changer controls. One shall be wired at the power supply incoming terminals and the second shall be wired at the end of the safety interlocks for the tap changer and one shall be wired to the three phase incoming supply and shall rely on the three phase supply to operate and not require additional single phase 120 V supply.	N/A

14.11 Accessories and Controls Supplied by Transformer Manufacturer

For LTC controls supplied by the transformer manufacturer, refer to section 33 LTC CONTROLS IN TRANSFORMER CONTROL CABINET.

15 DE-ENERGIZED TAP-CHANGER, SWITCHES AND LINKBOARDS

All switches are subject to the Purchaser's approval as evidenced by Contract Form 28-1 Technical Compliance of the Contract where detail is provided. Linkboards are also subject to approval by the Purchaser.

Approved switches shall also be detailed in the Instruction Manuals.

Switches are preferred over linkboards for the de-energised tap-changer. Series parallel reconnections or 0/180º phase transformations shall be linkboards.

If a switch is used, it must be a hand-operated switch preferably located on the tank side. A means of padlocking the handle in any operating position outside the tank shall be provided for the Purchaser's 9.6 mm diameter padlock shank. If contacts cannot be readily maintained through openings in tank cover, a port and cover plate shall be provided directly across from each individual switch mechanism on the transformer tank wall to permit inspection, maintenance and removal/replacement. The switches and associated drive assembly shall be mounted at least 1200 mm above the bottom of the tank.

ASP switches are not acceptable.

15.1 12.47 x 24.94 kV Reconnection

Unless otherwise specified in the Supplementary Technical Requirements, transformers with a 12.47 x 24.94 kV series / parallel re-connection may have a ±20% tap range in the 12.47 kV connection and a ±10% tap range in the 24.94 kV connection. Load drop compensator VTs must be suitably situated and chosen to output 120 V accurately in both connections. This may require the use of reconnectable VTs or separate VTs.

16 TANK

16.1 Design Withstand

The tank shall be constructed of welded steel plate and shall be suitably reinforced to withstand, without distortion, handling or excessive pressure during fault conditions. The maximum allowable tank deflection during the application of pressure test or full vacuum shall be shown on the Contractor's outline drawing.

The assembled transformer, including tank, radiators, oil pumps, all oil connections, valves, stems and other fittings, with the relief vent in place but with the relief diaphragm replaced by a steel plate, shall be capable of withstanding, without permanent visible distortion:

(a) when oil filled, a 50 kPa internal pressure measured at the elevation of the cover, and

(b) without oil, a vacuum of 50 microns absolute gas pressure at an atmospheric pressure of 760 mm of mercury (Hg).

Transformers of sealed tank design are not acceptable.

The maximum allowable tank deflections during the application of the 50 kPa pressure test or full vacuum shall be shown on the Contractor's outline drawing.

16.2 Accessories

Transformers shall be designed and equipped for vacuum filling in the field, whether or not the transformer is shipped with oil.

All brackets used to mount transformer accessories shall be designed so as to be detachable from the main transformer body (i.e., surge arrester brackets, support insulator brackets, etc.).

The tank cover shall be made sufficiently large to readily accommodate all accessories as specified.

16.3 Cover

Tank covers shall be welded.

The tank cover and gas collection pipework shall be designed to collect gas from all areas of the tank.

For HVDC Station	For All Others
For transformers rated above 115 MVA: A gas collection point at the bushing flange to the main gas collector shall be provided for all bushings. Displacement packing or nitrile rubber gas seals around the bushing ground sleeve are not permitted. The main gas collection pipe work for bushing turrets, horizontal pockets, tap changer, etc shall be routed on the outer perimeter of the tank, as opposed to the centre of the cover, with all collection points going outward to the tank edge to further allow the center of the tank cover to be free of encumbrances. All support stands for the gas collection system shall be designed to prevent water from collecting inside of the support stand. All horizontal pockets on the tank cover that are larger than 250 cc shall have a 2° to 3° slope with a minimum of two collection points at the corners of the high side of this surface to ensure no accumulation of gas. Displacement packing may be used to reduce the volume below the 250cc requirement. All vertical pockets / gas spaces on the tank shall incorporate a slope (>15°) on top ledge to allow gas to move upward and not collect in the pocket. Displacement pads or gas deflectors are optional but do not replace the requirement of the sloped top ledge.	N/A

The cover must be sloped to minimise the number of gas pipework collection points. This requirement includes the cover above the tap-changer(s) when the tap-changer selectors are mounted inside the main transformer tank. Specifically, the pockets around the tap-changer head must be piped and the cover around the tap-changer should be sloped. If it is not sloped, then it must be piped appropriately subject to the approval of the Purchaser.

The tank cover shall be designed with sufficient slope to properly shed water but not create a safety hazard for personnel working on top of the unit. The allowable slope for the tank cover shall be a minimum of 2º and a maximum of 3º.

All brackets and platforms / ramps / walkways used shall be designed so as to be detachable from the main transformer body.

Every effort shall be made to reduce the congestion on the tank cover and shall be subject to approval by the Purchaser.

16.4 Inspection Space

Tanks shall be sized to allow internal inspection. In general, tanks will require a minimum of 300 mm between lead work/structure and the tank wall. This may be relaxed somewhat if access is provided between the coils and the leads, and underneath the lead rack. The Purchaser will review the internal assembly drawing for this clearance.

This does not mean that each end or side of the tank must be fully passable, provided that enough manholes and access is provided for internal entrance and inspection.

Where bottom entrance access is limited, top access may be necessary from the cover manhole(s). Elevated wall access is not acceptable.

16.5 Post Holders and Fall Arrest System

All transformers with covers 2450 mm or greater (cover to underbase) shall have this fall restraint system.

The post holder davit cups and the fall arrest base plates shall be mounted level regardless of the slope of the cover. Their locations and mounting shall be subject to approval by the Purchaser.

16.5.1 Post Holder Davit Cups

Post holder davit cups shall be solidly welded around the perimeter of the tank cover edge at centres not exceeding 1220 mm in accordance with **Purchaser's Drawing 1-01000-DD-76880-0002 Sheet 001 below**. There shall be 150 mm clearance around the outside of the davit cups to allow for insertion of the locking pin. The post holder davit cups shall be manufactured and installed in accordance with the following Purchaser's drawings below:

(a) **1-01000-DB-76880-0003 Sheet 001**
(b) **1-01000-DB-76880-0004 Sheet 001**

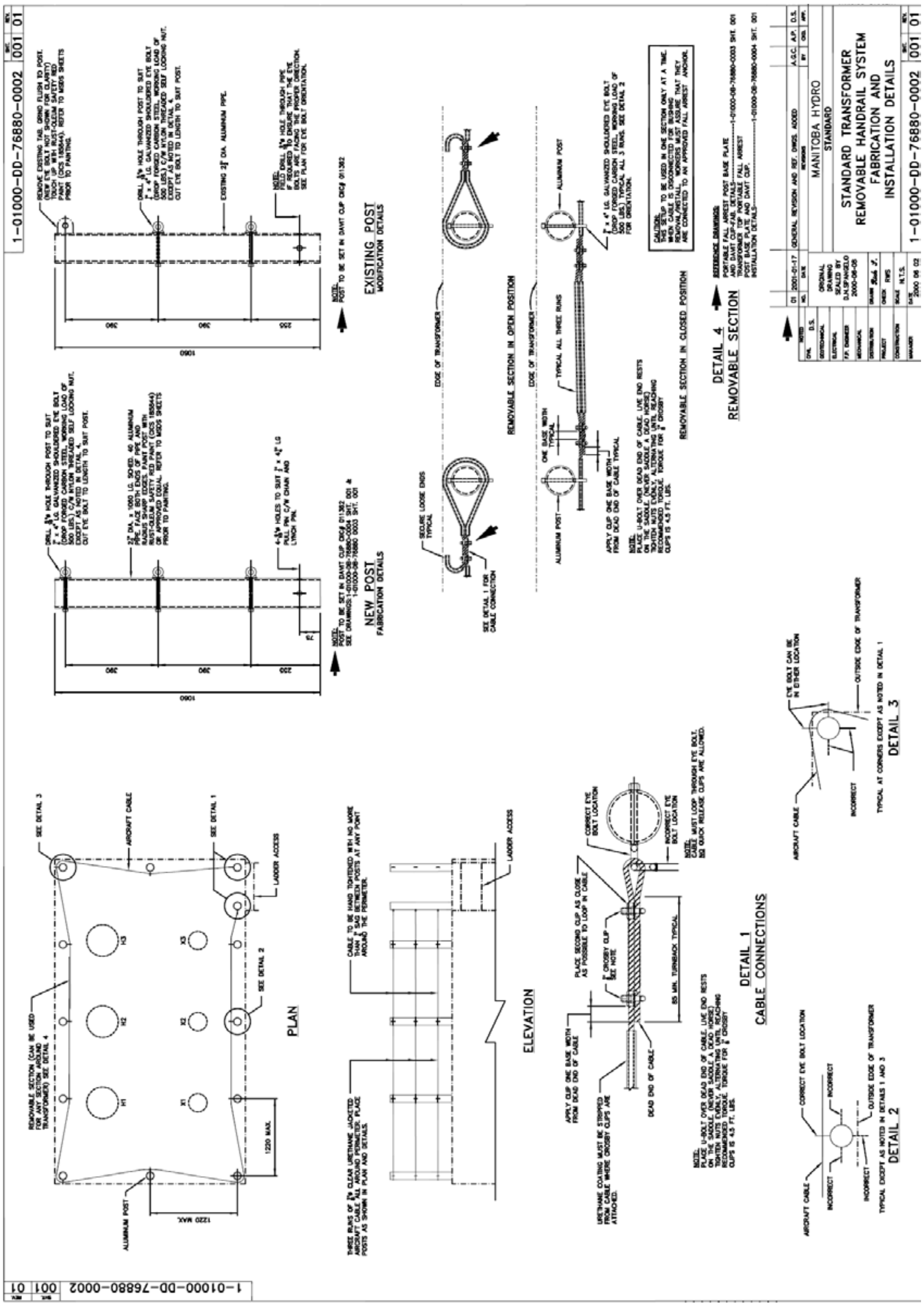
For HVDC Station	For All Others
When practical on units rated above 115 MVA, without extending the heights of turrets and gas-collection, the Contractor shall locate all post holders to allow the fibreglass posts to remain in place with the transformer in service.	N/A

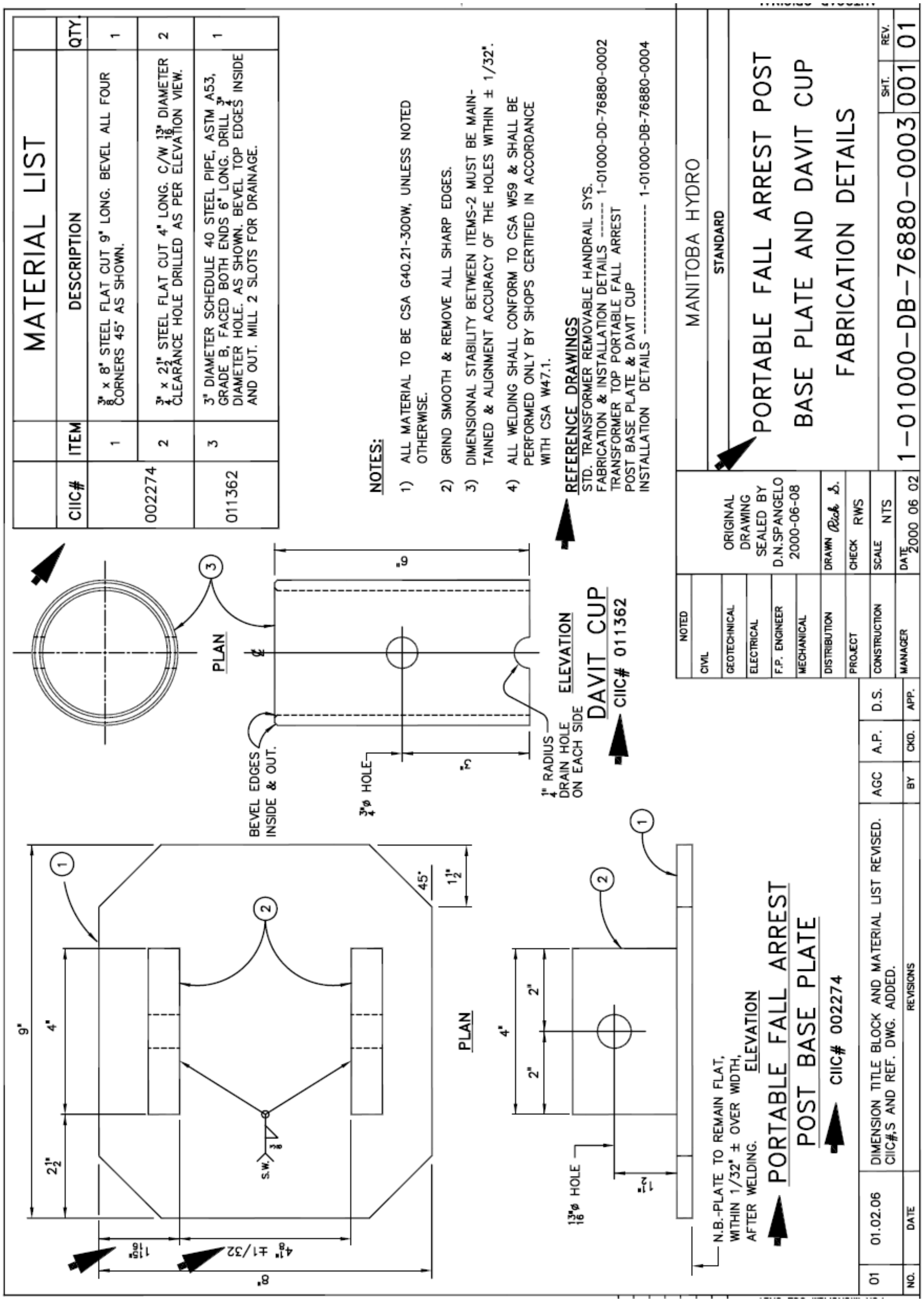
16.5.2 Portable Fall Arrest Post Base Plates

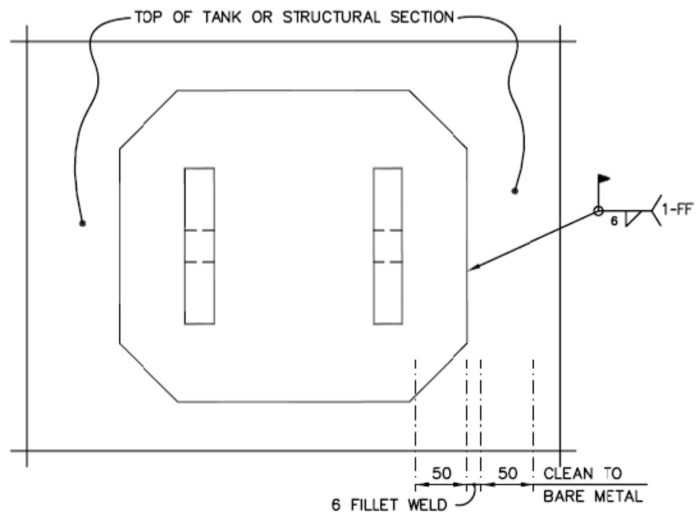
UCL Safety Systems (Uni-Hoist) Model 10816 non-rotating weld-on base plates for UCL fall arrest system shall be welded on the transformer tank cover. There must be 400 mm minimum clearance around the centre of the base plates and 150 mm from the outside of each gusset to allow for insertion of the locking pin. Number of base plates required and their locations shall be subject to approval by the Purchaser. Portable fall arrest post base plates shall be provided in accordance with the following Purchaser's drawings shown below:

(a) **1-01000-DB-76880-0003 Sheet 001**
(b) **1-01000-DB-76880-0004 Sheet 001**

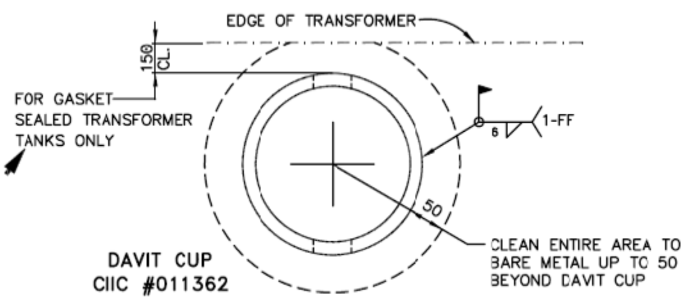
For HVDC Station	For All Others
On units rated above 115 MVA with permanent posts installed per 16.5.1 Post Holder Davit Cups, the Uni-Hoist base plates shall be boltable and removable. The Uni-Hoist would only be required as an alternative. Should another safety mounting pad style be required for the factory, it shall be removable without leaving any tripping hazards behind when the unit is in service.	Uni-Hoist base plates are welded to the cover.


1-01000-DD-76880-0002
PLAN
ELEVATION
NEW POST
FABRICATION DETAILS
EXISTING POST
MODIFICATION DETAILS
REMOVABLE SECTION IN OPEN POSITION
REMOVABLE SECTION IN CLOSED POSITION
DETAIL 4
REMOVABLE SECTION
DETAIL 1
CABLE CONNECTIONS
DETAIL 2
DETAIL 3
MANITOBA HYDRO
STANDARD
STANDARD TRANSFORMER
REMOVABLE HANDRAIL SYSTEM
FABRICATION AND
INSTALLATION DETAILS


MATERIAL LIST
CIIC# | ITEM | DESCRIPTION | QTY
1 | 3/8" x 8" STEEL FLAT CUT 9" LONG. BEVEL ALL FOUR CORNERS 45° AS SHOWN. | 1
002274 | 2 | 3/4" x 2 1/2" STEEL FLAT CUT 4" LONG. C/W 13/16" DIAMETER CLEARANCE HOLE DRILLED AS PER ELEVATION VIEW. | 2
011362 | 3 | 3" DIAMETER SCHEDULE 40 STEEL PIPE, ASTM A53, GRADE B, FACED BOTH ENDS 6" LONG. DRILL 3/4" DIAMETER HOLE. AS SHOWN. BEVEL TOP EDGES INSIDE AND OUT. MILL 2 SLOTS FOR DRAINAGE. | 1
NOTES:
1) ALL MATERIAL TO BE CSA G40.21-300W, UNLESS NOTED OTHERWISE.
2) GRIND SMOOTH & REMOVE ALL SHARP EDGES.
3) DIMENSIONAL STABILITY BETWEEN ITEMS-2 MUST BE MAINTAINED & ALIGNMENT ACCURACY OF THE HOLES WITHIN ± 1/32".
4) ALL WELDING SHALL CONFORM TO CSA W59 & SHALL BE PERFORMED ONLY BY SHOPS CERTIFIED IN ACCORDANCE WITH CSA W47.1.
REFERENCE DRAWINGS
STD. TRANSFORMER REMOVABLE HANDRAIL SYS. FABRICATION & INSTALLATION DETAILS ------ 1-01000-DD-76880-0002
TRANSFORMER TOP PORTABLE FALL ARREST POST BASE PLATE & DAVIT CUP INSTALLATION DETAILS ------ 1-01000-DB-76880-0004
PLAN
ELEVATION
DAVIT CUP
CIIC# 011362
6"
BEVEL EDGES INSIDE & OUT.
3/4"ø HOLE
1" RADIUS DRAIN HOLE ON EACH SIDE
PLAN
9"
4"
2 1/2"
8"
4 3/8" ±1/32
1 13/16
45°
1 1/2"
S.W.
2"
2"
4"
13/16"ø HOLE
N.B.-PLATE TO REMAIN FLAT, WITHIN 1/32" ± OVER WIDTH, AFTER WELDING.
ELEVATION
PORTABLE FALL ARREST
POST BASE PLATE
CIIC# 002274
MANITOBA HYDRO
STANDARD
PORTABLE FALL ARREST POST
BASE PLATE AND DAVIT CUP
FABRICATION DETAILS
ORIGINAL DRAWING SEALED BY D.N.SPANGELO 2000-06-08
NOTED
CIVIL
GEOTECHNICAL
ELECTRICAL
F.P. ENGINEER
MECHANICAL
DISTRIBUTION
PROJECT
CONSTRUCTION
MANAGER
DRAWN
CHECK RWS
SCALE NTS
DATE 2000 06 02
1-01000-DB-76880-0003
SHT. 001
REV. 01
01 | 01.02.06 | DIMENSION TITLE BLOCK AND MATERIAL LIST REVISED. CIIC#,S AND REF. DWG. ADDED. | AGC | A.P. | D.S.
NO. | DATE | REVISIONS | BY | CKD. | APP.



PORTABLE FALL ARREST POST BASE PLATE
CIIC #002274



DAVIT CUP
CIIC #011362

NOTES:

GENERAL:

1. BASE PLATE INTENDED FOR USE WITH PORTABLE FALL ARREST POST AND OPTIONAL EXTENSIONS REFER TO DRAWING 1-01000-DB-76880-0008 SHT. 001.
2. DAVIT CUP INTENDED FOR INSTALLATION OF REMOVABLE HANDRAIL SYSTEM REFER TO DRAWING 1-01000-DB-76880-0002 SHT. 001.

WELDING:

1. PORTABLE FALL ARREST POST BASE PLATE AND DAVIT CUP TO BE MOUNTED ONLY ON TANKS PLATES OF 10mm MINIMUM THICKNESS BACKED BY OIL OR ON STRUCTURAL SECTIONS AS APPROVED BY STRUCTURAL ENGINEERING DEPARTMENT. LOCATIONS TO BE DETERMINED AS NOTED ON DOCUMENT ENTITLED 'GUIDELINES FOR INSTALLATION FOR BASE PLATES AND DAVIT CUPS ON EXISTING ELECTRICAL APPARATUS'.
4. REMOVE EXISTING PAINT/GALVANIZING TO BARE METAL IN AREA TO BE WELDED AS SHOWN IN DETAILS.
5. THOROUGHLY CLEAN WELD SURFACES OF BASE PLATE, DAVIT CUP AND EXISTING STEEL ℙ/STRUCTURAL SECTION.
6. FIELD WELD AS PER APPROVED MANITOBA HYDRO WELDING PROCEDURES. FOR OIL FILLED TANKS MANITOBA HYDRO FLUX CORE WELDING PROCEDURE SPECIFICATION MH-2 AND WELDING PROCEDURE DATA SHEET 1-FF MUST BE USED TO ENSURE HEAT DOES NOT DAMAGE THE INTERIOR OF TANK SURFACE, GASKET MATERIAL OR CONTENTS.
7. AFTER ALL WELDS HAVE COOLED TOUCH UP EXISTNG AND PAINT NEW ℙ/CUP WITH APPROVED MATCH COLORED PAINT OR GALVACON ZINC RICH PAINT, IF GALVANIZED.
8. WELD PASSES SHALL BE AS SHOWN IN THE WELDING PROCEDURES HOWEVER EACH PASS SHALL BE COMPLETED IN ITS ENTIRETY PRIOR TO STARTING SUBSEQUENT PASSES.
9. SMAW (STICK WELDING) MAY BE USED ONLY UNDER SPECIAL CIRCUMSTANCES AND AT THE WRITTEN REQUEST OF THE WELDING SUPERVISOR, REFER TO DRAWING 1-01000-DB-76880-0007 FOR DETAILED WELD APPLICATION PROCEDURE.

REFERENCE DRAWINGS:

STANDARD TRANSFORMER REMOVABLE HANDRAIL SYSTEM. FABRICATION AND INSTALLATION DETAILS ---------------- 1-01000-DB-76880-0002 SHT.001

PORTABLE FALL ARREST POST BASE PLATE & DAVIT CUP FABRICATION DETAILS ---------------- 1-01000-DB-76880-0003 SHT. 001

NO.	DATE	REVISIONS	BY	CKD.	APP.
03	2002-04-18	CLEARANCE DIM'N FOR GASKET SEALED TRANSFORMERS ADDED	K.M.	K.M.	R.J.B.
02	2001.07.11	GENERAL REVISION	AGC	A.P.	R.J.B.
01	2001.01.16	REVISED NOTES AND WELDING SYMBOLS. REF. DWGS. ADDED	AGC	A.P.	D.S.

FOR MICROFILM USE ONLY

B SIZE – 279 x 394

NOTED	
CIVIL	ORIGINAL DRAWING SEALED BY D.N.SPANGELO 2000-06-08
GEOTECHNICAL	
ELECTRICAL	
F.P. ENGINEER	
MECHANICAL	
DISTRIBUTION	DRAWN Rick S.
PROJECT	CHECK RWS
CONSTRUCTION	SCALE N.T.S.
MANAGER	DATE 2000 06 02

MANITOBA HYDRO
STANDARD
TRANSFORMER TOP PORTABLE FALL ARREST POST BASE PLATE AND DAVIT CUP INSTALLATION DETAILS

1-01000-DB-76880-0004 SHT. 001 REV. 03

16.6 Provision for Dry-Air Bottles

Tanks shipped without dry-air bottles shall have mounting flags with 13 mm bolt holes, to allow for future addition of a standard gas bottle.

16.7 Lifting Lugs and Hauling Tackle

The tank and subassemblies shall have lifting lugs and jack steps as required for moving and dismantling the totally filled and assembled transformer, including bushings.

16.7.1 Jack Steps

Jack steps on transformers shall have a clearance of 400 mm above ground level. For transformers rated 140 MVA and above, the jack steps shall have a minimum of 350 mm projection and a width not less than 900 mm. For all others, the jack steps shall have a minimum of 250 mm projection and a width of not less than 500 mm. The tank shall be sufficiently reinforced to prevent flexing of the tank wall. Jacking points should be located close to the corners on the long sides of the transformer, with the entire area of the jack step having no obstructions between itself and ground. When a foundation drawing is included in the Supplementary Technical Specification, the jacking points should be located within the boundaries of the foundation. For transformers rated 140 MVA and above, the jack steps shall have holding clips to allow the hydraulic jacks to hang upside down by the bottom base, to allow the jacks to be moved with the transformer.

16.7.2 Skids

Transformers shall be equipped with a suitably reinforced base frame to form a skid assembly for skidding the transformer in any direction and for hauling over rollers. The skid assembly shall be designed with a minimum width of 200 mm per skid and sufficient protrusion to disperse the weight effectively for safe movement. Skid assembly shall be equipped with pull points for attaching hauling tackle. Skids are to be installed as close to the outside corners as possible to allow sufficient width for safe movement. The minimum size for pull holes shall be 51 mm.

For transformers rated 140 MVA and above, the transformer base shall be self supporting regardless of the type of tank base design.

16.7.3 Flat Base

On transformers requiring the design of a flat base plate, the tank wall shall be permanently marked showing the push points and where moving skids are to be placed. These locations shall coincide with the internal core frame and shall be sufficiently reinforced to prevent distortion of the base or tank wall during movement.

In no way shall the access, for hydraulic ramps, to the push points on the tank be obstructed by any accessories; this includes oil flow pipes, the control box and the conduit for external wiring. The hydraulic ramps also require a minimum of 450 mm of clearance above the push points for operation.

16.7.4 Lifting Lugs

Lifting lugs shall be provided for lifting the fully-assembled and oil-filled transformer. Lifting lugs shall be designed to accommodate lifting slings with or without the use of clevises.

16.8 Manholes and Handholes

Manholes and handholes shall be provided on the tank cover and as necessary on the tank walls to permit unhindered access for checking and repair or removal of current transformers, tap-changer components, winding connections and other devices that may require routine or emergency maintenance. An emergency access manhole shall also be provided on the tank wall at ground level. Flanges shall be provided for all handholes and manholes.

Transformers rated 16.7 MVA or less, shall have at least two (2) handholes for access through the cover. Transformers rated greater than 15 MVA shall have at least two (2) manholes on the tank cover for access to the interior without lowering the oil below the top of the core.

Tank cover manholes or handholes shall be strategically placed to access any internal bushing connections, internal winding ground connections and internal core and clamp ground connections.

Manholes shall be 600 mm x 600 mm (or 600 mm diameter) to allow free entry of a person attired in winter clothing. Handhole shall be 300 mm x 600 mm (or 400 mm diameter).

Every effort should be made to make all manholes the same size with the same gasket size and shape. Likewise, every effort should be made to make all handholes the same size with the same gasket size and shape.

All manholes, handholes, tap changer, bushing and other openings such as the pressure relief device on the cover shall have a flange of at least 50 mm, to prevent water from entering the openings when individual covers are removed.

All handholes and manholes shall be equipped with one or two handles depending on size. The combined weight of any individual handhole or manhole cover, including the blocking for space fill, shall not exceed 37 kg. The weight of each shall be specified in the Bill of Material (Legend). This weight limit does not apply to a removable conservator end plate.

Inaccessible welded studs or blind tapped holes are **not** acceptable.

If manholes are round, they shall be welded-on, with machined grooves and o-ring gasketing. The studs used must be screw in, not welded and they must not go completely through the machined flange. The studs must not be part of the oil seal.

All manholes are subject to Purchaser's approval at the drawing stage.

16.9 Bushing Turrets

16.9.1 Cover-Mounted

Cover-mounted bushing turrets shall not be removed for shipping. The purpose of this is to avoid re-wire CTs at site and to prevent designs were the bushings are moved out from beside the coils to above them, resulting in massively tall gas detector relay mounting.

16.9.2 Side-Mounted Horizontal Turrets

Turrets shall not be removed for shipping.

16.9.3 Side-Mounted Vertical Turrets

Side mounted stove-pipe type turrets may be removable.

Ramps / walkways shall also be provided that extend outward from the cover to the bushing turrets so as to access the bushing capacitance tap, bushing flange, CT secondary terminals and CT test loops. The ramps / walkways shall be designed so as to be detachable from the main transformer body. This ramp / walkway shall also incorporate safety post holders around the perimeter in accordance with Purchaser's Drawing 01000-DD-76880-0002. The walkway / ramp shall be subject to the Purchaser's approval.

16.10 Tank Marking

The serial number of the transformer shall be stamped on the transformer tank at a height of 1200 mm and adjacent to the control cabinet.

The shipping and assembled centres of gravity shall be clearly marked on all four (4) sides of the transformer tank. For centre of gravity markings, refer to **Purchaser's Drawing 1-01000-DA-54000-0004** below.

16.11 Tank Grounds

Typical grounding location is detailed on Purchaser's Drawing **1-01000-DD-56819-0001 below**.

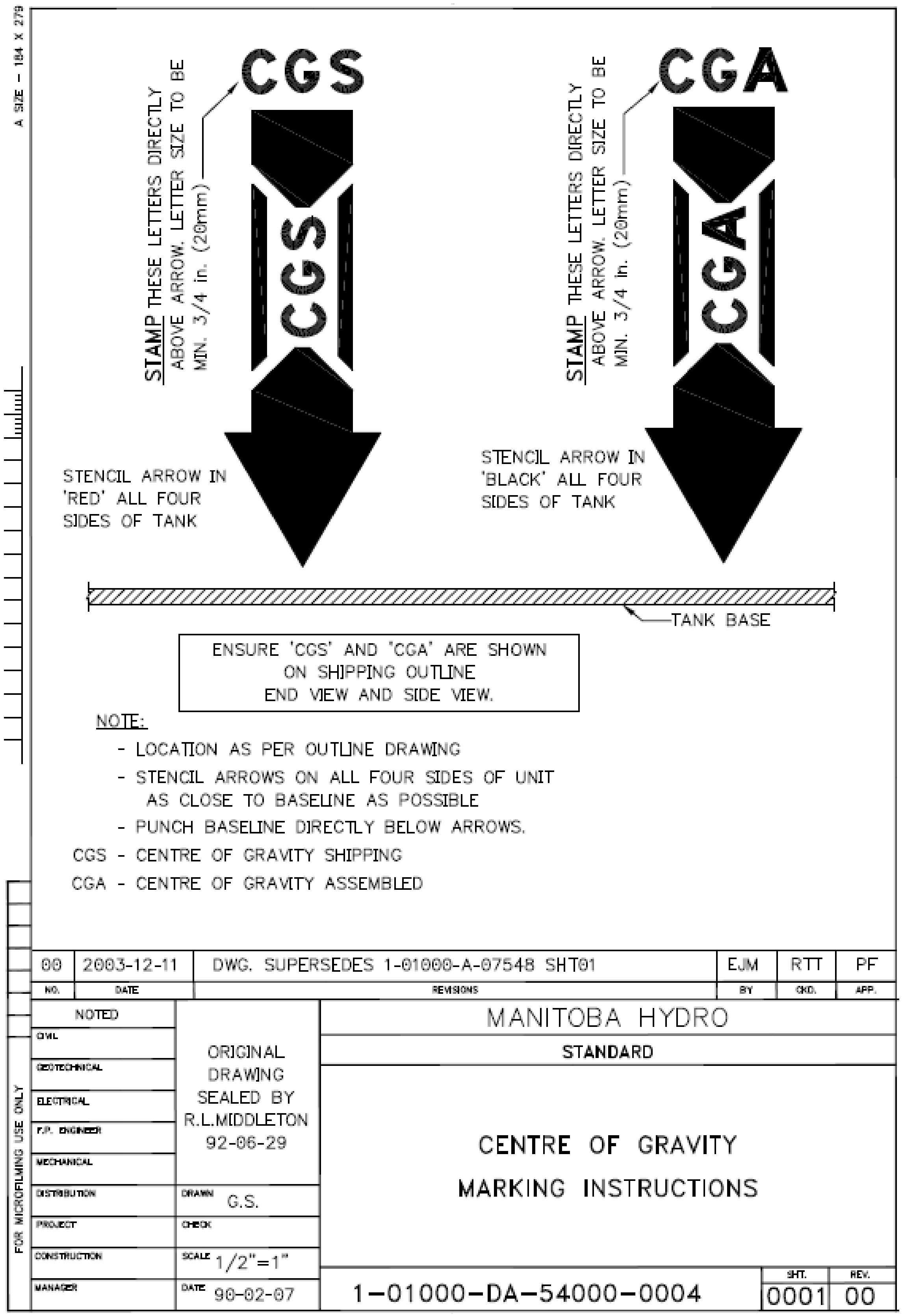
Two tank grounding lugs with clamp type terminals, suitable for No. 2/0 to No. 4/0 AWG stranded copper cable, shall be supplied. One ground lug shall be located towards the extreme right on the side of the low voltage bushings and the other diagonally opposite. Both shall be located so as not to interfere with the jacking facilities. The terminals shall be 2-bolt type, and shall be Travis 11-104 or approved equal.

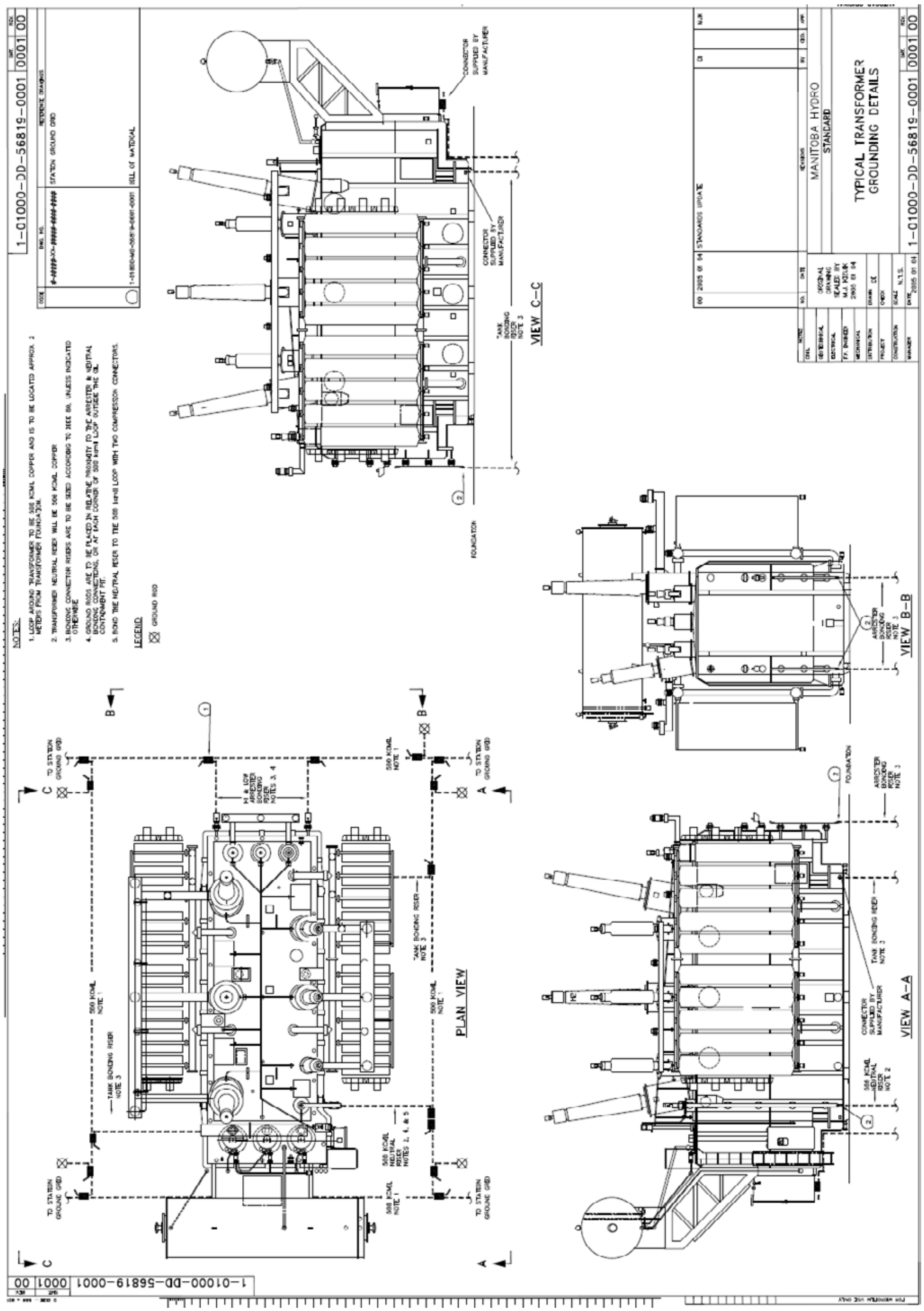
The requirement of Section 19.2 Screw ThreadsError! Reference source not found. applies to the tank grounds.

On transformers rated 30 MVA and less, there shall be two grounding pads supplied on the tank cover, one for each of the HV and LV sides. The grounding pads shall be identical to the grounding pads for the tank. The lugs for the pads are **not** required.

On transformers rated greater than 30 MVA, there shall be a grounding pad supplied between each of the bushings on the tank cover. The grounding pad shall be identical to the grounding pads for the tank. The lugs for the pads are **not** required.

Cover grounding pads shall have short bolts inserted to keep moisture out of the threads. The bolts shall be fully-threaded and fully-inserted so as to minimize the trip hazard


A SIZE – 184 X 279
CGS
STAMP THESE LETTERS DIRECTLY ABOVE ARROW. LETTER SIZE TO BE MIN. 3/4 in. (20mm)
CGS
STENCIL ARROW IN 'RED' ALL FOUR SIDES OF TANK
CGA
STAMP THESE LETTERS DIRECTLY ABOVE ARROW. LETTER SIZE TO BE MIN. 3/4 in. (20mm)
CGA
STENCIL ARROW IN 'BLACK' ALL FOUR SIDES OF TANK
TANK BASE
ENSURE 'CGS' AND 'CGA' ARE SHOWN ON SHIPPING OUTLINE END VIEW AND SIDE VIEW.
NOTE:
- LOCATION AS PER OUTLINE DRAWING
- STENCIL ARROWS ON ALL FOUR SIDES OF UNIT AS CLOSE TO BASELINE AS POSSIBLE
- PUNCH BASELINE DIRECTLY BELOW ARROWS.
CGS - CENTRE OF GRAVITY SHIPPING
CGA - CENTRE OF GRAVITY ASSEMBLED
00
2003-12-11
DWG. SUPERSEDES 1-01000-A-07548 SHT01
EJM
RTT
PF
NO.
DATE
REVISIONS
BY
CKD.
APP.
NOTED
CIVIL
GEOTECHNICAL
ELECTRICAL
P.P. ENGINEER
MECHANICAL
DISTRIBUTION
PROJECT
CONSTRUCTION
MANAGER
ORIGINAL DRAWING SEALED BY R.L.MIDDLETON 92-06-29
DRAWN G.S.
CHECK
SCALE 1/2"=1"
DATE 90-02-07
MANITOBA HYDRO
STANDARD
CENTRE OF GRAVITY
MARKING INSTRUCTIONS
1-01000-DA-54000-0004
SHT. 0001
REV. 00
FOR MICROFILMING USE ONLY


1-01000-DD-56819-0001
MANITOBA HYDRO
STANDARD
TYPICAL TRANSFORMER
GROUNDING DETAILS
PLAN VIEW
VIEW A-A
VIEW B-B
VIEW C-C

17 VALVES AND FITTINGS

All valves shall be capable of withstanding full vacuum and 15 psi oil pressure without leaking.

All valves shall be **brass** flanged c/w O-rings instead of being threaded. The flanges of the valves shall be grooved to fit the o-rings. Each outflow side of the flanged valve shall include a blanking plate and O-ring gasket to seal the valve, complete with the correct NPT-tapped hole size and NPT brass plug.

For HVDC Station	For All Others
All sample, drain and vent plugs shall be painted red for identification.	N/A

For HVDC Station	For All Others
An anodized nameplate showing the location of all valves on the tank complete with a legend shall be fixed to the tank near the control cabinet. It shall indicate the position of each valve for normal operation and for oil processing.	N/A

All lockable valves mention within the Technical specification shall be made for locking with a padlock having a minimum 6mm shackle unless otherwise indicated.

The transformer tank shall be equipped with the following valves and fittings, the positioning of which shall be subject to approval of the Purchaser.

17.1 Sampling

There shall be a 1" sampling connection, fitted with globe or ball valve, blanking plate and 1” NPT brass plug, adjacent to the drain valve but not in the sump.

17.2 Drain

There shall be a 2" drain connection fitted with globe valve, blanking plate and 2” NPT brass plug at the bottom wall of the tank. Ball valves will not be accepted. The connection shall be into a sump or as close as possible to the junction of the tank wall and bottom so that no more than 13 mm of oil will remain in the tank when empty The drain connection shall not be located under a control box or other projection that could make reaching it hazardous, unless prior approval has been given by the Purchaser. The valve stem shall protrude beyond the outer most section of the tank wall by at least 150 mm.

On transformers 95 MVA and greater, two (2) drain connections shall be provided, one at each end of the tank. At least one of these two drain valves shall be left on the tank during shipping to allow for draining of residual oil collected in the tank during transportation.

For HVDC Station	For All Others
In addition to the two bottom drain valves listed above, there shall be a 2” drain valve located at the height 25 mm above the lowest point on the tank that permits draining the oil to such a level that will not require oil processing of the transformer. There shall be a anodized label attached to this valve that states “Minimum Oil Level Without Requiring Oil Processing”	N/A

17.3 Filling

On transformers rated 16.7 MVA and less, there shall be a 2" filling connection on the tank cover, fitted with a globe valve, blanking plate, 90º elbows and 2” NPT brass plug, and located diagonally opposite the vacuum connection. Ball valves will not be accepted.

On transformers rated greater than 16.7 MVA, two 2" filling connections shall be provided on the tank cover. They shall have the same fittings as above and shall be located at diagonally opposite corners of the tank cover. In this case, the vacuum connection can be at either end of the tank cover, at the opposite corner to the filling connection.

A suitably designed nozzle shall be provided beneath the 2" connection to distribute a stream of oil over the core and coils assembly inside the tank. The nozzle shall be of adequate size to allow 152 L of oil per minute to pass with the tank at atmospheric pressure and a maximum pressure of 100 kPa on the inlet side. A suitably designed deflector or screen that bounces and sprays the oil is also acceptable, subject to approval.

17.4 Vacuum

For HVDC Station	For All Others
A 150 pound **8"** ANSI standard steel pipe flange with bolt holes, 8" lockable ball valve and cover plate for isolating the vacuum pump during oil filling and for performing the vacuum test.	A 150 pound **4"** ANSI standard steel pipe flange with bolt holes and cover plate shall be provided as a vacuum connection.

The flange shall be positioned such that an air operated vacuum valve requiring a clearance of approximately 310 mm in diameter by 750 mm high may be mounted on top without conflicting with bushings, explosion vent, gas relay, etc. A 12 mm expanded metal screen shall be fitted under this flange, in the tank, to prevent material dropping inside when the vacuum valve is removed.

When the transformer cover is too small to fit a 4" pipe flange, there shall be a 2" vacuum connection on the tank cover fitted with a blanking plate and 2" NPT brass plug.

17.5 Vacuum Gauge

A 1" connection fitted with a globe or ball valve, blanking plate and NPT brass plug, shall be located on the tank cover and in line with the 1" bottom sampling valve, for attaching a vacuum gauge, pressure gauge or for use with level indication (plastic hose) when vacuum filling.

17.6 Oil Level Gauge

For GSU Transformers	For All Others
Supply an oil level shipping gauge mounted just below the tank cover flange, indicating from approximately 150 mm below the flange, to the flange.	Only for units shipped with oil over the core and coils, supply an oil level shipping gauge mounted just below the tank cover flange, indicating from approximately 150 mm below the flange to the flange.

17.7 Oil Circulation

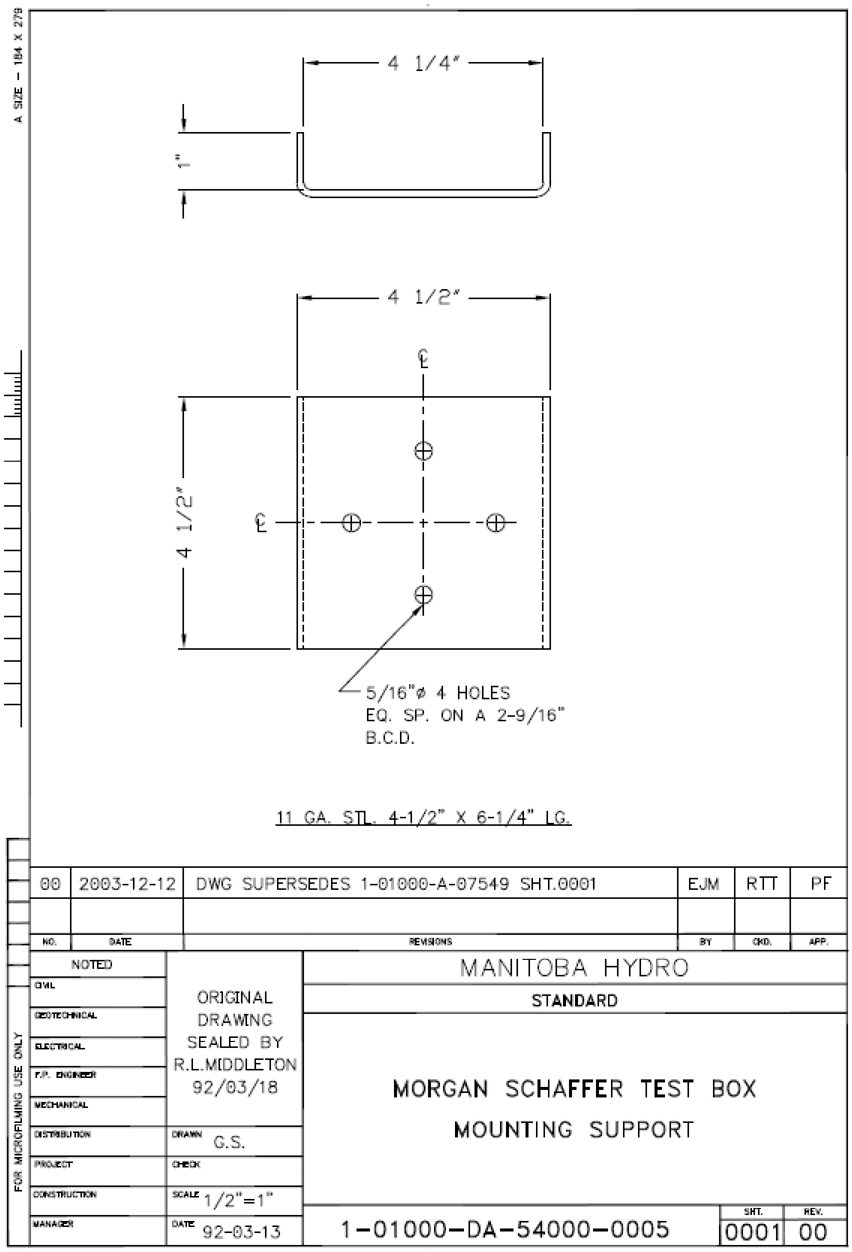
Transformers utilizing a common oil flow system shall have a 2" ball valve, blanking plate and NPT brass plug located in each common bottom oil pipe or header in such a position that the radiator valves can be closed off, but the Purchaser can utilise the valve(s) for circulating oil during field processing. On transformers with forced oil flow, the valve(s) shall be located in the pipe(s) between the main tank and pump(s).

17.8 Pump

Each pump shall be located in the bottom pipe and shall be designed and connected with a shut off valve on both sides so that it can readily be removed and replaced without taking the transformer out of service and without draining the radiators/cooler. All units must have the ability to isolate the main tank to permit removal of radiators, radiator headers, coolers and/or pumps.

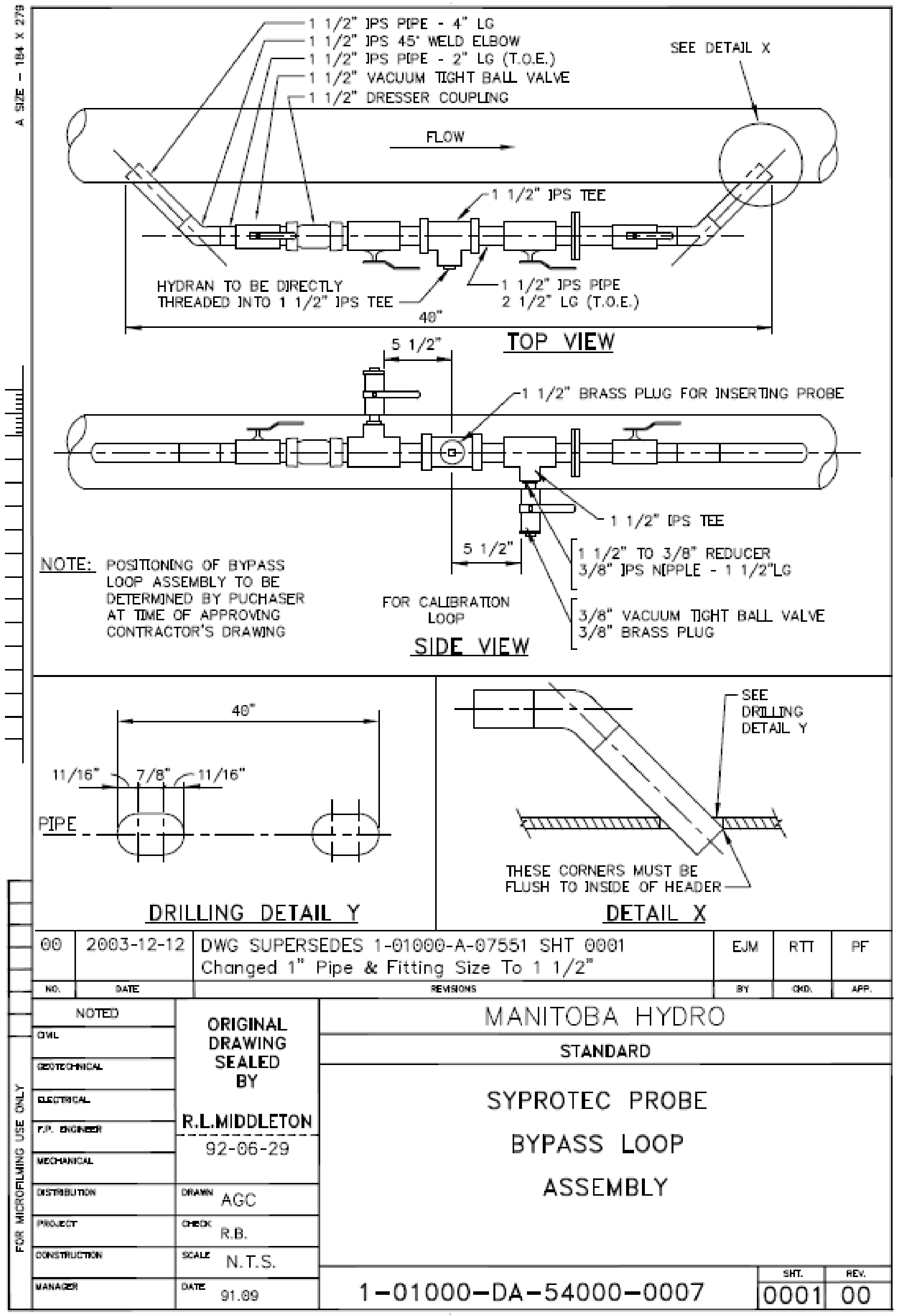
17.9 Morgan Schaffer/Syprotec Probe

On transformers rated from 12.5 to 30 MVA, inclusive, one (1) boss threaded for 1.5" NPT complete with bung shall be provided on top of the transformer to accept either a Morgan-Schaffer or Syprotec probe. On transformers rated greater than 30 MVA, two (2) bosses shall be provided as described above. Morgan-Schaffer or Syprotec probe will be supplied by the Purchaser. Mounting support for the probe test box shall be in accordance with **Purchaser's Drawing 1-01000-DA-54000-0005 below**. Boss location shall be subject to approval by Purchaser at the time of Contractor’s drawings approval. The probe is now known as the Fault Gas Probe Model GP 100. It is no longer available but is still in use by Manitoba Hydro.



17.10 GE Syprotec Hydran Bypass

On transformers with forced oil flow or rated 95 MVA or greater, a GE Syprotec Hydran probe bypass loop assembly shall be provided and located in the return oil path and in accordance with **Purchaser's Drawing 1-01000-DA-54000-0007 below**. The bypass loop assembly shall be located on the side of a bottom cooler pipe or header when applicable. If no header is provided, such as on small GSU transformers, the loop shall be mounted on the tank wall, subject to Purchaser's approval.



17.11 LTC Equalizing Valve

Refer to section 14.9.3 LTC Equalizing Pipework and Valve.

17.12 Stiffener

If the tank incorporates box-type stiffeners, each stiffener shall be fitted with a threaded drain boss and bung, on the bottom side of the stiffener, to prove the integrity of all main tank welded seams against oil leaks.

17.13 Gas Injection

For HVDC Station	For All Others
There shall be a minimum of two (2) brass plug for performing the gas injection test.	There shall be a minimum of one (1) brass plug for performing the gas injection test.

The plug shall be fitted with a temporary valve for test, and this valve shall be removed prior to shipping the transformer. The plug shall be located as far as possible from the main gas detector system collection point on top of the tank. The location of the plug(s) shall be subject to the Purchaser's approval. The Purchaser reserves the right to request additional injection tests at additional injection points to verify the design of the tank, decided during the drawing review.

17.14 Thermal Well for WTI

Refer to section 38.3 Thermal Well.

17.15 Pressure Monitor Valves

Refer to section 36 PRESSURE MONITORS.

17.16 Morgan Schaffer Calisto 9 System Valves

For HVDC Station	
If a common oil header is provided, there shall be two 1/2" ball valves provided and located in the bottom header for the Morgan Schaffer Calisto 9 system for the inlet and outlet flexible stainless steel oil lines. As per the manufacturer's requirement, the inlet and outlet locations must be spaced at least 1000mm apart. Boss locations shall be subject to approval by the Purchaser at the time of drawing review. The Calisto 9 system will be supplied by the Purchaser.	

For GSU Transformers	For All Others
Same requirement as for HVDC Station	These additional valves are not required.

18 DELUGE SYSTEM PROVISION

18.1 Deluge Pipe Support

Provision shall be made on the transformer tank to support the deluge pipes.

For GSU Transformers	For All Others
Supply deluge pipe support brackets on all GSU transformers.	Supply deluge pipe support brackets on transformers rated 95 MVA and above.

Each support shall consist of a steel plate 100 mm x 100 mm x 19 mm thick welded by one side to the tank and having a 19 mm hole in the centre. Exact details and position of these supports will be agreed upon with the Contractor after the transformer outline drawing has been approved by the Purchaser.

These supports shall be at heights of approximately 500 mm, 2000 mm, 3200 mm and 4500 mm above the base of the transformer, and 1500 mm and 150 mm below the cover, depending on the height of the tank. The top two supports shall have a clear horizontal window of 300mm X 300mm for routing the upper and lower deluge rings. These sets of four supports shall be provided at no more than 30 positions, and no less than 14 positions around the periphery of the tank.

For large transformers, rated 140 MVA and larger, detailed support locations are described as follows.

On each of the four corners of the tank, a set of vertical deluge supports shall be mounted on each of the two sides that make up the corner, with a mounting distance no greater than 150 mm from the corner, for a total of eight positions. The deluge support shall not be in line with ancillaries so that mounting the deluge supports will not interfere with the access to the ancillaries. In the event that it is not possible to avoid lining up the ancillaries with the deluge supports, the ancillaries shall be mounted 300 mm from the tank wall to allow for the installation of the vertical deluge supports behind the ancillaries. On the control box end, the control box shall be mounted 300 mm from the tank wall to allow for the continuation of the deluge vertical supports to the bottom of the tank.

In addition, there shall also be deluge supports supplied every 60° around all bushing turrets. On large turrets, the vertical spacing between supports shall be a maximum of 1200 mm apart with the first and last support being at the top and bottom, respectively.

On the top of the turrets, brackets shall be provided to mount heat detectors around all bushings. At least three brackets shall be placed around each line bushing and at least two (2) brackets around each neutral bushing.

On the common cooler mounting frame that supports the Unifn coolers there shall be a set of vertical deluge supports mounted on the cooler frame between the coolers. These vertical supports on the cooler frame shall be spaced a maximum of 2400 mm of horizontal distance along the cooler mounting frame.

On the conservator, there shall be deluge supports along the top for the entire length with spacing being a maximum of 1200 mm apart. In addition to deluge supports along the top of the conservator, three additional supports shall be place at approximately 15º from the top of the conservator. The three supports shall be located with one at each end and the third in the midpoint of the main conservator for supporting the heat detectors. There shall also be a support on each end plate of the conservator.

18.2 Heat Detector Monitoring Panel Provision - GSU Only

For GSU Transformers	For All Others
Supply heat detector monitoring panel provision on all GSU transformers.	Not required.

Provision shall be made on the transformer tank to support the Purchaser's heat detector monitoring panel, which will be provided and installed by the Purchaser upon delivery of the transformer.

The heat detector monitoring panel contains ten monitoring modules to be used with the Purchaser supplied and installed heat detectors. The approximate dimensions of the panel are 32" wide, 44" high, and 12" deep. The panel will be supplied with anti-vibration mounts. The Purchaser will supply and install rigid conduit for wiring to the panel from the control cabinet.

The Contractor shall provide provisions for Purchaser mounting of the panel. The provisions shall be in an accessible location, and shall permit the installation of the panel without the need to drill or puncture the transformer tank or the radiator or cooling fans. The final location of the provisions shall be Purchaser approved. The Contractor shall provide load capacity in the main control cabinet auxiliary supply panel to feed two (2) 400 watt heaters that will be installed in the panel.

Contractor to provide additional equipment and materials as required.

18.3 Heat Detector Monitoring Panel - HVDC Station Only

Refer to section 31.21 Heat Activated Detector H.A.D. Connection Cabinet.

19 CONNECTIONS

If lock washers are used on bolted connections, then the following information shall be provided on the appropriate drawing: material, inside diameter, outside diameter, thickness, load at flat and static height for Belleville washers. In the case where bolting sequence is required this too should be outlined on the drawings.

19.1 Workmanship

All joints and fastenings shall be so devised, constructed and registered that the component parts shall be accurately positioned and constrained to fulfil their required function. Heads of all bolts and nuts shall register flush on the surfaces which they fasten.

19.2 Screw Threads

All screw threads, screws, flanges and bolts shall be consistent throughout the fabrication of the product. Either standard Imperial sizes with Unified Standard Series (UNC) threads in accordance with the latest issue of ANSI/ASME B1.1. or standard metric sizes in accordance with the latest issue of ANSI/ASME B1.13M shall be used for the fabrication of the product. Under no circumstances shall the Contractor use a combination of Imperial and metric sizes in its fabrication of the product.

Metric or Imperial shall be clearly specified on the outline drawing.

19.3 Bolted Connections

All threaded flanges and bolts shall have Unified Standard Series threads.

The torque values for all fasteners used on the transformer shall be provided on the internal active assembly drawing or the outline drawing as applicable.

Stainless steel bolts shall not be permitted to be used with stainless steel nuts to prevent galling.

19.4 Structural External

Bolts shall be full size body with regular hexagonal heads. Nuts shall be regular hexagon semi-finished.

All connections shall be secured by bolts, nuts, flat washers and lock washers, except where welds are required. Flat washers shall also be used on either side of the bolted surface, to prevent damage to the finished paint. All bolted connections shall be bearing-type connections as defined by CSA S16.1-M.

All materials and fasteners shall be of suitable quality to ensure that the equipment can be readily dismantled after a long period of service. Carriage bolts are not acceptable.

Exceptions may be granted for subassemblies which are factory stock items, provided that all external connections are in accordance with the above requirements, and further provided that sufficient quantities of extra bolts, nuts, etc., for installation and future replacement of such subassemblies are included in the shipment.

A bevelled washer shall be used under any nut or bolt head where the slope of the bearing surface of the connected part exceeds 5º (i.e., inside faces of channel flanges), as measured from the perpendicular to the axis of the bolt. The washer bevel shall be the reverse of the bevel of the part to which it is fitted.

Lock washers shall be helical spring type with a thickness according to the Heavy Helical Spring Lockwasher profile, and shall conform to ANSI/ASME B18.21.1 or B18.21.2M. Nylock nuts are an acceptable alternative for lockwashers, nylock nuts that are removed for shipping or any other reason shall not be allowed to be re-used.

19.5 Structural Internal

All nuts and bolts used for structural connections inside the tank shall be nonplated black metal unless approved otherwise by the Purchaser. All connections shall be double-nutted or locked with plates or non-insert type self locking nuts or other means to provide a captive connection. ‘Belleville’ disc washers shall not be used where fibre or wood insulation is attached to metal.

19.6 Electrical External

Current-carrying connections shall be made with nonmagnetic materials which shall not be affected by industrial contaminants. Compatible materials shall be used to prevent galvanic corrosion. Silicon bronze is preferred for copper connections and aluminum alloy 2024-TO for aluminum connections. Galvanised steel bolted connections will not be permitted for current-carrying connections.

Lockwashers shall be suitably sized ‘Belleville’ conical spring type. Split helical washers will not be permitted.

19.7 Electrical Internal

Internal current carrying connections shall be made with nonmagnetic material.

For HVDC Station	For All Others
All bolted connections, except for connections to the tap changer mechanism, shall be made with a minimum of two (2) non-plated black metal 12 mm bolts to ASTM FT38M. At the tap changer itself, a single non-plated black metal 15 mm bolts are permitted.	All bolted connections shall be made with a minimum of two (2) nonmagnetic stainless steel or non-plated black bolts.

'Belleville' disc washers shall be used as a constant pressure washer on all bolted connections. Helical spring lock washers or insert type self locking nuts shall only be used if approved by the Purchaser.

19.8 Crimped Connections

Crimps joints referred to in this specification include all crimp joint not only current carrying connections but also crimp connections for bonding and grounding. This may include, but not be limited to crimp connections for conductors used for the winding, winding shields, core and clamp assembly bonding, core and clamp grounding, shield grounding and conductors used to carry current in the shield or clamping assembly.

All crimp connections used for both link and lugs shall be long barrelled so as to accommodate double crimping of all connections. The use of single crimp connectors for certain special applications shall only be used when approved by the Purchaser. Crimp connections onto winding conductor shall only be used when approved by the Purchaser.

Crimped connectors shall have a 3 mm diameter inspection hole to check for bottoming of the conductors.

Only proper sized crimp connectors are acceptable. The proper size crimp barrel and tool recommended by the connector manufacturer shall be used and shall be of the type that travels fully home before releasing. The use of 'fill material' in the joint is permitted only when it is calculated according to the tool and connector manufacturer's instructions. For crimps with winding conductor on one or both ends, samples must be provided of the actual conductor and fill material when making the crimp. If the sample has not completely flowed in the Purchaser's opinion, then the crimp shall be rejected and brazing shall be required.

For HVDC Station	For All Others
Samples of each connection shall be provided to the Purchaser.	Samples of each specific crimp joint may be required. This is determined upon inspection of the process.

20 CONSERVATOR TANK

For LTC conservators, refer to the following Technical Requirement sections:

(a) 14.8 LTC with the Selectors Mounted Inside the Main Transformer Tank, and
(b) 14.9.6 LTC with the Selectors Mounted in a Separate Tank, With Conservator.

20.2 Location

The conservator shall be located on the end of the transformer tank, above the load tap-changer, perpendicular to the line of HV bushings. It shall not be located above the main control cabinet. However, other locations may be specified or permitted subject to approval by the Purchaser. All brackets used to mount the conservator and accessories shall be designed so as to be detachable from the main transformer body.

20.3 Volume

The tank shall be of a size to accommodate the change in oil volume which will occur between an ambient temperature of -50ºC with the transformer out of service and an ambient temperature of +40ºC with the transformer operating at full load. The conservator oil volume shall in no case be less than

For GSU Transformers	
13.5%	

For HVDC Station	For All Others
13.5%	12.5%

of the sum of the oil volumes of the main tank and the radiators. The conservator oil volume must also be adequate for a top oil temperature of 110ºC.

All calculation shall use the Coefficient of Thermal Expansion for Luminol oil of 0.0827% per °C.

The Contractor shall submit a chart and table illustrating the following:

(a) Gauge Position (%) versus Top Oil Temperature (°C) with the conservator containing the recommended volume of oil in it. The temperature range shall be from -50°C to 105°C.

(b) Gauge Position (%) versus Conservator Tank Oil Volume (litres)

This chart and table shall be provided in the instruction manual with the oil filling procedure.

The oil level gauge arm with the float shall be shown on the outline drawing in both the high and low oil level position complete with angular references and the float rod length. The gauge complete with float shall be installed on their respective conservator and shall have the operation verified by removing the inspection cover and manually operating the float.

20.4 Connection

The conservator tank shall be designed for full vacuum and a vacuum-tight valve shall be provided in the connection between the tank and the conservator. The conservator tank shall be equipped with an outlet pipe projecting 40 mm into the conservator tank and fitted with a lockable, indicating type shut-off ball valve made for locking with a padlock having an 8mm shackle. The conservator piping shall be connected to the main transformer tank via the top cover.

For transformers rated 95 MVA and higher, on all possible conservator connection points on the main tank, an isolating valve at the tank cover and a second valve teed above this isolation valve shall be provided. These two valves along with the isolation valve at the conservator are to facilitate isolation and draining of the conservator feed pipe to allow for removal.

For HVDC Station	For All Others
The conservator tank shall be level with a sloped sump / trough in the bottom of the conservator with the drain valve placed at the lowest point of the trough.	The conservator tank shall slope 25.4 mm toward one end with the drain valve at the lower end and, where practicable, the oil level gauge at the higher end.

20.5 Accessories

The conservator tank(s) or each section thereof shall be provided with the following accessories, the location of which shall be subject to approval by the Purchaser.

All drain, fill and suction pipes/valves indicated below shall be identified at the valve located 1200 mm above the transformer base using Lamacoid or stainless steel anodized nameplates. All Purchaser designated oil sample points shall be individually identified with the oil volume contained in the length of each pipe plus 20%. The identification of this volume shall be at each sample point on an anodized nameplate and in the drawings. This information will be used to ensure enough oil is drained off to achieve a representative annual oil sample. All drain, fill and suction pipes/valves shall have free access without any encumbrances or obstructions, such as cooler, pipes etc. It would be preferable if the pipes are brought outward from the tank wall and rigidly supported for ease of access and to reduce congestion.

All valves shall be flanged c/w O-rings instead of threaded.

20.5.1 Outlet

A 2" minimum outlet pipe between conservator and main tank suitable for vacuum.

20.5.2 Filling

A filling connection shall be taken into the bottom of the conservator and extend up inside to within 40 mm of the top. An adequately supported extension pipe shall be provided from the conservator to within 1200 mm of the ground and fitted with a 2" globe valve, blanking plate and NPT brass plug so that it may be filled from this position. Ball valves are not acceptable. On ‘A’ frame mounted conservators, the pipe can be extended to within 1200 mm of the ground, if that is more readily accomplished.

20.5.3 Drain

1" drain connection pipework shall be adequately supported and shall be provided from the conservator to within 1200 mm of the ground and fitted with a 1" globe or ball valve, blanking plate and NPT brass plug so that it may be drained from this position.

20.5.4 Main Tank Pipework

The conservator pipework between the conservator and the first pipework support must have a flexible coupling to allow for expansion. Flexmaster connections shall not be allowed for any pipe work from the tank to coolers and / or conservator.

Where extension pipes are brought down to ground level, the valves must have a nameplate indicating their connection.

20.5.5 Breathers

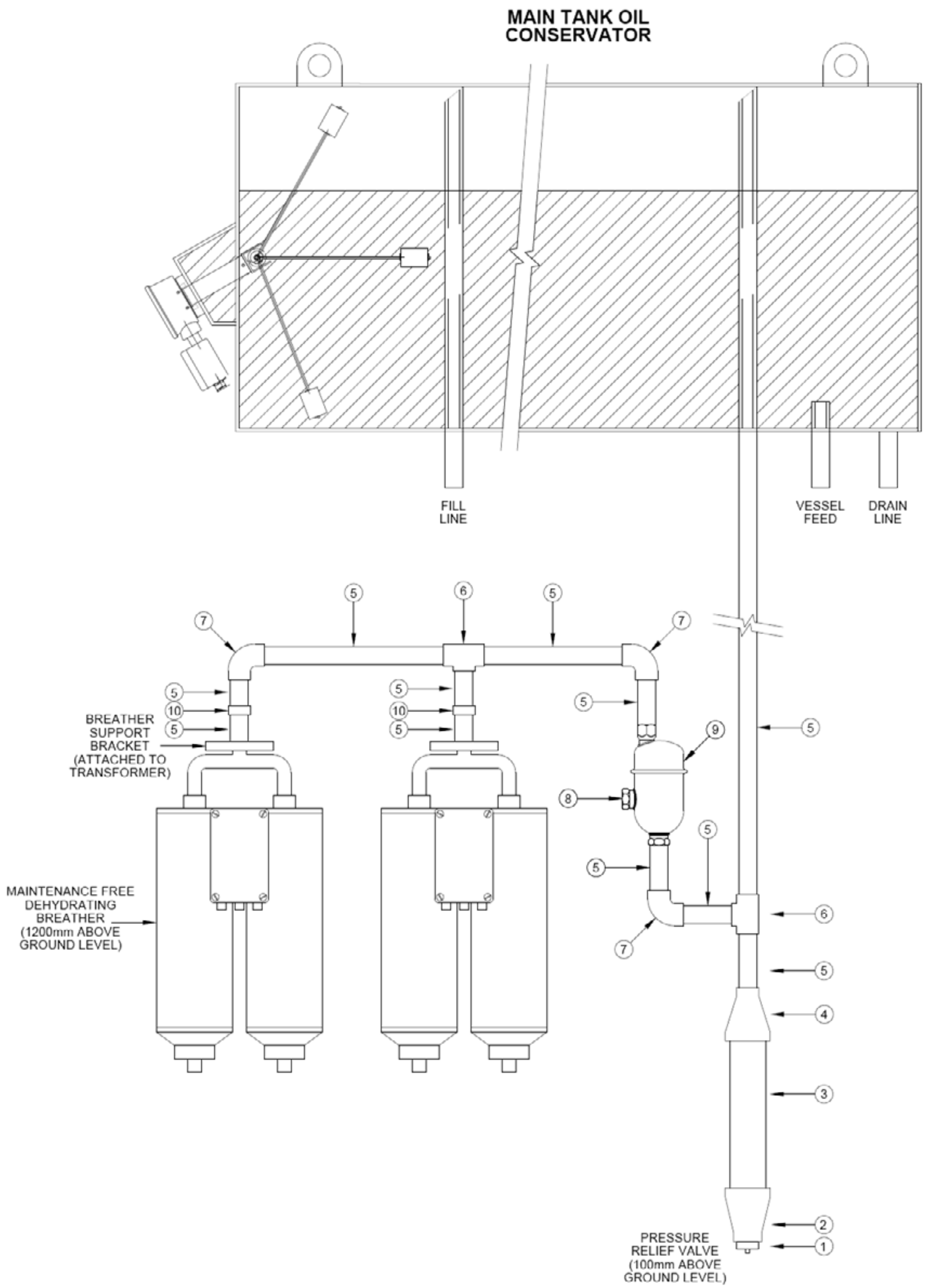
All transformers and reactors, except for grounding transformers, shall use electronic breathers for both the main conservator and the LTC conservator.

The main conservator tank shall be provided with a Messko (Maschinnenfabrik Reinhausen) MTraB maintenance free dehydrating breather with Beta controller, and no equals will be accepted.

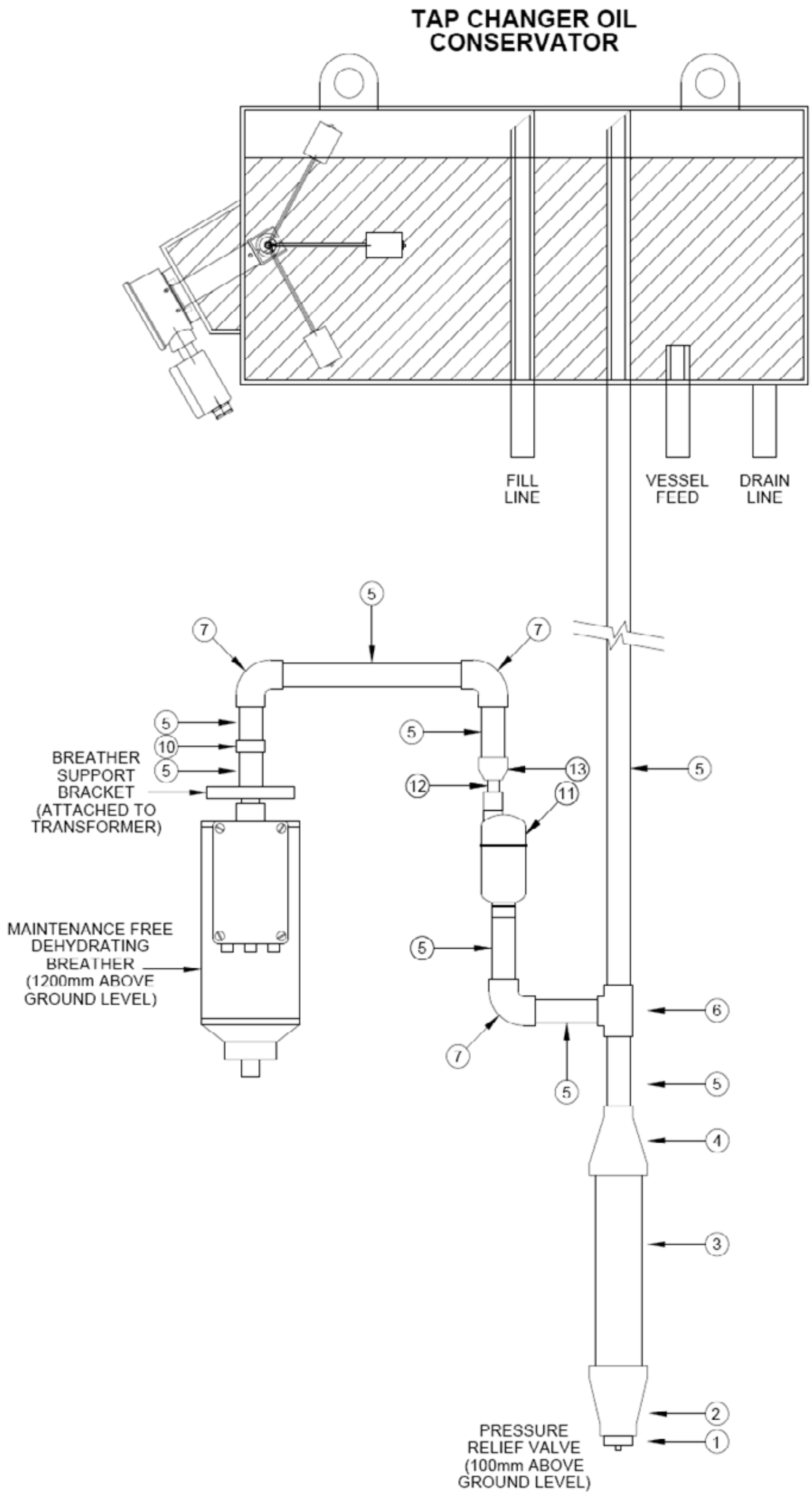
For HVDC Station	For All Others
The main conservator tank shall be provided with two Messko DB200 RM D-T-HT maintenance free dehydrating breathers, Messko Part #686-2DAB42NJLZJNJ06N. The tap changer conservator tank shall be provided with one Messko DB-100 RM-HT maintenance free dehydrating breather, Messko Part #686-1EAA42NJLZJNJ06N. Refer to the sketches below.	Supply the HT version.

The breather for either application shall be a HT version which is capable of operating at and under -5°C for more than 20 consecutive days. The controller will be supplied 120 VAC and individually protected by a circuit breaker. The controller terminal box color shall be RAL 7038 standard gate grey, and shall have three (3) ½ inch – 14 NPT cable glands in its bottom plate for cable entry. The controller shall have a 4 – 20 mA analog output, heating system status contact, and a device malfunction contact. Additional options that are to be supplied on the dehydrating breather unit are a system test button, insect protection for the high grade steel filter and a protection grid. The analog output, heating system status contact and alarm contact shall be independently wired back to the control cabinet from the dehydrating breather’s controller.

For HVDC Station	For All Others
To prevent oil from entering the Messko breathers via the breather pipe in the event of overfilling, an Armstrong Stainless Steel Stainless Steel 1" NPT 13-AV Air Vent shall be placed in the main tank conservator breather pipe prior to the Messko breather. For the tap changer conservator an Armstrong ¾" NPT 11-AV Air Vent shall be placed in the tap changer conservator breather pipe prior to the Messko breather. The breather pipe shall be taken into the bottom of the conservator(s) and extend up inside to the top and be at opposite ends of the conservator as the fill pipe. The breather pipe shall be fitted with a VIAT Model 310-3 pressure relief device to operate at 2 p.s.i. , mounted at 1000 mm above the ground to release any oil that may enter the breather pipe. The Messko maintenance free dehydrating breather(s) shall be connected as shown in the sketches below.	The dehydrating breather shall be installed in accordance with manufacturer's recommendations.



HVDC Station Only: Main Breather Assembly



HVDC Station Only: LTC Breather Assembly

ITEM	DESCRIPTION
1	VIAT PRESSURE RELIEF DEVICE MODEL 310-3 (2 P.S.I.)
2	1-1/4" TO 2" CLASS 150 REDUCER, THREADED NPT
3	2" THREADED CS SCHEDULE 40 PIPE NPT
4	1" TO 2" CLASS 150 REDUCER, THREADED NPT
5	1" THREADED CS SCHEDULE 40 PIPE NPT
6	1" CLASS 150 PIPE TEE. THREADED NPT
7	1" 90 DEGREE CLASS 150 ELBOW, THREADED NPT
8	1" PIPE PLUG
9	ARMSTRONG - 13-AV BACK UP VALVE
10	1" CLASS 150 UNION; PLACE AS REQUIRED
11	ARMSTRONG - 11-AV BACK UP VALVE
12	1/2" THREADED CS SCHEDULE 40 PIPE NPT
13	1/2" TO 1" 45 CLASS 150 REDUCER. THREADED NPT

HVDC Station Only: Breather BOM

The dehydrating breather shall be installed in accordance with manufacturer's recommendations and be mounted 1200 mm off the ground. The connecting flange supplied on the dehydrating breather is to be made for use with ½ inch screws.

If two or more Messko breathers are supplied, each breather shall be supplied power from a separate circuit breaker.

For grounding transformers, two (2) open type weatherproof breathers, one near each end of the conservator (breathers shall be Donaldson model BAS00-0080 or approved equivalent). The intake of one breather shall be located at the bottom of the conservator and extend up inside to within 10 mm of the top. The other breather shall be located at the top of the conservator.

20.5.6 Removable End Plate

For conservators with a diameter less than 900 mm, provide removable end plates on both ends. For larger diameter conservators, provide a manhole at least 600 mm in diameter.

A hand hole shall be provided on the end plate with the gauge to allow for operation and calibration of the gauge with the float. The hand hole for operating the gauge shall be positioned so the bottom of the handhole in 50mm above the mid point of the conservator.

For HVDC Station	For All Others
The main access shall be on the on the end opposite to the oil level gauge.	Main access location depends upon location of LTC conservator. It shall be at the opposite end of the oil level gauge when possible.

For transformers without an LTC conservator, the Purchaser prefers that the access be located at the end opposite to the dehydrating breather whenever practical.

20.5.7 Oil Level Gauge

For GSU Transformers	For All Others
The main and LTC conservator tank shall be provided with a Qualitrol 042-305-01 CS 43801 visual oil level indicator and no equals will be accepted. It shall be a direct drive style and not gear driven with a potentiometer output from 0 to 5 kΩ. There shall be a terminal box for terminating all of the electrical connections. The gauge face shall have a black background with white lettering and a white position pointer. The position pointer travel will be from 7 o’clock to 11 o’clock. The following white letter markings MIN, 25°C, MAX, shall appear on the gauge’s black background at 7 o’clock (MIN), 9 o’clock (25°C) and 11 o’clock (MAX) respectively. Both oil level indicator face plates shall come supplied with a bezel to facilitate rotating of the dial hand for calibrating the 509 electronic temperature monitors.	For transformers utilizing the Qualitrol 509 Intelligent Temperature Monitor (specified in Supplementary Technical Requirements) and requiring a potentiometer-type of oil level gauge, follow the requirements for a GSU transformer. Otherwise supply a magnetic dial type oil level gauge visible from the ground. On transformers rated 1.0 MVA or greater, the gauge shall be equipped with alarm contacts.

The gauge shall be mounted at a 30° downward facing angle.

For HVDC Station	For All Others
In addition to the GSU requirements above: The oil level gauge shall uses an intermediate marking of 30°C in lieu of 25°C. The oil level gauge for the main conservator shall be connected to Qualitrol 509 ITM-A, for alarm on low and high main conservator oil. The oil level gauge for the LTC conservator shall be connected to Qualitrol 509 ITM-B, for alarm on low and high tap changer oil.	N/A

Also refer to section 21 CRITICAL OIL LEVEL TRIP.

20.5.8 Lifting Eyes

Lifting eyes provided for handling purposes.

20.5.9 Strobe Light

For sites without a building, as specified in the Supplementary Technical Requirements, a 120 VAC red strobing alarm light, Thomas & Betts Hazlux Cat# DXS61RTGP-P2SR-C or approved equivalent, shall be mounted on top of the conservator to provide a general alarm and trip indication from the alarm and 86 relays. There shall be a switch in the control cabinet to turn this feature on or off.

21 CRITICAL OIL LEVEL TRIP

At sites with a building, a critical low oil level trip contact is required. This contact trips the primary breaker when the oil level reaches the point where an internal flashover may occur. The most likely cause of this low oil level is damaged radiators.

The critical oil level may be below the main cover or above it, depending upon the manufacturer's design.

If the critical level is above the main cover, or right at the main cover, then either the oil level gauge or a separate device mounted on the conservator shall provide the trip contact suitable for DC. If the conservator gauge provides this trip contact, it shall only activate when the conservator is essentially empty. However, this level must still be above the 40 mm protrusion of the outlet pipe. The critical level contact shall activate approximately 10 to 25 mm above the outlet pipe protrusion (section 20.4 CONSERVATOR TANK Connection). It is understood that this may not always be practical but every attempt should be made to get near this level with the float arm.

If the critical oil level is below the main cover of the transformer, install a separate magnetic dial type oil level gauge complete with a DC rated trip contact.

22 RADIATORS

Radiators shall be manufactured by MENK Apparatebau GmbH or Menk USA, or approved equal.

Radiators shall be of the detachable type mounted directly on the tank and equipped with shut-off valves. Radiators shall be supplied with drain plugs, vent plugs and lifting eyes. Radiators shall be properly supported and braced to prevent movement by wind or vibration.

For transformers and reactors shipped oil filled, **brass** flanged globe or ball drain valves c/w O-rings, blanking plates and NPT brass plug shall also be provided on each radiator, in addition to a drain plug/cap.

Where radiator banks are mounted separately from the transformer tank, interconnecting oil piping shall be fitted with at least one (1) flexible coupling at each end of each interconnection. The flexible couplings used shall be either Dresser or Victaulic fittings. Expansion type fittings shall not be used unless prior approval is obtained from the Purchaser. Flexmaster connections shall not be allowed for any pipe work from the tank to coolers and / or conservator. The transformer tank and individual radiators shall be equipped with shut-off valves.

All transformer radiator headers shall be equipped with shut-off valves, vent plugs, drain plugs, 2" globe valve, blanking plate and NPT brass plug (to be utilized for field circulation) and lifting eyes. Ball valves are not acceptable.

It shall be possible to padlock the radiator and header valves in the open and closed positions, with the position of the valve being readily identifiable.

In no case shall the radiator or cooling circuit pipework be connected to the cover of the transformer, because this will collect gas and shunt it into the radiators.

23 LADDER

Transformers rated 12.5 MVA or greater and all transformers regardless of MVA rating with covers 3050 mm or greater (cover to underbase) shall have a ladder provided on one side of the tank. The ladder shall be a means for conveniently inspecting the gas detector relay with the transformer energised and also for gaining access to the top of the transformer.

The top landing of the ladder shall be at the same level as the main cover and shall be completely filled in with an approved grating and also the top shall be equipped with safety-handrails.

The rungs of the ladder shall be arranged such that the spacing between all rungs are equal, including the space from the base of the transformer to the first rung and the last rung to the top landing of the ladder.

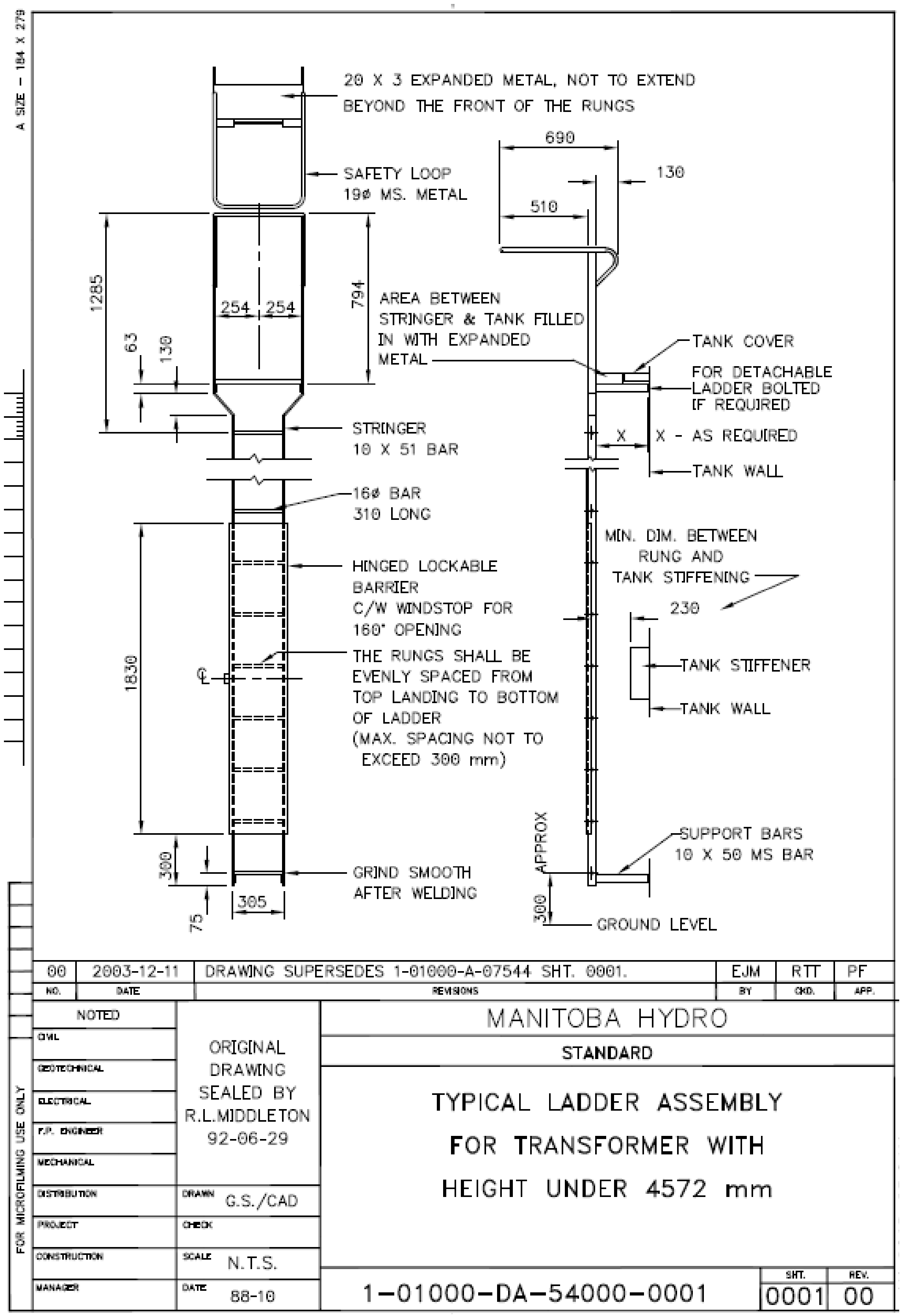
The lower section of the ladder shall be equipped with a barrier complete with a wind stop, to secure in a 160º open position, and provision for locking with a padlock having a 9.6 mm shackle.

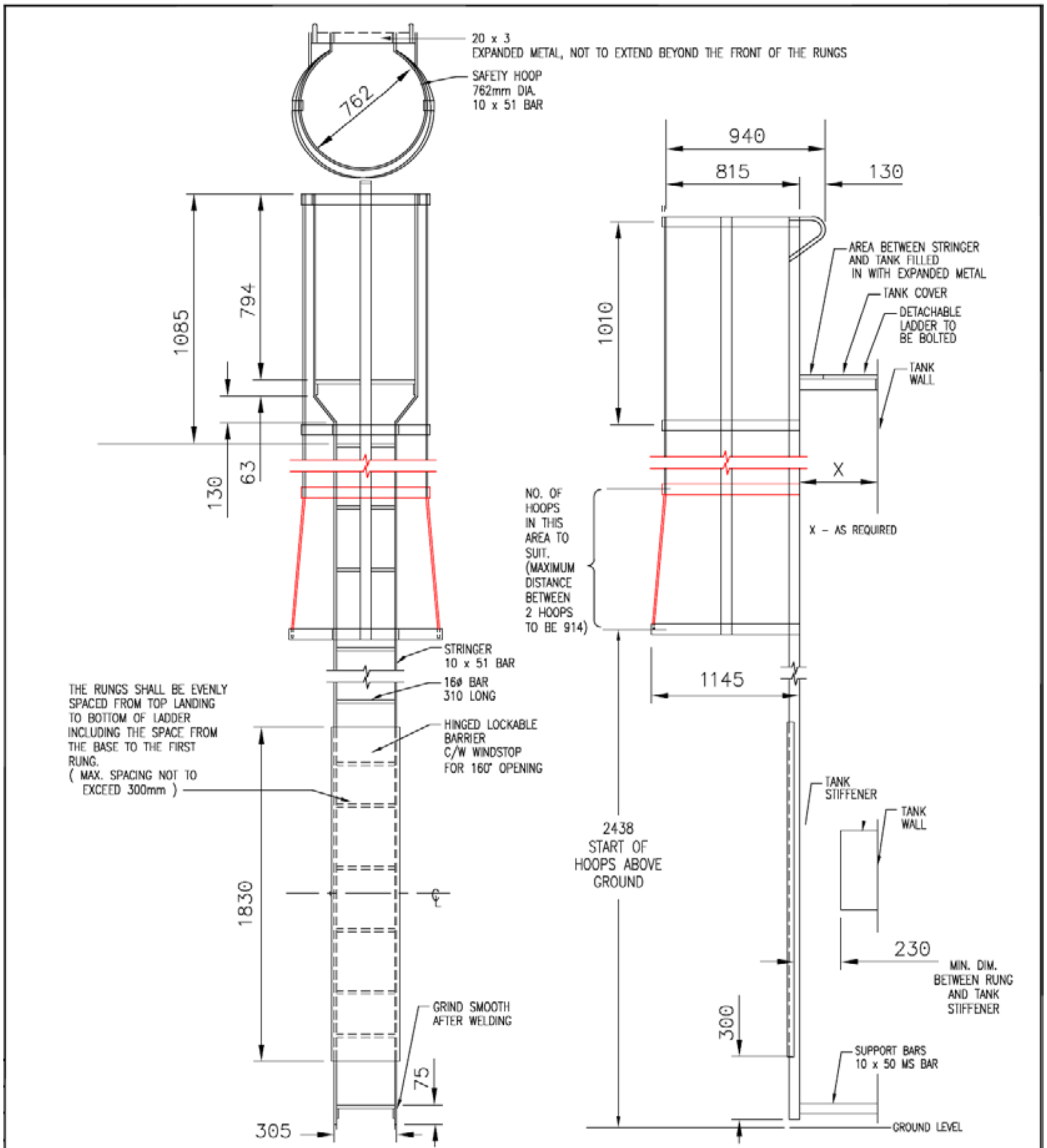
Two (2) safety post holders shall be provided, one on each side of the ladder and welded to the tank. There shall be a minimum of 150 mm clearance around the outside of one gusset of the plates to allow for the insertion of a pin.

The tank cover directly in front of the ladder must be unobstructed. The location and design shall be subject to the Purchaser's approval.

For typical ladder assembly, refer to **Purchaser's Drawing 1-01000-DA-54000-0008** below for transformers with a height of 4572 mm and greater, and Purchaser's Drawing 1-01000-DA-54000-0001, Sht. 001 below for transformers less than 4572 mm high.

Ladders shall have a minimum with of 305 mm as shown in the Purchaser's drawings, but when at all possible, the ladder shall be wider with an optimum width of 405 mm.


A SIZE - 184 X 279
20 X 3 EXPANDED METAL, NOT TO EXTEND BEYOND THE FRONT OF THE RUNGS
SAFETY LOOP 19ø MS. METAL
690
510
130
1285
794
254
254
63
130
AREA BETWEEN STRINGER & TANK FILLED IN WITH EXPANDED METAL
TANK COVER
FOR DETACHABLE LADDER BOLTED IF REQUIRED
STRINGER 10 X 51 BAR
X
X - AS REQUIRED
TANK WALL
16ø BAR 310 LONG
MIN. DIM. BETWEEN RUNG AND TANK STIFFENING
230
HINGED LOCKABLE BARRIER C/W WINDSTOP FOR 160° OPENING
1830
THE RUNGS SHALL BE EVENLY SPACED FROM TOP LANDING TO BOTTOM OF LADDER (MAX. SPACING NOT TO EXCEED 300 mm)
TANK STIFFENER
TANK WALL
APPROX
SUPPORT BARS 10 X 50 MS BAR
300
GRIND SMOOTH AFTER WELDING
305
75
300
GROUND LEVEL
00 2003-12-11 DRAWING SUPERSEDES 1-01000-A-07544 SHT. 0001. EJM RTT PF
NO. DATE REVISIONS BY CKD. APP.
NOTED
CIVIL
GEOTECHNICAL
ELECTRICAL
F.P. ENGINEER
MECHANICAL
DISTRIBUTION
PROJECT
CONSTRUCTION
MANAGER
ORIGINAL DRAWING SEALED BY R.L.MIDDLETON 92-06-29
DRAWN G.S./CAD
CHECK
SCALE N.T.S.
DATE 88-10
MANITOBA HYDRO
STANDARD
TYPICAL LADDER ASSEMBLY FOR TRANSFORMER WITH HEIGHT UNDER 4572 mm
1-01000-DA-54000-0001
SHT. 0001
REV. 00
FOR MICROFILMING USE ONLY



NO.	DATE	REVISIONS	BY	CKD.	APP.
00	2003 12 12	DRAWING SUPERSEDES 1-01000-A-07552 SHT. 0001.	EJM	RTT	PF

NOTED	ORIGINAL DRAWING SEALED BY R.L.MIDDLETON 92-09-11	MANITOBA HYDRO
CIVIL		STANDARD
GEOTECHNICAL		TYPICAL LADDER ASSEMBLY FOR TRANSFORMER WITH HEIGHT 4572 mm AND OVER
ELECTRICAL		
F.P. ENGINEER		
MECHANICAL		
DISTRIBUTION	DRAWN F.S.G.	
PROJECT	CHECK	
CONSTRUCTION	SCALE N.T.S.	
MANAGER	DATE 92-08-06	1-01000-DA-54000-0008 SHT. 0001 REV. 00

24 GAS DETECTOR

A gas detector relay of the combined gas accumulation and pressure type, shall be provided on all transformers. The relay shall be calibrated in the factory for 2.5 psi pressure operation.

For GSU Transformers	For All Others
Qualitrol Part Number 038-003-01 CS 49483 Dial face to give visual indication of accumulated gas volume, and shall have a black background with white lettering and a white position pointer. Potentiometer output from 0 to 5 kΩ.	**ABB** Model 12 or approved equivalent Dial face to give visual indication of accumulated gas volume up to the alarm point. Electrically separate pairs of contacts to close on slow gas accumulation and rapid increase in pressure.

For HVDC Station	
Same as GSU Transformers The gas accumulator will be wired to the Qualitrol 509 ITM/A.	

The relay shall be connected to the highest possible gas collection pockets on the main tank, and located so that the dial can be read from ground level. The relay shall be mounted:

For HVDC Station	For All Others
-above the highest possible gas collection pockets; -less than **1800** mm above than the main tank cover; -below the minimum oil level in the conservator.	-above the highest possible gas collection pockets; -less than **1500** mm above than the main tank cover; -below the minimum oil level in the conservator.

An indicating type shut-off ball valve with a bleed screw, MA Stuart part number B-3D, on the gas accumulation indicator side of the valve shall be supplied in the main gas collection pipe work immediately prior to the gas accumulation indicator.

The gas piping shall be designed to not impede the movement of fault gasses.

Provision shall be made for gas/oil samples to be drawn from the gas detector relay at ground level by means of a length of copper or stainless steel tubing terminated in a small valve. The copper tube shall be protected, to avoid damage to the tubing, throughout the entire routing from the gas detector relay to the sampling point. The tube shall be run inside of ½" steel pipe. The steel pipe shall be welded to the tank wall through support flags.

The use of gas piping from the bushing turrets and manhole covers to the gas detector relay is not allowed. Only the cover itself may have gas collection pipework. Bushing turrets must have gas seals or deflectors installed to prevent gas from entering the turret. Manholes and handholes must have solid filling material to prevent the collection of gas.

The relay shall be visible and legible when viewed from ground level.

25 PRESSURE-RELIEF DEVICE

The transformer tank and load-tap-changer compartments shall be protected against either rapid or slow rate of rise of the internal pressure by a mechanical pressure-relief device. The maximum settings of these devices shall be 10 psi.

The mechanical pressure-relief device shall be designed so that the pressure due to internal fault shall not over-stress the tank or components. After operation, it shall initiate tripping and shall prevent water ingress.

The device to be used shall be a self-resealing mechanical pressure-relief device from Qualitrol Corporation, having the following accessories:

(a) SPDT Hi DC 10 A continuous 125 V dc Trip normally-open hand reset switch 3P02
(b) Qualitrol connector STD1/2NPT
(c) Standard nitrile gasket from Qualitrol
(d) Standard yellow polycarbonate semaphore
(e) 10 psi operating pressure

For HVDC Station	For All Others
For the transformer tank, supply Qualitrol part# XPRD00-00019011 CS-47803 (10 psi with bleed screw). For the load tap changer compartment, supply Qualitrol part# XPRD00-00037160 (15 psi with bleed screw).	For the transformer tank, supply Qualitrol part# XPRD00-00017801. For load-tap-changer compartments, supply either an XPRD or an LPRD with the same features.

It shall be mounted near the edge of the tank cover and on a pipe assembly as detailed on Purchaser's Drawing

For HVDC Station	For All Others
1-42000-DA-54408-0002 Sht 1	1-01000-DA-54000-0003 Sht. 2 or 1-42000-DA-54408-0002 Sht 1

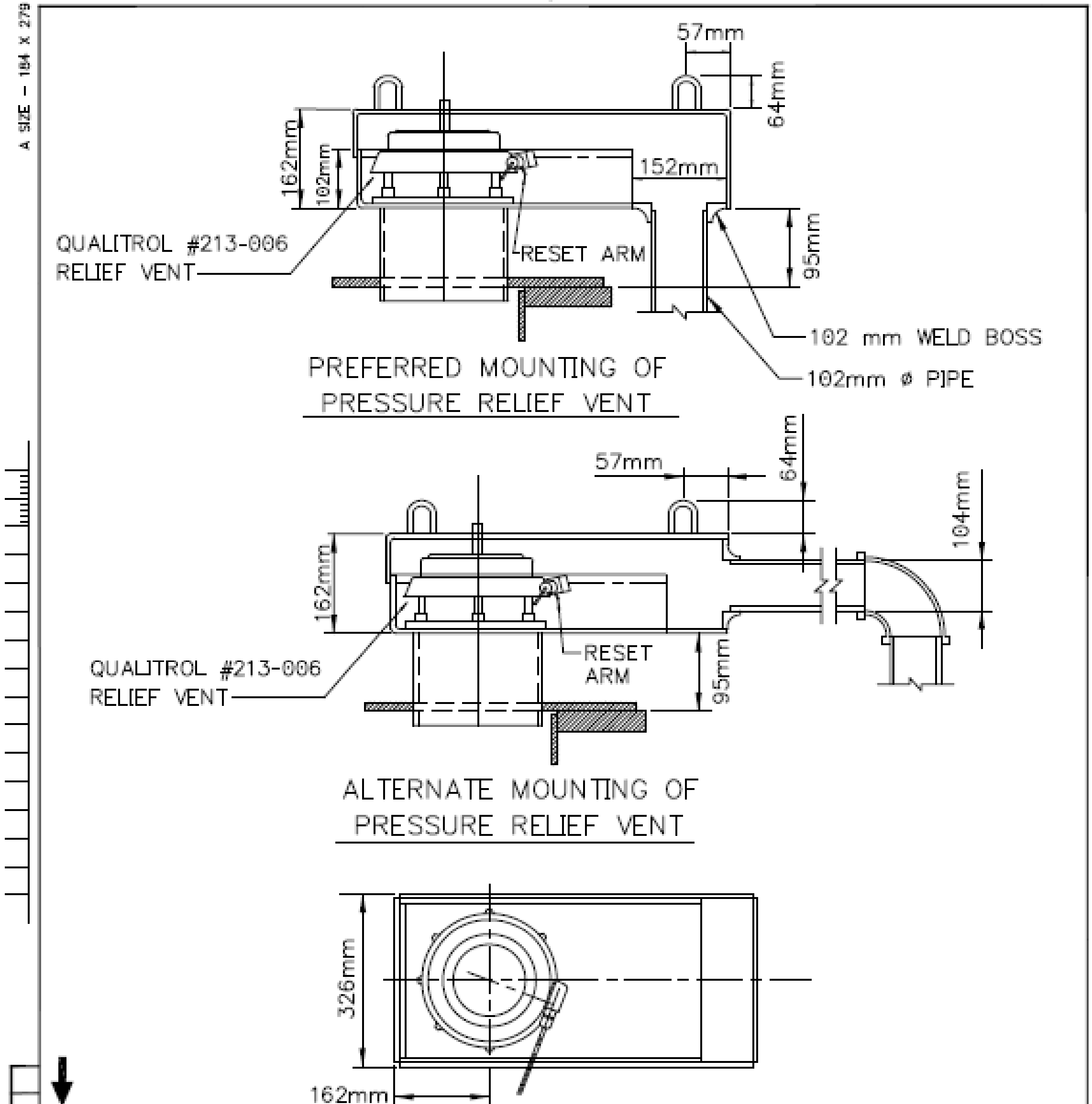
below or approved equivalent design, to direct the oil discharge downwards and away from the control cabinet and operational controls where field personnel may likely be standing. The pipe shall be aluminum or UV-resistant plastic pipe or approved equal. In no case shall the oil be discharged over the radiators or fans. Routing of the oil pipe shall be subject to Purchaser's approval.

For HVDC Station	For All Others
The discharge pipe shall be brought down to approximately **100** mm from the base of the tank.	The discharge pipe shall be brought down to approximately **300** mm from the base of the tank.

More than one (1) pressure-relief device may be required depending on the volume of oil in the main tank.

On the inside of the tank there shall be no barrier placed in front of the XPRD opening to prevent gas accumulation and impede a pressure wave that would reduce the response time of the XPRD operation.

For HVDC Station	For All Others
For each XPRD two trip contacts and one alarm contact (CS-47803) shall be terminated individually in the control cabinet. All wiring shall be terminated on terminal blocks.	N/A



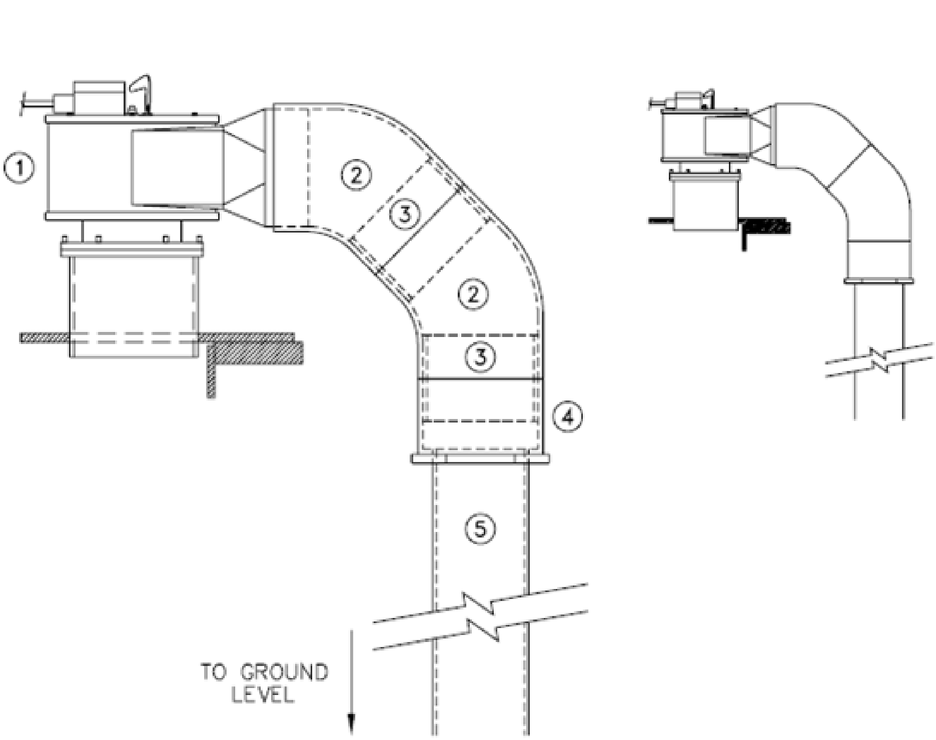
NO.	DATE	REVISIONS	BY	CKD.	APP.
01	2005-02-18	REVISED DRAWING TITLE	EJM		PF
00	2003-12-11	DRAWING SUPERSEDES 1-01000-A-07546 SHT.0002	EJM	RTT	PF

NOTED	ORIGINAL DRAWING SEALED BY C.G. ALLARD 2002-02-12	MANITOBA HYDRO
CIVIL		STANDARD
GEOTECHNICAL		STANDARD PIPE ASSEMBLY FOR MOUNTING QUALITROL RELIEF VENT
ELECTRICAL		
F.P. ENGINEER		
MECHANICAL		
DISTRIBUTION	DRAWN MP	
PROJECT	CHECK R.B.	
CONSTRUCTION	SCALE N.T.S.	
MANAGER	DATE 02-02-08	1-01000-DA-54000-0003 SHT. 0002 REV. 01

FOR MICROFILMING USE ONLY

A SIZE - 184 x 279

ITEM	QTY.	DESCRIPTION
1	1	QUALITROL XPRD XTRA PROTECTION RELIEF DEVICE
2	2	8" SCHEDULE 40 PVC 45-DEGREE PIPE ELBOW
3	2	8" SCHEDULE 40 PVC PIPE COUPLING
4	1	8" to 6" SCHEDULE 40 PVC BUSHING
5	1	6" SCHEDULE 40 PVC PIPE 150mm SERIES 16



NO.	DATE	REVISIONS	BY	CKD.	APP.
00	2009-05-12	MH FIRST ISSUE	DAS	JLeung	JLeung

FOR MICROFILMING USE ONLY

NOTED
CIVIL
GEOTECHNICAL
ELECTRICAL
MECHANICAL
F.P. ENGINEER
DISTRIBUTION
PROJECT
CONSTRUCTION
MANAGER

DRAWN J.L.
CHECK
SCALE N.T.S.
DATE 2009-02-14

ORIGINAL DRAWING APPROVED by J. LEUNG
Member# 23688
2009-07-17

MANITOBA HYDRO
HVDC STATIONS

CONVERTER TRANSFORMERS
QUALITROL
PRESSURE RELIEF VALVE (XPRD)
STANDARD PIPE ASSEMBLY

1-42000-DA-54408-0002
SHT. 0001 REV. 00

AUTOCAD ORIGINAL

26 GASKETS

All gaskets specified and/or manufactured by/for the Contractor, and all gaskets provided for mating with the transformer, including those supplied by outside part manufacturers shall meet the requirements of this Section. This includes gaskets such as:

- radiator valves;
- gas and oil piping;
- valves;
- handholes and manholes;
- gauges;
- Qualitrol thermal plate;
- CT terminal blocks;
- bushings including spark-plug type bushings;
- gas detector relay to pipework;
- LTC access holes and front door on ABB UZ and MR RMV tap-changers;
- DTC handle flange (excluding ABB and MR);
- bolted flanges.

The following gaskets may be acceptable as supplied by the outside part manufacturer, subject to Purchaser's approval:

- LTC and DTC flange to tank for in-tank ABB and MR tap-changers;
- Qualitrol pressure relief device;
- fibre-optic feed-throughs;
- non-oil-sealing gaskets such as on the faceplate of a gauge.

This Section does not apply to the welded tank cover flange.

26.1 Type

It is preferred that the 'O-ring' type of flange seal shall be used on all round openings up to 610 mm in diameter. The 'O-ring' grove shall be in the fixed flange and both the grove and the flanges must be properly machined to ensure proper compression and sealing of the 'O-ring'. The 'O-ring' shall be properly sized for the grove and be able to hold itself in place without the use of adhesives or mechanical devices. The use of 'O-ring' type of flange seals in square, rectangular or other configurations of openings will not be accepted. O-rings shall be uncut and shall not be glued, vulcanized or joined in any manner other than poured as one solid o-ring. Spare 'O-ring' type of flange seals shall be provided for all handholes and manholes and any piece removed for shipping or assembled on site. They shall be tagged with the item number from the Outline Drawing and the Legend.

26.2 Material

Gasket/'O-ring' material must be fluoro-silicon and used in conjunction with inside and outside gasket stops. All metal mating surfaces shall be thoroughly cleaned. Under no circumstances shall glue be applied to the gaskets. Proper size gasket stops shall be used to prevent over-compression of gaskets. Spare gaskets shall be provided for all handholes, manholes, bushings, and radiators. They shall be tagged with the item number from the Outline Drawing and the Legend.

Fluoro-silicon gasket material must be suitable for use between an ambient temperature of -50ºC with the transformer out of service and an ambient temperature of +40ºC with the transformer operating at full load.

Gasket materials shall be compatible with transformer oil at operating temperatures over a life of at least 15 years. Samples of the gasket/'O-ring' material shall be submitted by the Contractor to the Purchaser for testing as described in Section 43 MATERIALS TO BE SUBMITTED FOR SAMPLING of the Technical Requirements.

26.3 Testing by Manufacturer

Every batch of gasket material shall be tested, for every transformer, per ASTM D1229 at -40°C. This test shall be done by either the manufacturer of the material, or by the transformer manufacturer, or by an independent laboratory. A certified test report and specification sheet, complete with the name of the gasket manufacturer, shall be submitted to the Purchaser. This test is in addition to any testing done by the Purchaser, and shall be successfully completed prior to the sample submission to the Purchaser.

26.4 Samples

Approval of the sampled material shall apply only to the sampled batch and shall not be construed as a blanket approval of the material. Samples from different batches shall be submitted separately to the Purchaser for testing and approval.

Once the gasket materials have been approved by the Purchaser, the Contractor shall allocate sufficient materials as required for exclusive use for the Work.

26.5 Spare Gaskets

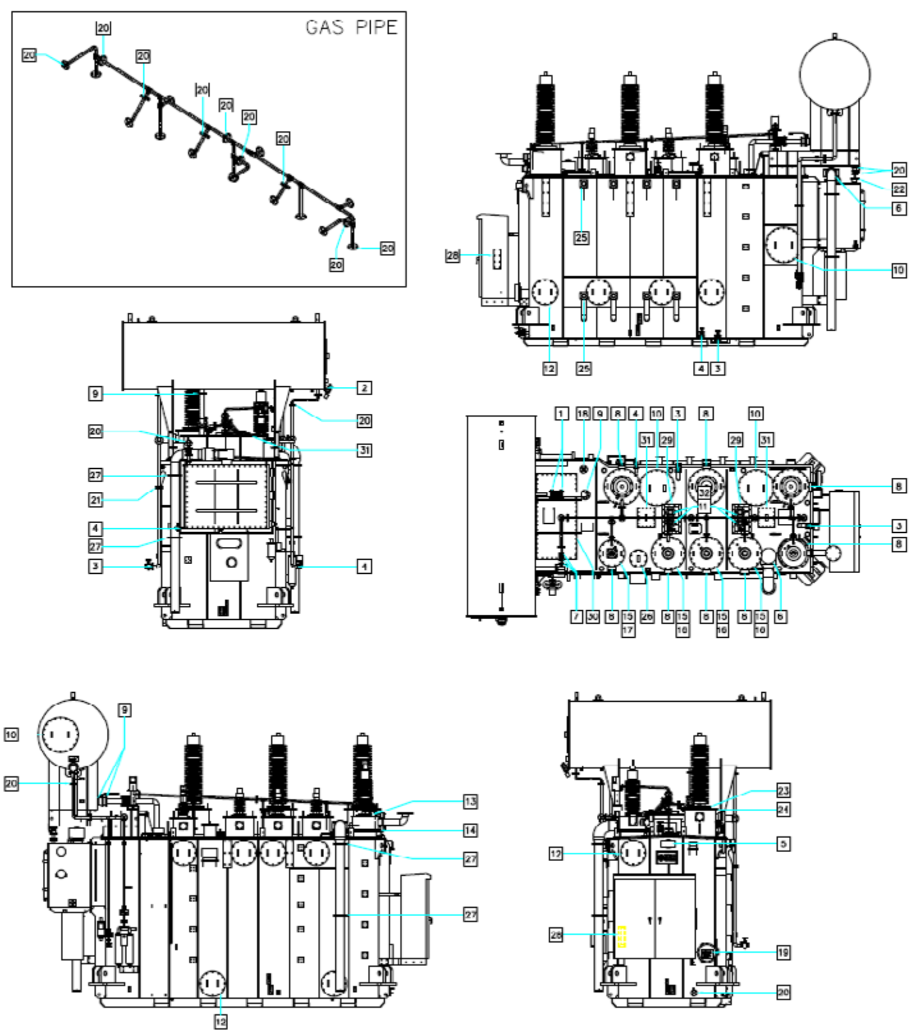
Two spare sets of gaskets shall be provided. The first set is a complete set of gaskets, marked individually but assembled as one package, to be stored for future use by the Purchaser. The second set is a partial set for any gasketed joint assembled during site assembly. This includes all handholes, manholes, bushings and radiators, and anything else that is removed for shipping. This second set will be used when assembling the transformer at site.

26.6 Transformer Factory Test

Transformers and reactors must be factory tested with the fluoro-silicon gaskets installed. Installation of temporary gasket material is not allowed.

26.7 Gasket List

A gasket list drawing shall be provided showing the location and details of each gasket as shown below:



Item Number	Quantity			Gasket Type	Material	Part #	Manufacturer	Gasket dimensions					Description (assembly point)
	Pre-installed	Assemble	Spares					I.D	O.D	Length	Width	Thickness	

Notes:

Item number - identify item number from transformer outline
Quantity - identified gaskets pre-installed in the factory, number to assemble on site, spares supplied
Type - identify type, o-ring, flat, etc.
Material - identify gasket material, i.e. Fluoro-silicone
Part# - every gasket requires a part number
Manufacturer - identify gasket manufacturer
Gasket dimensions - identify size, i.e. I.D, O.D, Length, width, thickness, as applicable
Description - describe location/device gasket is installed

Typical Gasket List Drawing

26.8 Gasket Penalty

A penalty of $10,000, in the currency of the Contract, shall be applied against the transformer purchase price, for each gasket shipped to the delivery location, which is the wrong type or size. This penalty, in total, shall not exceed $100,000.

27 NEUTRAL BUSBAR

A copper busbar shall be brought down from the neutral bushing(s) to the base of the transformer for 3-phase transformers only. A compression connector, Burndy YGHA34-2N or IEEE 80 approved equivalent, suitable for 500 MCM stranded copper, shall be provided at the end of the busbar, located 300 mm from the base of the transformer. The neutral busbar shall be mounted on 15 kV stand-off station post-type insulators PCORE (Lapp) Catalogue No. 315205-70 or equal, located on the transformer tank between the neutral bushing and the base of the transformer, at a maximum of 900 mm centres. Any joints or connection points in the neutral busbar shall be silver-plated and connected with:

(a) two (2) bolts for busbar less than 75mm wide; and
(b) four (4) bolts for busbar 75mm or wider.

28 SURGE ARRESTER SUPPORTS AND BUS ASSEMBLY

This requires the following to be included on the Equipment:
(a) arrester support structure;
(b) ground bus between the arrester base and ground; and
(c) stand-offs.

The surge arresters shall be mounted on a suitable bracket on the transformer tank. If possible, the arresters shall be mounted so that their top connector is level with the respective transformer bushing connector.

The mounting for the arrester shall be a 254 mm diameter bolt circle, with six bolt holes (60˚ spacing), each 16 mm diameter.

The ground bus and stand-offs are described below. The design is subject to the approval of the Purchaser. The arrester and a connector for the arrester shall only be supplied by the Contractor where specified in the Supplementary Technical Requirements, otherwise, the Purchaser shall supply the arrester and its connector.

On a transformer with an ungrounded neutral, the Contractor shall also supply the bus between the neutral bushing and arrester.

28.2 Arrester Supports

Whenever possible, the top of the arrester's NEMA pad shall be at the same elevation as the bushing's NEMA pad. If this is not possible, the arrester shall have a higher elevation. For the shorter arresters in the range, this may require the use of a booster seat. The booster seat shall be supplied by the Contractor.

Manitoba Hydro performs high voltage testing of arresters while they are mounted on the transformer, with the transformer bushings grounded. This is typically done at the arrester's 1 mA level, which typically coincides with about twice the arrester's MCOV rating. Spacing between arresters and bushings shall be adequate for this test voltage. Spacing between adjacent arresters shall also meet this clearance. For 230 kV, the clearance between the arrester's grading ring and the transformer bushings shall be 1600 mm minimum. Refer to the table below, for required minimum clearances.

If the Contractor requires any additional clearance requirements, either with or without the booster seat, the Contractor shall provide this information, clearly, on the transformer outline drawing.

Nominal System Voltage (kV)	System Y / D	System Grounding	Transformer Y / D	Transformer Grounding	System MCOV (Uc) Line to Ground (kV rms)	Maximum Dynamic System 60 Hz Voltage Line to Ground (kV rms)	Dynamic Voltage Duration (Seconds)	Maximum Residual Voltage at 20 kA 8/20 A wave kV (crest)	Duty	Energy Rating single shot kJ/Rated kV	Arrester Rated Voltage (Ur) Line to Ground (kV rms)	Arrester MCOV (Uc) Line to Ground (kV rms)	Voltage Applied to Arrester during 1mA IV Test = 2 x Uc Line to Ground (kV rms)	Minimum Arrester-to-Bushing Clearance No bird allowance (mm)
Line Terminal Arresters														
500	Y	Effective	Y	Effective	346.4	468.0	10	1200	Special Duty	14	436	349	698	3610
230	Y	Effective	Y	Effective	159.3	258.0	10	666	Special Duty	14	240	192	384	2210
230	Y	Effective	Y	Effective	146.1	204.5	10	490	Extra Heavy Duty	7	192	154	308	1600
138	Y	Effective	Y	Ungrounded	108.4	151.8	10	490	Extra Heavy Duty	7	192	154	308	1600
				Effective	87.6	122.6	10	290	Extra Heavy Duty	7	114	91	182	1120
124	Y	Effective	Y	Ungrounded	91.2	133.2	2	290	Extra Heavy Duty	7	114	91	182	1120
				Effective	76.8	107.6	10	290	Extra Heavy Duty	7	114	91	182	1120
115	Y	Effective	D	Ungrounded	90.4	126.6	10	365	Extra Heavy Duty	7	114	91	182	1120
			Y	Ungrounded	90.4	126.6	10	260	Extra Heavy Duty	7	114	91	182	1120
			Y	Effective	73.0	101.6	10	260	Extra Heavy Duty	7	96	77	154	940
66	D	Impedance 120 ohm	D	Ungrounded	72.6	72.6	∞	240	Heavy Duty	4	91	73	146	940
46	D	Ungrounded	D	Ungrounded	55.2	60.5	∞	238	Heavy Duty	5	78	62	124	940
33	D	Ungrounded	D	Ungrounded	36.3	36.3	∞	120	Heavy Duty	4	46	36.8	73.6	380
24.94	Y	Effective	Y	Effective	15.8	22.2	10	60	Heavy Duty	4	21	16.8	33.6	200
24.0	D or Y	Impedance 120 ohm	D	Ungrounded	26.4	26.4	∞	90	Heavy Duty	4	33	26.4	52.8	300
	Y	Effective	Y	Effective	15.2	21.4	10	60	Heavy Duty	4	21	16.8	33.6	200
13.8	D	Ungrounded	D	Ungrounded	15.2	15.2	∞	55	Heavy Duty	4	19	15.2	30.4	200
12.47	Y	Effective	Y	Effective	7.9	11.1	10	30	Heavy Duty	4	10.5	8.4	16.8	150
8.32	Y	Effective	Y	Effective	5.3	7.4	10	22	Heavy Duty	4	8	6.4	12.8	150
4.16	Y	Effective	Y	Effective	2.7	3.7	10	14	Heavy Duty	4	3.5	2.8	5.6	150
Neutral Arresters														
500 kV Neutral	Y	Effective	Neutral	Grounding Reactor	87.6	87.6	10	290	Extra Heavy Duty	7	114	91	182	1120
138 kV Neutral	Y	Effective	Neutral	Ungrounded	87.6	87.6	10	290	Extra Heavy Duty	7	91	73	146	940
124 kV Neutral	Y	Effective	Neutral	Ungrounded	78.8	78.8	10	290	Heavy Duty	7	91	73	146	940
115 kV Neutral	Y	Effective	Neutral	Ungrounded	72.6	72.6	10	240	Heavy Duty	7	91	73	146	940
Re-connectable Arresters for MES (Maintenance Emergency Spare) Transformers														
12.47 x 24.94	Y	Effective	Y	Effective	7.9 x 15.8	11.1 x 22.2	10 x 11.1	30 x 60	Heavy Duty	4	10.5 x 21	8.4 x 16.8	16.8 x 33.6	150 x 200
33 x 66	D	Impedance 120 ohm	D	Ungrounded	36.3 x 72.6	36.3 x 72.6	∞	120 x 240	Heavy Duty	4	46 x 91	36.8 x 73	73.6 x 146	380 x 940
8.32 x 12.47	Y	Effective	Y	Effective	5.3 x 7.9	7.4 x 11.1	10	22 x 30	Heavy Duty	4	8 x 10.5	6.4 x 8.4	12.8 x 16.8	150
4.16 x 12.47	Y	Effective	Y	Effective	2.7 x 7.9	3.7 x 11.1	10	14 x 30	Heavy Duty	4	3.5 x 10.5	2.8 x 8.4	5.6 x 16.8	150

Arrester Clearances

28.3 Arrester Ground Bus

The Contractor shall supply the applicable mounting insulators and ground bus arrangement, as detailed on Purchaser's Drawing **1-01000-DA-54000-0006 Sht 1 and 2 below as applicable**. The ground bus shall be of an ample cross section connecting the three (3) surge arresters to a terminal connector located 300 mm off the base. This connector shall be a 4-bolt clamp-type to accommodate a No. 4/0 AWG stranded copper cable, Travis 11-104 or approved equal.

The arrester ground bus, insulated copper rod and discharge counter shall be insulated at 7.5 kV minimum using stand-off station post-type insulators, PCORE (Lapp) Catalogue No. 315202-70 or equal, located on the transformer tank between the arrester base and the base of the transformer, at a maximum of 600 mm centres.

Individual 2.5 kV insulated copper ground rod shall be run from the base of the each arrester to a height of 3050 mm above the transformer base where they will be joined and continue toward the base as a single ground bus. Stiff supported copper cable may be used in place of the copper rod but is subject to the approval of the Purchaser.

The purpose of using 7.5 kV insulators is to obtain good quality insulators. The purpose of insulating the connection between the arrester base and the counter is to prevent maintenance personnel from using this connection as a ground point.

The Contractor shall design all surge arrester support brackets to be a detachable type and ensure that the connectors of the corresponding bushings and arresters are at the same elevation when mounted.

NOTE: Final design details shall be subject to the Purchaser's approval at the time of Contractor's drawings review.

Porcelain insulator colour shall be grey.

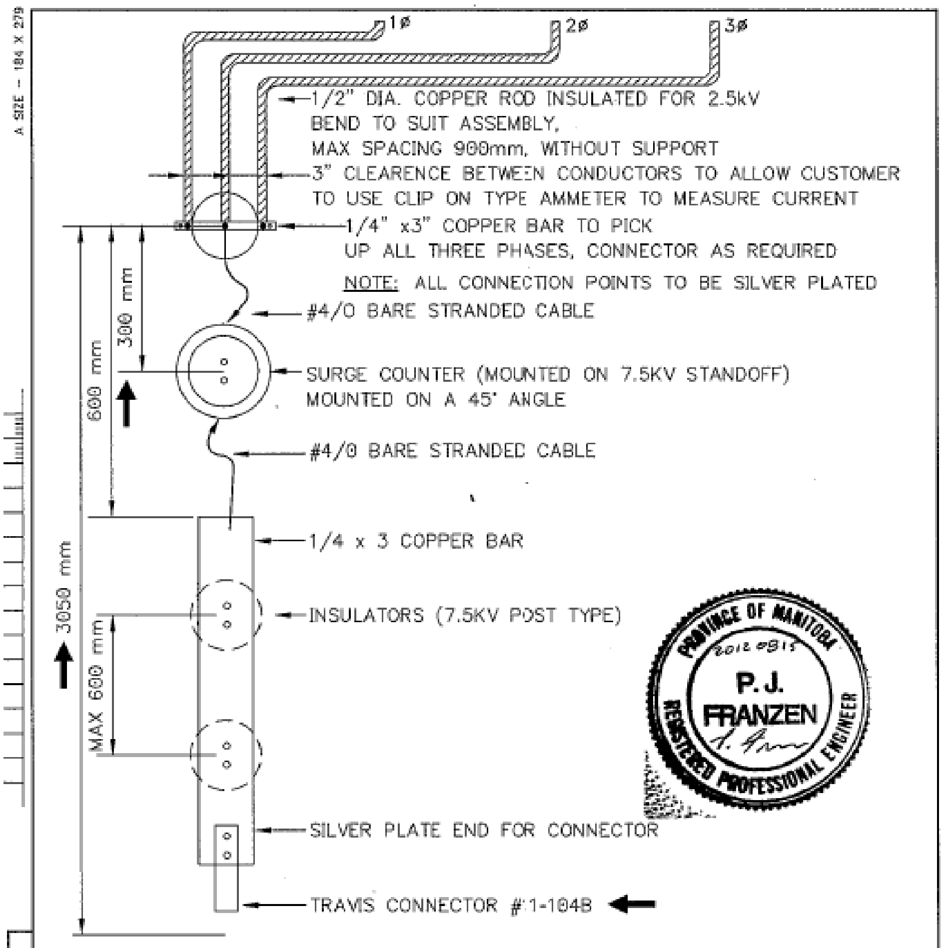
28.4 Discharge Counter

A common discharge counter, GE model 9L26FBE005E / Cooper AM22A1 / Tyco Bowthorpe SC12 or approved equivalent, shall be supplied for each circuit meeting one of the following conditions:

(a) - voltage is 115 kV or above;
(b) - voltage is 66 kV of 230 – 66 kV transformer;
(c) - HV Wye neutral is rated 350 kV LIL;
(d) - as specified in the Supplementary Technical Requirements.

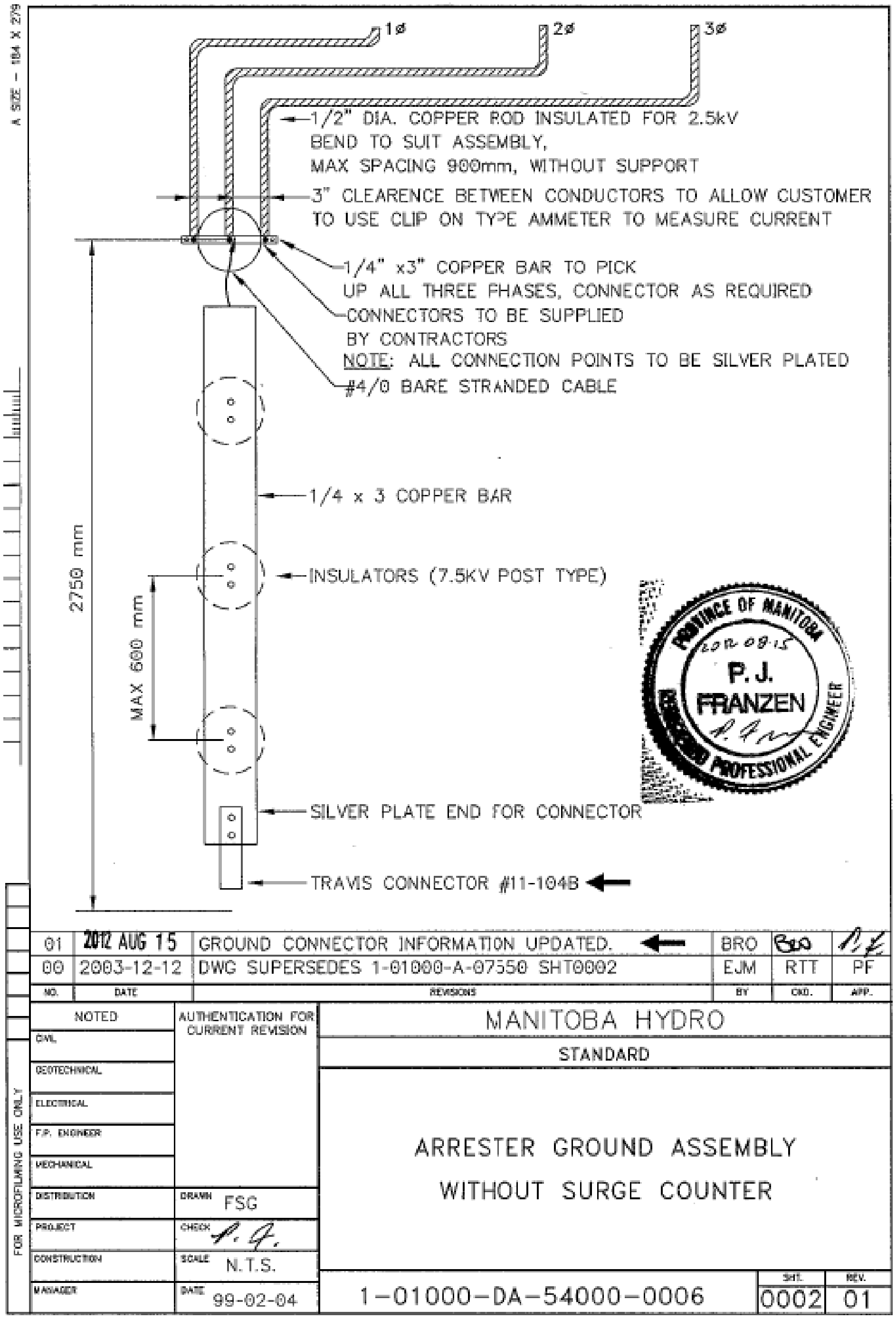
The three phases of one circuit requires only a single common surge counter. Each circuit requires its own surge counter. A 350 kV LIL neutral requires its own surge counter.

The discharge counter shall be mounted at a height of 2750 mm above ground level, and tilted downward at a 45º angle, to facilitate viewing.



NO.	DATE	REVISIONS	BY	CKD.	APP.
01	2012 AUG 15	GROUND CONNECTOR INFORMATION UPDATED. COUNTER & COPPER BAR HEIGHT CHANGED.	BRO		
00	2003-12-12	DWG SUPERSEDES 1-01000-A-07550 0001	EJM	RTT	PF

NOTED	AUTHENTICATION FOR CURRENT REVISION	MANITOBA HYDRO
CIVIL		STANDARD
GEOTECHNICAL		ARRESTER GROUND ASSEMBLY WITH SURGE COUNTER
ELECTRICAL		
F.P. ENGINEER		
MECHANICAL		
DISTRIBUTION	DRAWN AGC	
PROJECT	CHECK	
CONSTRUCTION	SCALE N.T.S.	
MANAGER	DATE	1-01000-DA-54000-0006 SHT. 0001 REV. 01



29 FINISH

29.1 Surface Preparation

The outside of the tank, radiators, conservator, etc., shall be thoroughly cleaned, primed and finished with a high quality weatherproof paint as specified in the Supplementary Technical Requirements and in accordance with the paint manufacturer's performance specification requirements.

All metal parts to be painted shall be thoroughly cleaned by degreasing and abrasive blasting or other equivalent means to suit the particular application.

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.

29.2 External

All external paint requires ultra-violet (UV) protection.

Paint on the exterior shall have a primer coat, tie-coat and a finish coat.

The tank cover shall be finished with a safety travel paint (skidproof).

29.3 Paint Preparation

All paints shall be mixed and applied in accordance with the manufacturer's specification and data sheets. The applied thickness shall meet application requirements and the surface shall be properly prepared between coats of paint. Separate paint systems shall be used to apply incompatible paint products to avoid contamination of the products.

29.4 Touch-up Paint

Extra paint for retouching site assembled equipment shall be supplied by the Contractor. The extra paint supplied shall be clearly labelled as such and a copy of the Material Safety Data Sheet for the paint shall be submitted with the extra paint.

29.5 Interior

The interior of the tank, control cabinet, conservator, radiator headers, oil flow pipes, and the core clamping assembly shall be finished with a white paint which shall not affect or be affected by the oil throughout the range of operating temperatures. The application of this white paint shall be the same as for the exterior paint described above.

30 NAMEPLATE

A nameplate shall be provided in accordance with CAN/CSA-C88-M90.

The nameplate information and presentation format shall be subject to the Purchaser's approval at time of drawing review. The nameplate shall be located on the transformer control cabinet. Any other proposed location shall be subject to the Purchaser's approval.

All nameplate information shall be anodised, and mechanical stamping or etching will not be acceptable for any information.

In addition to the information required by the aforementioned CSA standard, the nameplate shall include:

30.1 Designations

(a) the Purchase Order # and corresponding Item #; and
(b) the SPEC ID#.

30.2 Oil

(a) the type of oil shall be listed as **mineral oil**, regardless of brand; and
(b) a declaration that the equipment contains less than 1 mg/kg of PCBs.

30.3 Impedance

(a) the positive sequence impedance (T-diagram if applicable) of the transformer for the maximum, nominal rated, neutral and minimum LTC tap positions in the nominal rated DTC tap position at the ONAN rating;
(b) the zero sequence impedance (T-diagram if applicable) of the transformer for the maximum, nominal rated, neutral and minimum LTC tap positions in the nominal rated DTC tap position at the ONAN rating; and
(c) For transformers with a buried tertiary, the nameplate shall also provide the calculated equivalent-T positive-sequence and zero-sequence impedances of the transformer for the maximum, rated, neutral and minimum LTC tap positions in the rated DTC tap position at the ONAN rating. This must be labelled as calculated values and it is in addition to the tested HV to LV impedances.

30.4 Vector

In addition to the physical vector drawing, the IEC vector designation shall be written on the nameplate near the basic rating data such as MVA. The vector designation shall be of the form of Dyn1, etc.

30.5 Current

The rated currents for the individual tap positions shall be shown for both the ONAN rating and the maximum MVA rating.

30.6 Ratings

(a) the current rating of the DTC, LTC and series/parallel switches
(b) continuous current rating factors for all bushing-type current transformers

(c) the MVA capacity of the transformer at the appropriate ambient temperature, rather than the CSA standard at 0 ºC ambient temperature
   i) at -20 ºC for Distribution stations
   ii) at -15 ºC for Transmission stations

For GSU transformers, supply the CSA standard 0ºC ambient temperature capability.

30.7 Loading

The loading report number shall be included on the transformer nameplate with the statement:

For GSU Transformers	For All Others
No statement is required.	For Distribution: **This transformer is suitable for Distribution Station loading per the Report EDPD W01 08.** For Transmission: **This transformer is suitable for Transmission Station loading per the Report SPD 2006/01.**

30.8 Oil Volumes

Oil volume total and in each component:

(a) tank
(b) conservator
(c) LTC
(d) LTC conservator
(e) coolers

30.9 Temporary Test Leads

The nameplate shall also show the internal connections of temporary test leads, reactors, diverter switches and internal protective devices such as tie-in resistor or non-linear resistor elements. If temporary test leads are used, the tap location and its rated voltage shall be shown.

30.10 MCIC Approval Number

If the current transformers are approved for revenue metering application, the approval certificate number issued by Measurement Canada, An Agency of Industry Canada Measures Canada, Un Organisme d'Industrie Canada (MCIC), shall also be included on the nameplate.

30.11 Sound Level

Both the base and and top rating tested sound levels shall be shown on the nameplate.

31 CONTROL CABINET

31.1 Type

A weatherproof control cabinet shall be provided on the end of the transformer. The control cabinet shall be designed to be weatherproof under driving rain conditions and shall be insulated and adequately ventilated to prevent condensation. It shall also be insulated thermally.

On transformers rated greater than 30 MVA, or any transformer with deluge brackets, a modified NEMA type 4 control cabinet design including cross ventilation and heaters shall be used. Cross ventilation shall be designed to prevent water intrusion.

Control cabinets with two or more doors shall allow for a removable center post mullion to facilitate wiring.

The design of the control cabinet shall be subject to approval by the Purchaser.

31.2 Location

The bottom of the main control cabinet shall be 915 mm above the transformer base; any other height shall be subject to Purchaser's approval.

The bottom of the load-tap-changer control cabinet shall be between 915 mm and 1500 mm above the transformer base; any other height shall be subject to Purchaser's approval.

For HVDC Station	For All Others
The bottom of the load tap changer control cabinet shall be at the same height as the bottom of the control cabinet.	N/A

31.3 Sizing

The cabinet shall be designed with ample space for ease of maintenance and inspection. If load-tap-changing transformers are supplied, two (2) control cabinets will be necessary. Wiring from tap-changer control cabinet shall be brought into main control cabinet in rigid conduit and suitably terminated on terminal blocks for the connection to the Purchaser's control cables. The conduit between control cabinets shall be sized for 50% extra wire space capacity and a minimum conduit size of 50 mm.

31.4 Conduit

The conduit shall not enter control boxes or junction boxes from the top and special precautions shall be taken to seal conduit entry locations and conduit covers. All wiring junction boxes shall be NEMA type 4 watertight design.

All references to “rigid” conduit refer to the type of conduit and EMT, IMC or any other type of conduit are not acceptable.

31.5 Door

The control cabinet shall be equipped with a hinged door, three-point latching system, with provision for accommodating the Purchaser's 9.6 mm diameter padlock shank and a door stop which will secure the door in a 140º open position. The handle shall directly drive the latching system without requiring additional actions.

All control cabinet door(s), including swing panels, shall be equipped with a robust solid rod style door stop and capable of opening to a 140º locked position independently of the state of other control cabinet doors or any other accessories that may hinder their opening. Outline drawing shall show all control cabinet doors in the open 140º locked position.

When a Qualitrol 509 ITM or 930 Pressure Sensors are supplied, the door shall be equipped with a viewing window. Viewing window(s) shall be located and sized such that all of these devices are visible without having to open the door.

Door opening shall actuate an additional dry contact for NERC cyber-security purposes.

31.6 Light and Convenience Outlet

For HVDC Station	For All Others
The control cabinet shall be provided with a led wraparound led light; Cooper Lighting metalux ap series, 2' Part # 2SLWP2040ND-120V.	The control cabinet shall be provided with a medium base incandescent light bulb base (E-27) 1.03" diameter with a 1.05" depth and door operated switch.

Two (2) NEMA 125 V, 15 A, 1 phase, 3 wire duplex convenience outlets with a ground fault circuit interrupter are to be installed with one (1) outlet located inside and one (1) weatherproof outlet located on the outside of the control cabinet.

The convenience outlet and lights shall be fused separately from the heaters and thermostat circuit.

For GSU Transformers	
One GFCI NEMA 125 V, 15 A, 1 phase, 3 wire duplex convenience outlet with a ground fault circuit mounted in a cast aluminum weatherproof box shall be provided on the tank cover located in the vicinity of the end opposite the control box. The receptacle shall be supplied from a separate 15 A circuit breaker in the control cabinet.	

For HVDC Station	For All Others
Two GFCI NEMA 125 V, 15 A, 1 phase, 3 wire duplex convenience outlet with a ground fault circuit mounted in a cast aluminum weatherproof box shall be provided on the tank cover. One convenience outlet shall be located in the vicinity of the end opposite the control box and the other at the tap changer end of the cover. These receptacles shall each be supplied from a separate 15 A circuit breaker in the control cabinet.	Convenience outlets are not required at the top of the transformer tank

31.7 Heater

Heaters and a thermostat shall be supplied to maintain control equipment at an operating temperature greater than -10ºC throughout the insulated control cabinet with an ambient temperature of -40ºC. The heaters and thermostats shall be located so that an even distribution of heat shall be obtained throughout the control cabinet, without the use of fans, to eliminate extreme temperatures on the wiring and control devices. If required, a heater for condensation shall be supplied and controlled by a separate humidistat.

For GSU Transformers	
A dual thermostat shall be supplied in the control cabinet to alarm for temperatures less than -10°C or temperatures higher than 50°C.	

For HVDC Station	For All Others
A dual thermostat shall be supplied in the control cabinet to alarm for temperatures less than -10°C or temperatures higher than 50°C.	Not required

For HVDC Station	For All Others
Redundant heaters and hygrotherms shall be supplied to maintain the control cabinet interior. The hygrotherms shall be located so that an even distribution of heat shall be obtained throughout the control cabinet, to eliminate extreme temperatures on the wiring and control devices. All heaters shall be located on the back of the control cabinet doors or swing panels so as to provide maximum space for the Purchaser's control cables in the bottom of the control cabinet and to avoid fire hazards. Heaters shall not be mounted on the bottom of the control cabinet. The main control cabinet shall have a minimum of 2400W provided by four Hoffman heaters Part # DAH4001B (400W) and Part # DAH8001B (800W). The heaters shall be supplied by a minimum of two circuit breakers, allowing a maximum of 50% of the heaters to be supplied by any one circuit breaker. One breaker supplies the left hand side of the cabinet heaters (one 800W and one 400W) and is controlled by a single hygrotherm. The other breaker supplies the right hand side of the cabinet heaters (one 800W and one 400W) and is controlled by a single hygrotherm.	To avoid damage to nearby parts, and to prolong heater life, use 240 V heaters with a 120 V power supply.

31.8 Removable Bottom Plate

Provision shall be made in the form of a removable plate at the bottom of the control cabinet, suitable for drilling in the field, to facilitate the entrance of the Purchaser's control cables.

31.9 Removal for Shipping

All control cabinets shall be mounted and fully wired to all internal and external devices for testing and shipping. The control cabinets shall not be removed for shipping unless approval has been given by the Purchaser. If in the event the control cabinets must be removed for shipping, the Contractor is responsible for all costs associated with the re-wiring of the control cabinet and re-verification of the wiring at site. The control cabinets shall be mounted, fully wired and function tested in the factory.

31.10 Electrical Supply and Distribution

31.10.1 Incoming Electrical Supply

For GSU Transformers	For All Others
The Purchaser shall provide a 600 V 3-phase, 4-wire power supply. The Contractor shall supply a suitably sized and fused 600 V - 208 V delta - grounded wye transformer in its own cabinet mounted on the transformer wall near the main control cabinet. The 208 V 4-wire secondary shall feed the main load disconnect in the main control cabinet.	As specified in the Supplementary Technical Requirements and directly connected to the main breaker in the control cabinet.

31.10.2 Auxiliary Supply

Where specified in the Supplementary Technical Requirements, an ac auxiliary supply of 120 V, 1-phase shall be wired as a 120/240 V, 3-wire system.

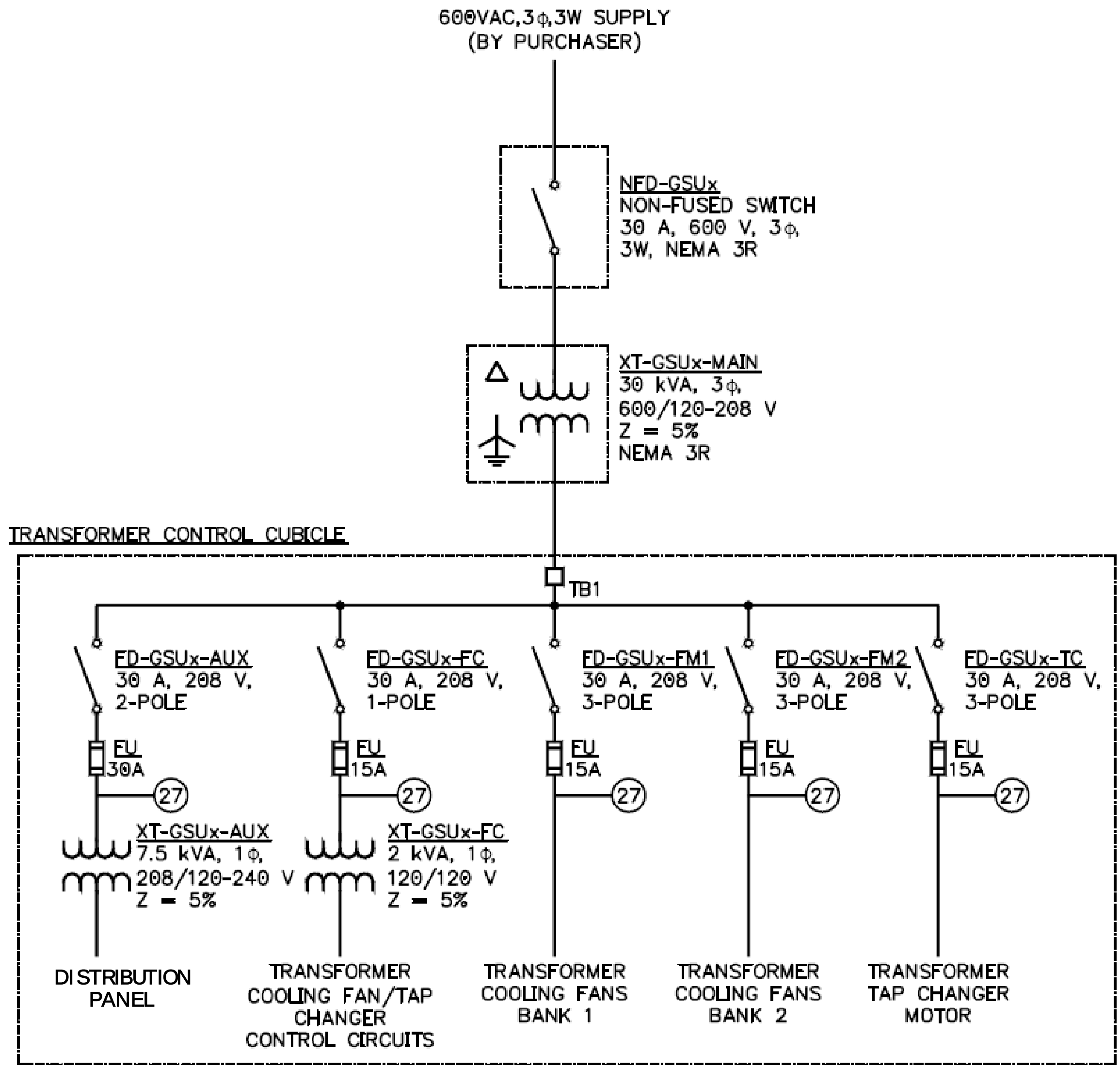
Any supply’s neutral shall be grounded at the site’s station service transformer. The neutral shall not be grounded at or in the power transformer’s control cabinet.

31.10.3 Non-Fused Main Disconnect Switch - GSU Only

For GSU Transformers	For All Others
The Contractor shall provide one (1) 600 V, three-pole, non-fusible load-break disconnect switch with adequate continuous current and momentary short-circuit withstand ratings as required. The switch shall be horsepower rated to ensure it is capable of breaking the locked rotor current of the connected motors. The non-fused disconnect switch shall be padlockable with a padlock in the open position. The disconnect switches shall be CSA approved, and shall be clearly labelled as such. The switch door shall be designed such that it cannot be opened when the switch is in the closed position. The non-fused disconnect switch shall be mounted inside a modified NEMA type 4 enclosure, with cross ventilation designed to prevent water intrusion. A window shall be provided to enable verification of the contact position. The switch enclosure shall be mounted adjacent to the Control Cabinet with anti-vibration pads to prevent damage, loosening of fasteners, or inadvertent operation. Under voltage monitoring shall be provided to monitor all phases on the load side of each disconnect switch listed in this section. A common alarm shall be wired to the Purchaser's interconnecting terminal blocks in the control cabinet.	Not required. Use main breaker.

31.10.4 Zone Fusing - GSU Only

For GSU Transformers	For All Others
Fused disconnect switches shall be provided for major loads such as tap changers, fans, pumps, heaters and convenience plugs as shown in the sketch below. Fused disconnect switches shall be as listed below or Purchaser approved equivalent: Allen-Bradley Single-pole 194R-J30-1753 Double-pole 194R-J60-1753 Triple-pole 194R-C30-1753 All other circuits shall be fused: Class J time-delay fuses shall be Mersen Amp-Trap 2000 type AJT, size and quantity as required. Class CC time-delay fuses shall be Mersen Amp-Trap 2000 type ATDR, size and quantity as required. Auxiliary contact blocks shall be provided to indicate switch position. A common alarm shall be wired to the Purchaser's interconnecting terminal blocks in the control cabinet. All independent fuses and disconnects shall be padlockable in the open position. Under voltage monitoring shall be provided to monitor all phases on the load side of each disconnect switch listed in this section. A common alarm shall be wired to the Purchaser's interconnecting terminal blocks in the control cabinet.	Not required. Use local breakers.



Typical AC Distribution for GSU
Ratings are conceptual only.

31.11 Circuit Breakers

31.11.1 Main Breaker

For GSU Transformers	For All Others
Not required	All control cabinets shall have a main circuit breaker adequately sized for the anticipated load. Loss of this ac supply will result in an alarm.

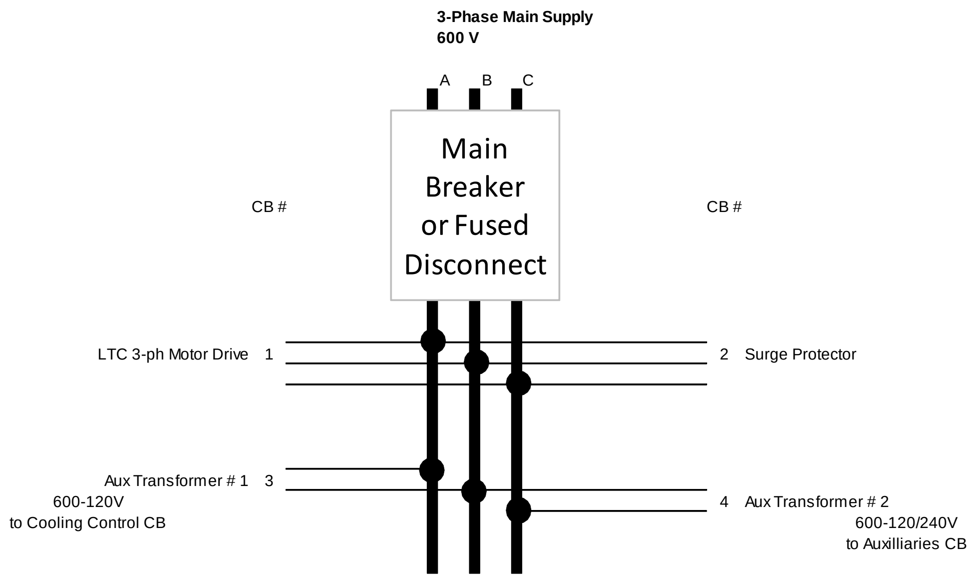
31.11.2Panel

For HVDC Station	For All Others
Stand alone main breaker and three single phase distribution blocks and DIN rail mounted 120/240 V distribution breaker mounted on the left hand swing panel. The cooling equipment shall be supplied by Cooper Bussman Fusible disconnects.	N/A

All circuit breakers, including the main breaker, shall be placed in CSA approved electrical distribution panel board boxes except as noted above. This is required to meet CSA standards. The breakers shall then be wired to the terminal blocks, or the next panel, using no more than one conductor on the breaker terminal.

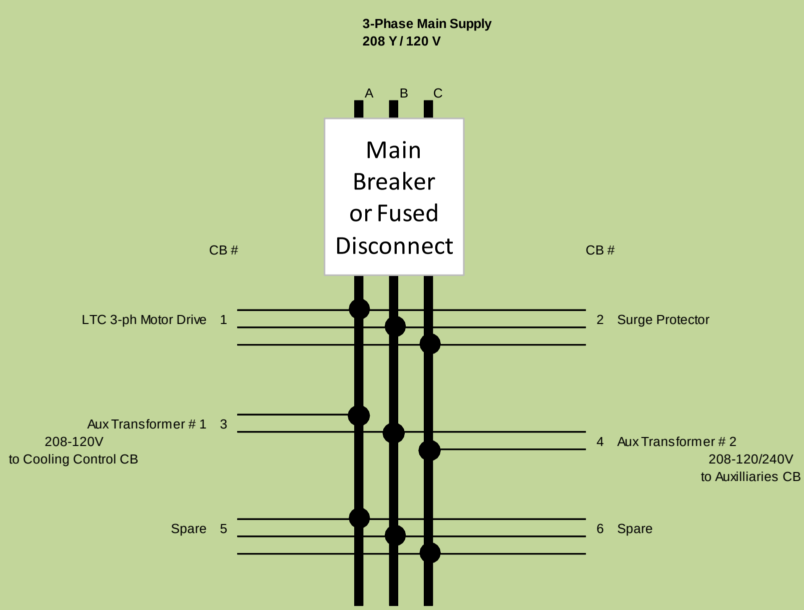
The panel board shall be supplied with a 4-wire plus ground surge protector to protect the connected panel board loads from switching surges from the fan motors.

For GSU Transformers	For All Others
Required for heaters, convenience outlets, lights, auxiliary devices and other low power requirements. This is in addition to any fusing. Breakers shall be lockable in either position. The Contractor shall provide load capacity in the main control cabinet auxiliary supply panel to feed two (2) 400 watt heaters that will be installed in the Heat Detector Monitoring Panel (section 18.2). Refer to the figures below labelled for HVDC and GSU Stations	Circuit breakers are required for all circuits. Refer to the figures below for all other stations.



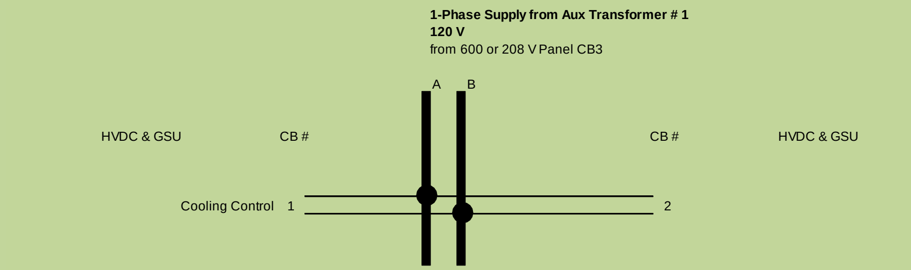
Typical Panel Arrangement for 600 V Main Supply

For HVDC Station



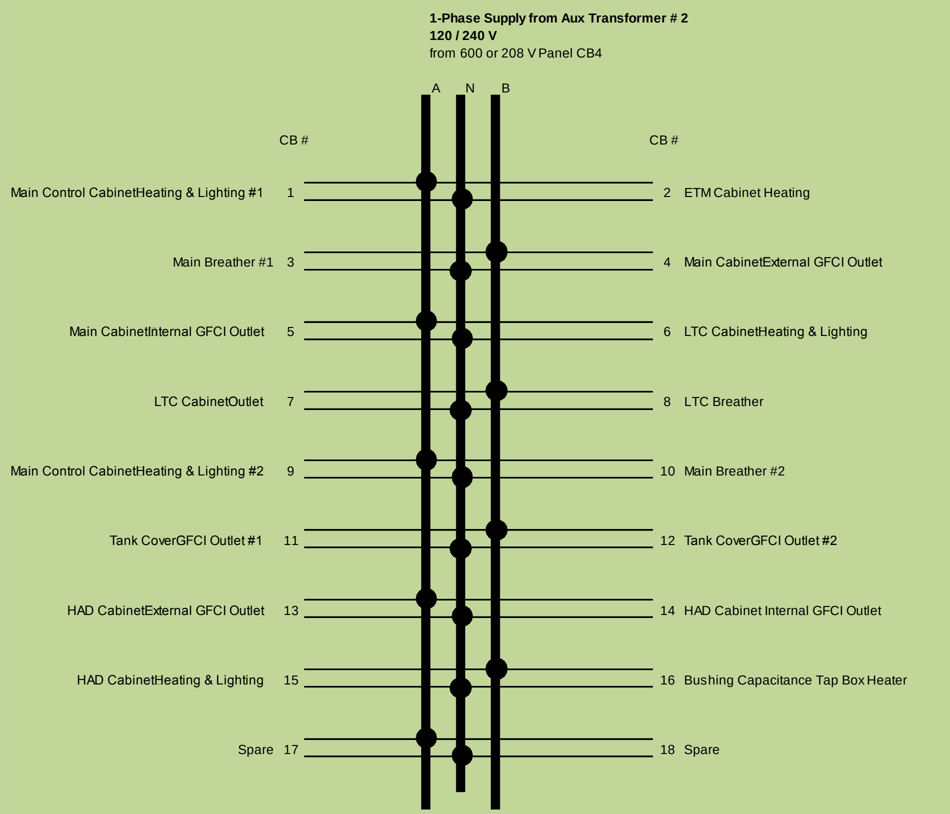
Typical Panel Arrangement for 208 V Main Supply

For HVDC Station



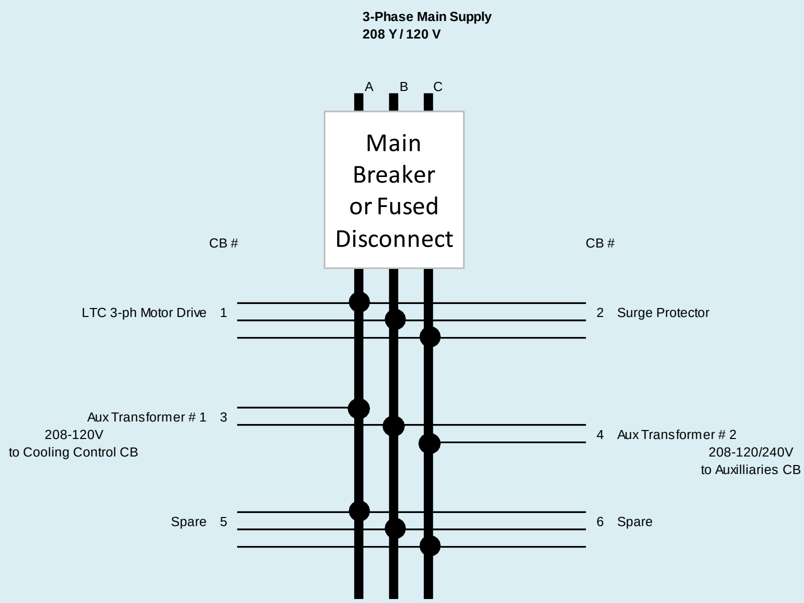
Cooling Control Breaker

For HVDC Station

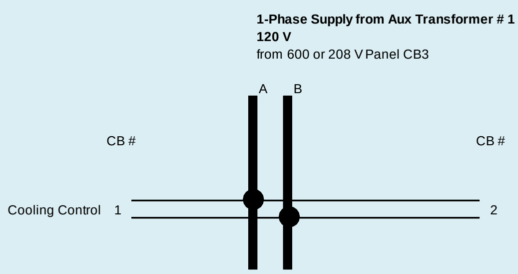


120 / 240 V Distribution Panel

For GSU Transformers

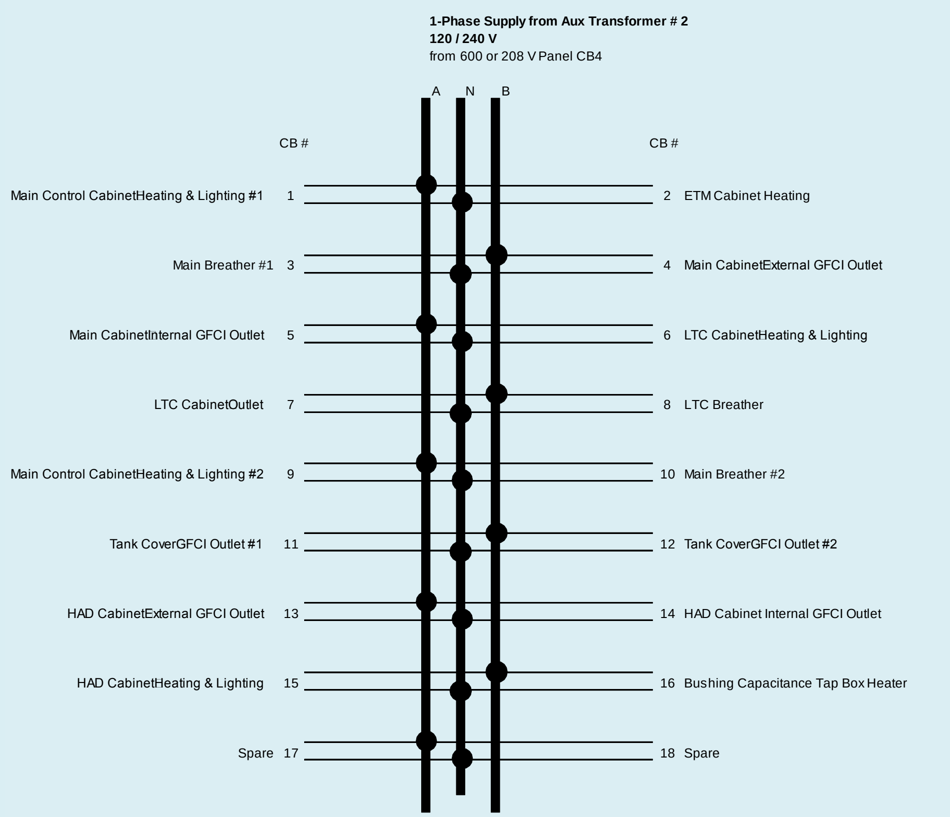


Typical Panel Arrangement for 208 V Main Supply

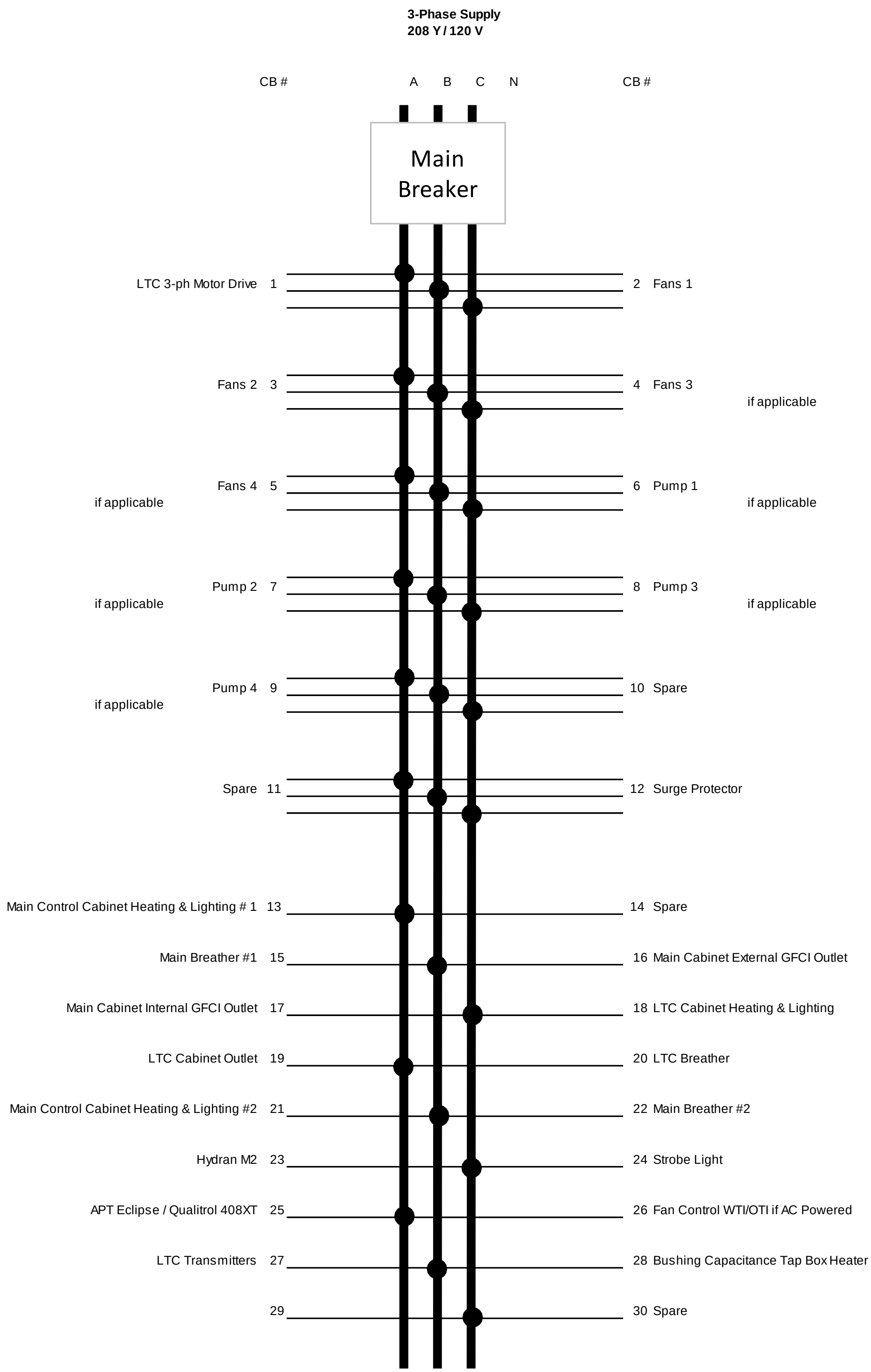


Cooling Control Breaker

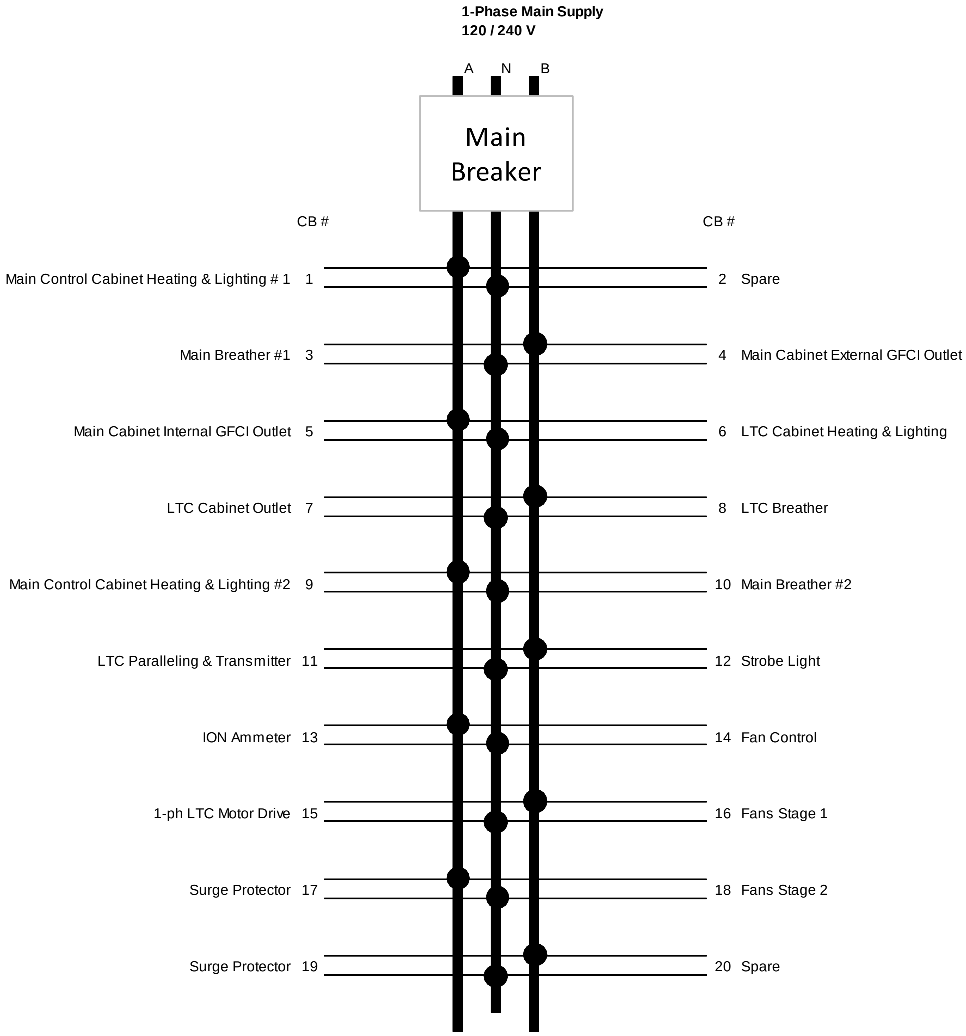
For GSU Transformers



120 / 240 V Distribution Panel



208 / 120 V Distribution Panel for all others



240 / 120 V Distribution Panel for all others

31.11.3DC System Zone Protection - GSU Only

If independent fusing is required (for example in the dc system) then it shall be suitably sized, coordinated with upstream devices and utilize finger safe fuse holders.

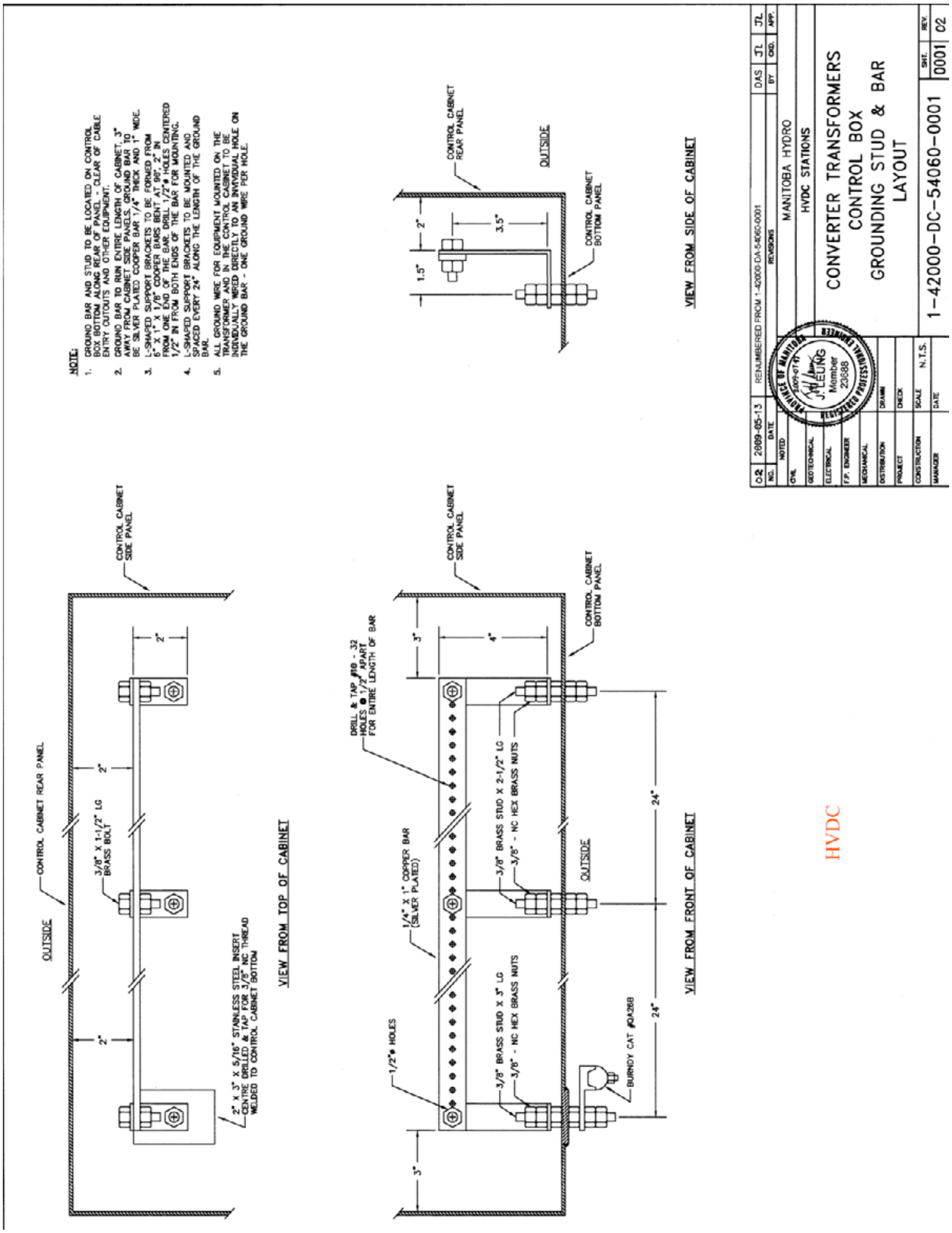
For GSU Transformers	For All Others
Fuse holders shall be pad lockable in the open position. Device sizing, type and coordination shall be approved by the Engineer.	No extra requirements.

31.12 Ground Bar

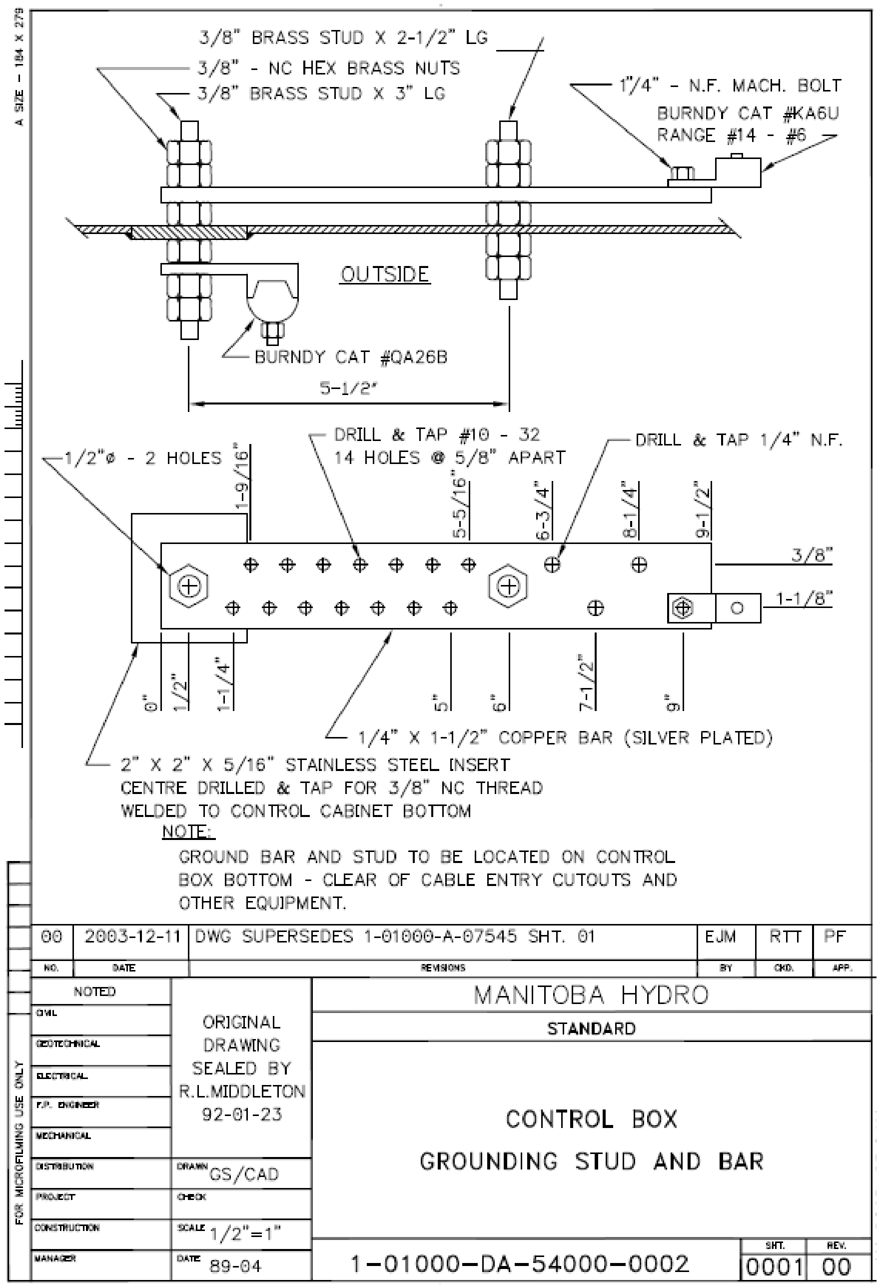
A ground connection consisting of a ground bar and grounding stud, in accordance with **Purchaser's Drawing**

For HVDC Station	For All Others
1-42000-DC-54060-0001	1-01000-DA-54000-0002

below, shall be provided on the inside and outside of the control cabinet respectively.


CONVERTER TRANSFORMERS
CONTROL BOX
GROUNDING STUD & BAR
LAYOUT
MANITOBA HYDRO
HVDC STATIONS
1-42000-DC-54060-0001
VIEW FROM SIDE OF CABINET
VIEW FROM TOP OF CABINET
VIEW FROM FRONT OF CABINET
OUTSIDE

HVDC



31.13 Labelling

All devices in the control cabinets shall be labelled using the same designations as used on the schematic and wiring diagrams.

31.14 Interior Finish

The inside of the control cabinet shall be painted white.

31.15 Gauge Mounting

Gauges such as the Winding and Oil Temperature Indicators shall not be mounted on the top of the control cabinet unless approved by the Purchaser. This is a safety issue. The gauges must be serviceable while standing at ground level.

Electronic temperature monitors shall be mounted inside the cabinet on a swing panel. The main transformer cabinet door shall have a cut-out with a glass or UV resistant polycarbonate plate, adjacent to the indicator, so that it may be viewed without opening the cabinet door.

31.16 AC and DC Loads

The electrical schematics shall include a table or statement showing the expected AC and DC loads in amps. This shall include the loads of other cabinets such as the LTC control cabinet and any separately mounted devices such as a fibre-optic monitor or Hydran if supplied. The loads shall be broken down to each cabinet and external device, but the internal loads may be lumped together.

31.17 Contacts

Wire-out all contacts (normally-open and normally-closed) from the protective devices to ensure the Purchaser has access to the contacts required. Certain older station annunciators only accept normally-open contacts for alarms and trips. This may necessitate some changes to fail-safe relay contacts.

31.18 Control Switches

The transformer control cabinet (not the tap changer cabinet) shall use GE type SBM control switches or approved equal.

31.19 Pump and Fan Control Sketch

When integral coolers are provided, a nameplate shall be mounted in the control cabinet next to the fan and pump switches indicating the pump or fans that are controlled with which pump or fan switch on a cooling layout diagram.

31.20 Relays

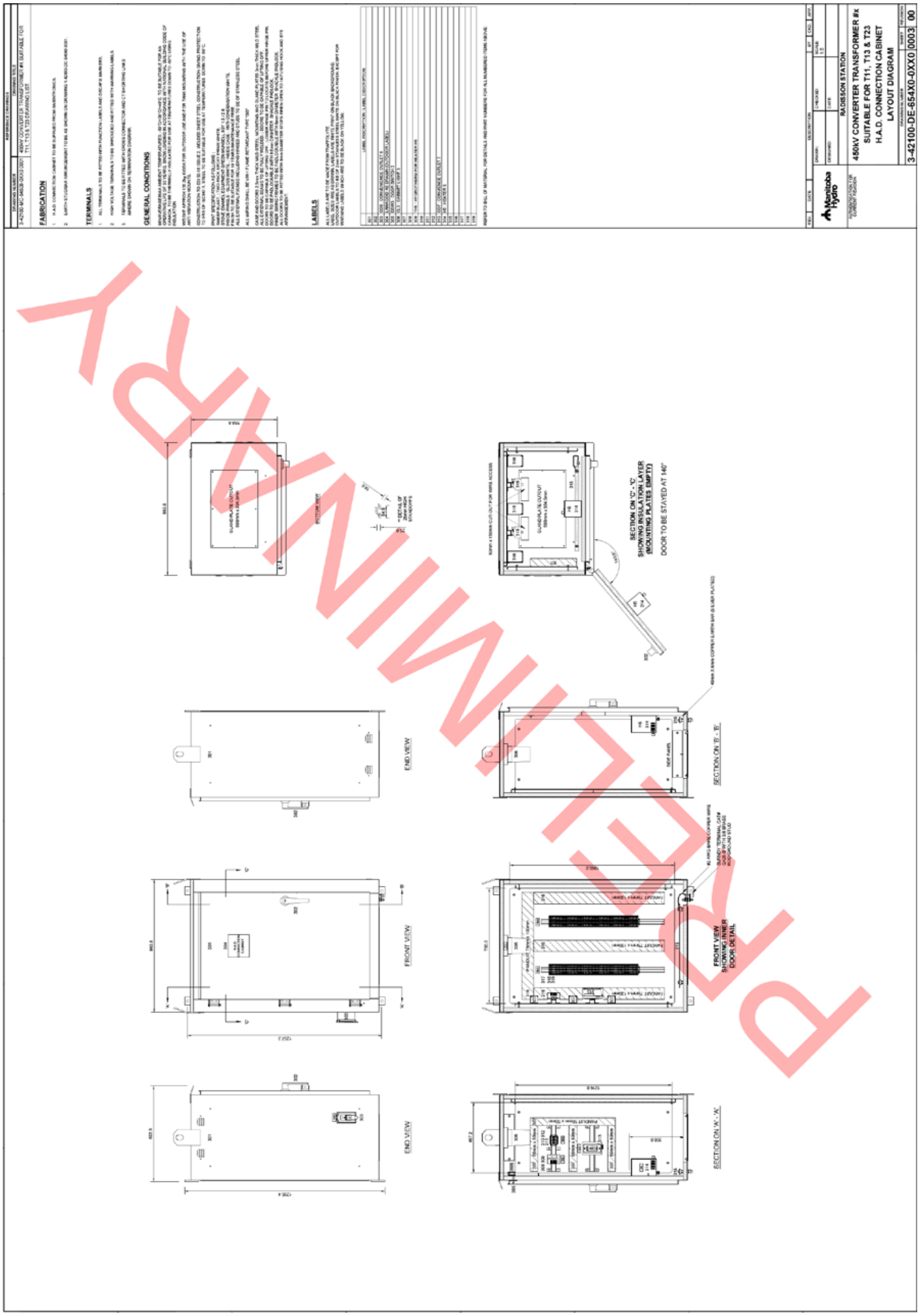
All cooling control relays for integral coolers, and other relays where possible, shall be hermetically sealed type relays where they are removable from their base without rewiring.

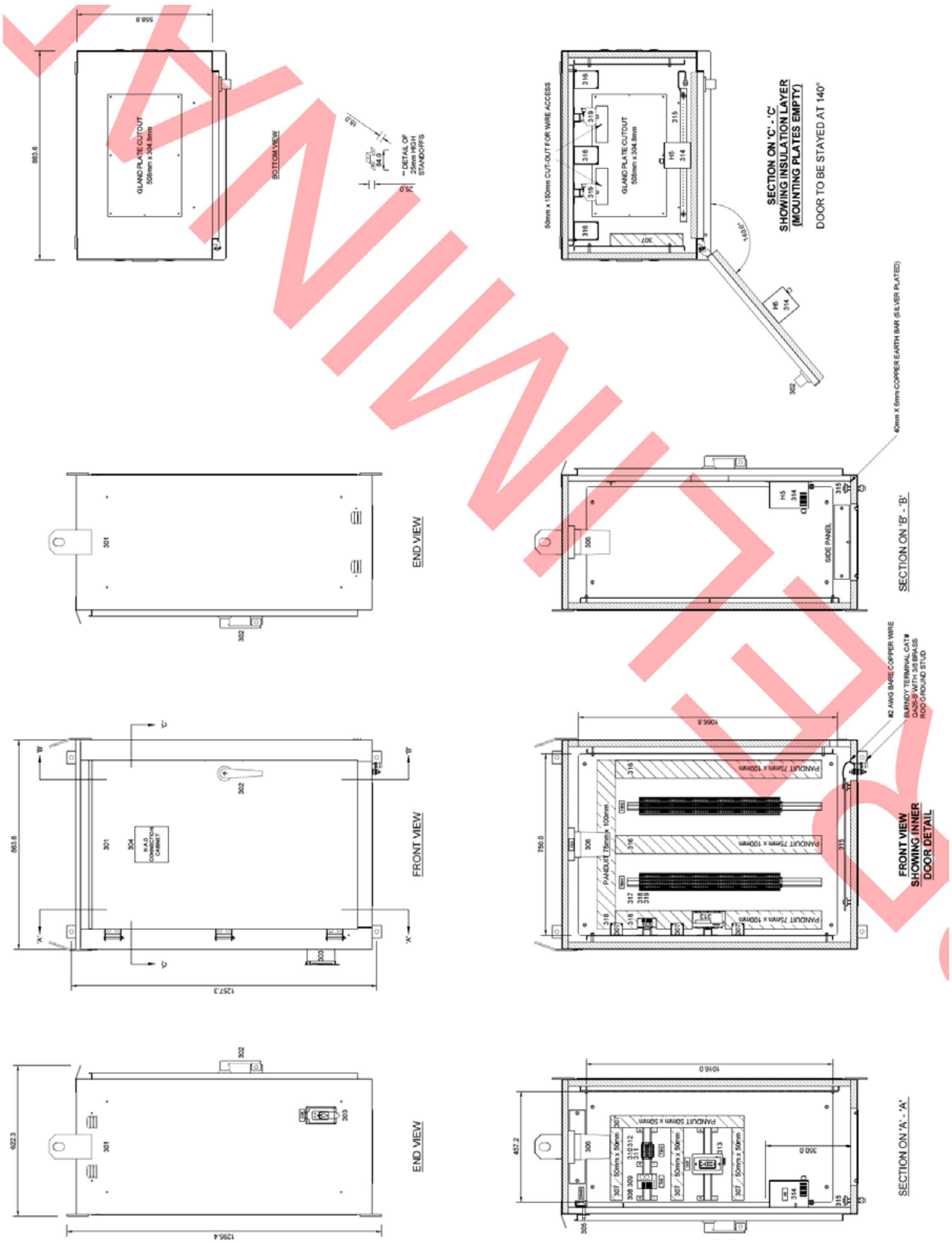
All cooling and tap changer controls shall be 120VAC. The 120 VAC control voltage monitoring relay for the cooling control supply shall be wired at the end of the chain of the 120VAC controls for both the line and neutral ends.

31.21 Heat Activated Detector H.A.D. Connection Cabinet

For GSU Transformers	
When space is available, provision for mounting a H.A.D. Connection Cabinet shall be provided. Refer to section 18.2 Heat Detector Monitoring Panel Provision - GSU Only	

For HVDC Station	For all others
This cabinet is used to house the controls and wiring for the detection of fire on the transformer.The H.A.D. Connection cabinet shall be supplied by the Contractor from Inventronics, part number 309010. The cabinet shall be designed similar to the main control cabinet, with the same general requirements. However, there is no need to include a separate panel for the H.A.D. cabinet. Light, power, heat, terminal blocks and a ground bar are required to be supplied by the Contractor. There shall be three separate circuit breakers from the main control cabinet that supply the H.A.D. cabinet. One circuit breaker shall supply the light and the thermostat and heater circuit, one circuit breaker shall supply the internal outlet circuit and one circuit breaker shall supply the external outlet. The H.A.D. cabinet shall be supplied with two columns of 54 Weidmuller RSF2 terminal blocks for a total of 108 RSF2 terminal blocks. The H.A.D. connection cabinet shall be sized 48 inches (high), 34 inches (wide), and 22 inches deep. The cabinet shall be supplied with two columns of 72 Entrelec Type M 6/8.STP.RS 1SNA 115 678 R0200 terminal blocks (TBH1 & TBH2) for a total of 144 terminal blocks and Entrelec Type M 6/8 RS 1SNA 115 685 R1200 for a third terminal block (TBH3) for the light, heater and outlets and shall be located on the left side panel inside of the H.A.D. cabinet.	H.A.D. cabinet is not required.


PRELIMINARY
RADISSON STATION
450kV CONVERTER TRANSFORMER 8x
SUITABLE FOR T11, T13 & T23
H.A.D. CONNECTION CABINET
LAYOUT DIAGRAM
3-42100-DE-654X0-0XX0 0003 00



FABRICATION

1. H.A.D. CONNECTION CABINET TO BE SUPPLIED FROM INVENTRONICS.
2. EARTH STUD/BAR ARRANGEMENT TO BE AS SHOWN ON DRAWING 1-42000-DC-54060-0001.

TERMINALS

1. ALL TERMINALS TO BE FITTED WITH FUNCTION LABELS AND DECAFIX MARKERS.
2. HIGH VOLTAGE TERMINALS TO BE SHROUDED AND FITTED WITH WARNING LABELS.
3. TERMINALS TO BE FITTED WITH CROSS CONNECTOR AND CT SHORTING LINKS WHERE SHOWN ON TERMINATION DIAGRAM.

GENERAL CONDITIONS

MIN/AVERAGE/MAX AMBIENT TEMPERATURES: -50°C/+30°C/+40°C. TO BE SUITABLE FOR AN OPERATIVE LIFE OF 30 YEARS. SNOW LOADING IN ACCORDANCE WITH NATIONAL BUILDING CODE OF CANADA. TO BE THERMALLY INSULATED FOR USE AT TEMPERATURES DOWN TO -50°C USING INSULATION

WEIGHT APPROX 130.2kg KIOSK FOR OUTDOOR USE AND FOR TANK MOUNTING WITH THE USE OF ANTI-VIBRATION MOUNTS.

CONSTRUCTION TO ESI 50-18 ISSUE 2. WELDED SHEET STEEL CONSTRUCTION GIVING PROTECTION TO IP55 OF IEC947-1. STEEL TO BE SUITABLE FOR USE AT TEMPERATURES DOWN TO -50°C.

PAINT SPECIFICATION AS FOLLOWS :
SWEEP BLAST. ; TWO PACK EPOXY PRIME WHITE.
STOVE ENAMEL EQUIPMENT GREEN MUNSELL 9GY 1.5 / 2.6.
INSIDE PANELS - GLOSS WHITE. ; INSIDE CASE - ANTI-CONDENSATION WHITE.
FINISH TO BE SUITABLE FOR 10 YEARS MAINTENANCE FREE.
ALL EXTERNAL FIXINGS INCLUDING HINGES AND STUDS TO BE OF STAINLESS STEEL.

ALL WIRING SHALL BE VW-1 FLAME RETARDANT TYPE "SIS"

CASE AND DOORS 2.5mm THICK MILD STEEL; MOUNTING AND GLAND PLATES 3mm THICK MILD STEEL.
ALL EXTERNAL SEAMS TO BE FULLY WELDED. ; DOORS TO BE CAPABLE OF LIFTING OFF.
DOORS TO BE CAPABLE OF LIFTING OFF. ; LOWER HINGE PIN TO LOCATE BEFORE UPPER HINGE PIN.
DOORS TO BE PADLOCKABLE WITH 9.6mm DIAMETER SHACKLE PADLOCK.
INNER SWING FRAMES TO BE PADLOCKABLE WITH 6mm DIAMETER SHACKLE PADLOCK.
ALL DOORS TO BE FITTED WITH 8mm DIAMETER STOPS WHEN OPEN TO 140°USING HOOK AND EYE ARRANGEMENT.

LABELS

ALL LABELS ARE TO BE MADE FROM TRAFFOLYTE.
LABEL SIZES ARE AS DRAWN. LABELS ARE WHITE PRINT ON BLACK BACKGROUND.
OUTDOOR LABELS TO BE OF 2mm STAINLESS STEEL WHITE ON BLACK FINISH. EXCEPT FOR WARNING LABELS WHICH ARE TO BE BLACK ON YELLOW.

	LABEL INSCRIPTION : LABEL DESCRIPTION
301	
302	
303	CO6 : CONVENIENCE OUTLET 6
304	LAMACOID AS DRAWN (OUTDOOR LABEL)
305	DSW3 : DOOR SWITCH 3
306	CL3 : CABINET LIGHT 3
307	
308	
309	TH5 : HYGROTHERM FOR HEATER H5
310	
311	
312	
313	CO7 : CONVIENCE OUTLET 7
314	H5 : HEATER 5
315	
316	
317	
318	
319	

REFER TO BILL OF MATERIAL FOR DETAILS AND PART NUMBERS FOR ALL NUMBERED ITEMS ABOVE.

32 CONTROL WIRING

32.1 Type

All wiring shall be flame-retardant type ‘SIS’ or approved equal conforming to CSA C22.2 No. 127. ‘TEW’ is not acceptable because it is not suitable for pulling in conduit. Wire size shall not be less than No. 14 AWG stranded copper, except as noted. All hinged wiring shall be extra flexible, protected and supported.

32.2 Labelling

All wiring shall be properly labelled using the same designations as used on the schematic and wiring diagrams for identification.

32.3 Wire Colour-Coding - GSU Transformers and HVDC Stations Only

Colour-coded wiring shall be supplied for GSU transformers and HVDC stations. Single colour wiring may be used for all other transformers and reactors.

Wire colour coding shall be identified on a lamacoid located on the inside panel door. Lamacoid shall be engraved, be affixed with mechanical fasteners and be black with white lettering.

Function	GSU Transformers HVDC Station	AWG	All Others
4-20mA Signal	Red (+) / Black (-)	#16 Twisted Pair	All grey
RTD / Potentiometer etc	Red / Black / White	#16 Triad	
Communication	Red / Black / White	#16 Triad	
125Vdc Power Supply	Red (+) / Black (-)	#16 Twisted Pair	
125Vdc Trip	Orange	#14 or #16*	
125Vdc Alarm	Yellow	#14 or #16*	
120Vac Control	Grey	#14	
120Vac Control Neutral	White	#14	
208Vac 'A' Phase	Red	#14	
208Vac 'B' Phase	Black	#14	
208Vac 'C' Phase	Blue	#14	
120Vac Aux. Supply	Grey	#8	
120Vac Aux. Neutral	White	#8	
120Vac Aux. Ground	Green	#8	
CT Phase A(polarity)	Orange	#10	
CT Phase B(polarity)	Yellow	#10	
CT Phase C(polarity)	Brown	#10	
CT 'N'	White	#10	
Ground	Green	#14	

*Use #16 for the Qualitrol 509 ITM and the GE Hydran M2 where a larger wire doesn't fit.

32.4 Terminal Block Arrangement

In the main control cabinet the terminal blocks should be as follows:

For GSU Transformers For HVDC Stations	For All Others
TB1 – 208 Vac Supply, shall be mounted in the upper section of the cabinet and covered with a clear barrier. TB2 – 125 Vdc or 250 Vdc Supply TB3 – 125 Vdc or 250 Vdc Trip Signals TB4 – Alarm Signals TB5 – Analog Input Signals TB6 – Analog Output Signals TB7 – Cooling Control TB8 – 120 Vac Auxiliary Supplies TB9 – 208 Vac Fan Supply, shall be mounted in the upper section of the cabinet and covered with a clear barrier. TB10 – RS-485 Communications Terminations TB11 – High Side CT Terminations TB12 – Low Side CT terminations TB13 – Tap changer functions	Terminal block groups shall be chosen judiciously, lumping types together rather than scattering them around.

32.5 Raceways

This clause applies only to transformers rated above 285 MVA and reactors rated above 60 MVAr.

The type MC Panduit wiring duct in the control cabinets shall be sized a minimum of 75 mm wide and 100 mm deep or sized for a 60% fill, whichever is greater. The control cabinet shall be sized to accommodate a minimum spacing of 76mm from the edge of each Panduit to all terminal blocks. In areas where the Panduit is mounted in a corner, corner Panduit shall be used. This Panduit will allow the available area on the back plate of the control cabinet to be maximized.

All terminal block DIN rails shall be raised up using 1" standoffs so that the top of the terminal blocks are at the same height as the top of the Panduit.

The cabinet shall be designed with ample space for ease of maintenance and inspection.

32.6 Termination

Arrangement and location shall be such that outgoing cables can be suitably supported and the routing of individual wires conveniently arranged for connection to the terminal blocks.

The Contractor shall not use the terminals on the Purchaser's side of the terminal blocks. Additional terminal blocks shall be added if required.

No more than one wire shall be terminated per lug and no more than two wires shall be terminated per terminal block.

Sufficient terminal blocks shall be provided for all circuits plus 15% spares. All terminal blocks shall be provided with removable marking strips.

Wiring between terminals of the various devices shall be point to point. Splices or tee connections are not acceptable. Wire runs shall be trunked in wiring troughs or neatly bound in groups and mechanically anchored to the panels. Secondary wiring shall be shielded from the primary conductors.

32.6.1 No. 14 AWG and Lighter Wire

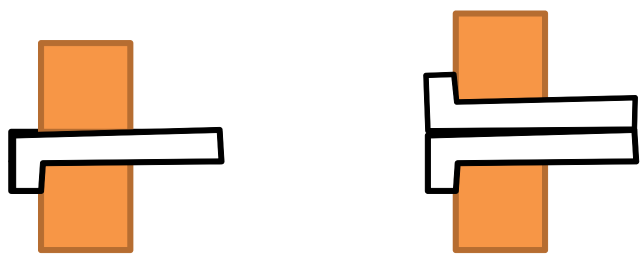
All control wiring, except for alarms and trips, shall be terminated on:

For HVDC Station	
Entrelec M6/8.STP.RS screw clamp spring loaded terminal blocks, part# 1SNA 115 685 R1200	

For GSU Transformers	For All Others
Weidmueller Type WDU 6 SL/EN 500V/5A, 300V/45A or approved equivalent, with marking strips. The standard mounting rail will be the symmetrical DIN standard PR5: Entrelec TS 35/CF6 part# 101 598.26 or an approved equal.	Entrelec M10/10.RS - 600V - 51A screw clamp spring loaded terminal blocks or an approved equal. The standard mounting rail will be the symmetrical DIN standard PR4: Entrelec TS 35/C1 part# 168 500.12 or an approved equal.

Wire terminations shall be made with approved pressure-type terminal lugs.

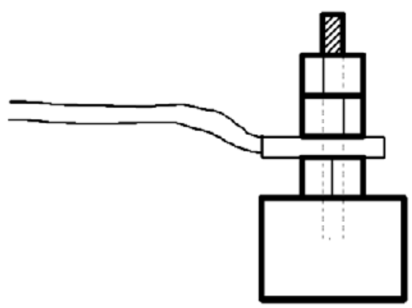
Lipped blade terminal lugs shall be used when connecting wires to terminal blocks. Lugs are to be installed facing the back of the terminal blocks. If there are two lugs in a terminal on the terminal blocks, lugs should be facing opposite directions with the lip facing outwards.



32.6.2 No. 12 AWG and Heavier Wire

Stud-type terminal blocks G.E. type 'EB', Klippon (Weidmuller) type ST-5 or approved equal, shall be used for wires larger than No. 14 AWG stranded. This includes the voltage and current transformer secondary leads which shall be minimum No. 10 AWG.

Three nuts per stud are required on the Weidmuller terminal blocks, as shown below, including screws that have no lugs on them.



Wire terminations shall be made with approved pressure-type terminal lugs: ring type lugs (Burndy YAV14D or approved equivalent).

For GSU Transformers	For All Others
Clear covers shall be installed on ST5 terminal blocks, Weidmueller Part #0447700000.	Covers are not required.

When current transformers are shorted and grounded at the terminal blocks, they shall be shorted and grounded on a per CT basis and not as a group. This is to allow the use of CTs as desired.

32.6.3 Terminal Blocks for Alarm and Trip Circuits

For all alarm and trip circuits, terminal blocks shall be test-disconnect terminal blocks.

For HVDC Station	
Entrelec M6/8.STP.RS screw clamp spring loaded terminal blocks, part# 1SNA 115 685 R1200	

For GSU Transformers	For All Others
Weidmueller WTR 4 SL/EN	Entrelec M6/8.STP.RS screw clamp spring loaded terminal blocks, part# 0115 678.02. The standard mounting rail will be the symmetrical DIN standard PR4: Entrelec TS 35/C1 part# 168 500.12. End stop is BAM, part # 0103 002.26. Test plug is FEMR8T part# 0116 991.06.

32.7 Routing/Conduit

All groups of bundled conductors to hinged doors shall use extra flexible wire and be arranged so that a twisting rather than a bending motion is imparted to the moving conductor bundle. Each bundle shall be anchored to the fixed member at the opposite side of the hinge axis to the anchoring point on the moving member so that the moving bundle length is the maximum available without loops.

All anchoring and fastening of wire and cable bundles shall be done with mechanical type fasteners. Adhesive type fasteners are not acceptable.

All wiring connections shall be readily accessible and removable for test or other purposes. Sufficient slack shall be left at component terminals and terminal blocks to permit rearrangement of connections between terminals of any particular component. Whenever possible, unused areas of panels shall be kept free of wiring to facilitate the installation of future equipment.

All wiring between devices and control boxes shall be without joints or hi-links and run in rigid conduit with the appropriate fittings. The use of liquid tight flexible conduit shall be kept to a minimum of 300 mm and only used when rigid conduit is impractical. Any flexible conduit is to be used only when connecting to the device at the end of the conduit run from the control cabinet, nowhere in the middle of a conduit run or at the control box end, unless approved by the Purchaser. After final painting, a small bead of silicone sealant shall be applied to all connectors and watertight joints on the conduit. All references to “rigid” conduit refer to the type of conduit and EMT, IMC or any other type of conduit are not acceptable.

32.8 Fusing

Fusing shall be

For HVDC Station	For All Others
HRC Class J	HRC Form II

33 LTC CONTROLS IN TRANSFORMER CONTROL CABINET

For LTC controls supplied by the LTC manufacturer, refer to section 14.10 Accessories and Controls Supplied by LTC Manufacturer.

33.1 Control Switches

The tap-changer control shall be provided with a manual local/automatic/remote transfer switch, a local control switch for ‘raise’ and ‘lower’ over the entire range of tap-changes, master/follower/independent paralleling switch, necessary terminal blocks, circuit protection, etc., all mounted in the main control cabinet. The switches shall be a C.G.E. type SB1 or an approved equivalent. Separate voltage testing terminals for manual and automatic positions shall be provided.

These switches shall include spare contacts for each condition:

(a) 3 pairs each of the transfer switch
(b) 2 pairs each of the local control switch;
(c) 3 pairs each of the paralleling switch.

Refer to the switch tables in section 33.9 Paralleling Equipment, for contact types. These contacts are to be shown in the control schematics and wiring diagrams, and be wired to terminal blocks. They shall be grouped together with the other spare contacts.

33.2 Step-by-Step Operation

The tap-changer remote electrical operation shall be so arranged that the tap-changer shall move only one step at a time when a 'raise' or 'lower' signal switch is held closed.

33.3 Minimum Voltage Relay

A relay or other means shall be provided to block the operation of the tap changer if the voltage is less than 90 V on the output of the voltage transformer.

33.4 Breaker Reclosing Blocking Relay or Contact

A relay or other means shall be provided in the tap-changer control circuit to block the operation of the tap-changer when the Purchaser's associated circuit breakers are going through a reclosing cycle. This blocking shall be effected by the opening of a remote contact which shall be wired to a terminal block in the main transformer cabinet for connection to the Purchaser's external cabling.

33.5 Neutral Return

A neutral return feature shall be provided for the automatic return to neutral and blocking of the tap-changer in the neutral position by means of the Purchaser's remote return-to-neutral control scheme. This scheme is used for paralleling transformers in the unregulated neutral position only and shall be accomplished by a 3-wire circuit connected to the Purchaser's remote 'Neutral-Auto-Block' switch. The 'Return-to-Neutral Signal' will be indicated by the closing of a contact and the blocking will be effected by the opening of a contact. The wiring shall be connected to a terminal block for connection to the Purchaser's external cabling.

Neutral / Auto / Block Switch supplied by Purchaser

CONTACT DIAGRAM FOR 43NAB Neutral / Auto / Block Switch supplied by Purchaser					
CONTACTS		POSITIONS			
		NEUTRAL	AUTO	BLOCK	
Spare A 1 —┤ ├— 7 8 —┤ ├— 2	1 - 7		X	X	reserved for switchgear
	2 - 8	X	X		reserved for switchgear
3 —┤ ├— 9 10 —┤ ├— 4	3 - 9	X			**available for Contractor**
	4 - 10			X	**available for Contractor**
5 —┤ ├— 11 12 —┤ ├— 6	5 - 11	X			**available for Contractor**
	6 - 12			X	**available for Contractor**

The purpose of this switch is to easily allow the installation or removal of one of two banks, without dumping load. It is typically housed in a switchgear building.

NEUTRAL: Run to Neutral and remain there, regardless of any other signals. This effectively blocks the LTC in Neutral until the switch is moved to Auto.
AUTO: Control reverts to the transformer cabinet.
BLOCK: Block the LTC from moving (and blocks the breaker from closing). This can be in any LTC position.

Blocking in NEUTRAL is typically done by blocking the Control Switch and Paralleling Switch contacts.

Blocking in BLOCK is typically done by cutting off the LTC motor's power supply, either through the 96 and/or 27 relays.

Show the above contact diagram on the schematic. If it needs to be revised for the design, state so on the drawing and show the required contact diagram.

The neutral return switches, limit switches, etc., shall be mechanically driven to ensure correct and positive operation relative to the position of the tap-changer contacts.

33.6 Remote Operation

Interposing relays shall allow remote electrical operation of the tap changer ac controls from the Purchaser's dc control circuitry. The Purchaser uses both 24 VDC and 125 VDC systems so two mutually exclusive systems shall be provided: one with 125 VDC relays, and one with 24 VDC relays. Unless otherwise specified in the Supplementary Technical Requirements, only the 125 VDC system shall be wired to the tap changer's control circuitry. The 24 VDC relays shall be permanently mounted in the transformer's control cabinet immediately beside the 125 VDC relays, but not wired. The wiring shall be long enough to allow the wires to be removed from the 125 VDC relays and connected to the 24 VDC relays. This applies for supervisory control of 'Raise', 'Lower' and 'Auto'.

Freewheeling diodes shall be connected across the relays for the protection of the Purchaser's PLC equipment.

33.7 Voltage Control Equipment

This is always required except for the following transformers:
(a) 230 to 138 kV auto-transformer; and
(b) 230 to 115 kV auto-transformer.

A Beckwith M-2001D fully automatic self-contained voltage control shall be supplied with the tap-changer.

For stations without a building, supply model
M-2001D-6V4S2B00*00

60 Hz, vacuum florescent display, ST fibre connectors, RS-232 & Bluetooth, no ethernet, DNP, *no paralleling, no power quality monitoring, no backup power for fibre.

For stations with a building, supply model
M-2001D-6V4S2BFU*00
60 Hz, vacuum florescent display, ST fibre connectors, RS-232 & Bluetooth, fibre ST 100BaseFX ethernet, IEC 61850 (new stations) and DNP 3.0 (existing stations) protocol, no paralleling, no backup power for fibre.

This equipment shall include the necessary voltage relay, time delay relay, limit switches, neutral switch, etc., together with self contained current compensating transformers for the operation of the control equipment.

33.7.2 VT for Voltage Sensing Circuit

The voltage transformer (VT) used for voltage sensing is supplied by either the Purchaser or the Contractor. The Contractor shall supply a 1-phase voltage transformer (VT) on all power transformers with a LV less than 66 kV.

All windings shall be constructed of copper. It shall be installed external to the main power transformer and shall be dry-type. They shall have LIL insulation levels equal to or higher than the power transformer's bushings. Both HV bushings shall be fully insulated, rather than using a small spark plug or the case for the neutral terminal.

If supplied by the Contractor, it shall be Ritz USA, type VZF as required. Ritz Germany VT designs are not acceptable because they have a lower lightning impulse level.

The VT shall meet the Canadian standards, CSA 640044-2.

Voltage	**Model**	**Voltage Ratio**	**kV LIL**	**Catalogue Number**
12.47 kVY	VZF 15-20	7200 - 120 V	110	122030010 60320
12.47 kVY x 24.94 kVY	VZF 25-10	14400 - 120/240 V centre-tap	150	special
24.0 kV delta	VZF 36-10	24000 - 120 V	150	122030010 60353
24.94 kVY	VZF 25-10	14400 - 120 V	150	122030010 60351
33.0 kV delta	VZF36-10	34500 - 120 V	200	123030010 60384

The VT must be installed and connected during the dielectric and no-load loss testing of the main power transformer.

For 4.16 and 8.32 kV, a specially designed VZF will be required, similar to the above models.

For low voltage re-connections other than 12.47 x 24.94 kV, the Contractor shall supply VTs for both connections when it is not practical to supply a re-connectable VT (e.g., 4.16 x 24.94 kV). Both VTs will be mounted, with one being shorted-out and grounded.

33.7.3 Load Drop Compensator CT

For certain transformers, a LDC CT is required in both the HV (H1) and LV (X1) circuits, to allow for step-down and step-up operation. This applies to:

(a) all 230 - 138 kV auto-transformers
(b) all 230 - 115 kV auto-transformers;
(c) all 230 - 66 kV transformers;
(d) all 115 - 66 kV transformers.

This does not apply for the voltage transformer, since that will be supplied by the Purchaser for these transformers.

33.7.4 Knife Switch

A knife switch for disconnecting the VT from the controls shall be supplied. This switch shall be connected between the VT and the one-to-one isolating transformer. It shall isolate the VT and allow connection of an external source. It must be a break-before-make switch. Its purpose is to provide visual indication of the source and to de-energise the control circuitry. The two positions of this switch shall be labelled ‘external’, ‘internal’ and/or ‘open’ as applicable, describing the supply voltage source(s).

33.7.5 Special Isolating Voltage Transformer

A one-to-one ratio isolating voltage transformer shall be provided for transformers with a voltage regulating relay, and a delta connected secondary of 66, 33 or 24.0 kV, or for a 24.0 kV wye connected secondary. The purpose is to isolate ground fault currents from the voltage regulating relay back to the VT because both the VT and the control cabinet have separate grounds. The isolating VT also controls the fault voltage applied to the voltage regulating relay when the fault is not immediately cleared.

This isolating voltage transformer shall be 240 V to 240 V to avoid any possibility of saturation occurring. The isolating voltage transformer shall be accurate for operation at 120 V which requires a special VT for a 0.6% accuracy at a minimum burden of 8VA. The standard 240 V VT does not meet the accuracy requirements at 120 V. One acceptable option is a GE Model JVA-0C Cat# 760X134643 rated 240:240.

33.8 Re-Connectable Windings

If the tap changer is part of the circuit containing re-connectable windings, the control drawings shall show the LDC CT and VT connections for both configurations.

33.9 Paralleling Equipment

A modified version of the EEMAC (CEMA) Scheme B (master/follower) control shall be used unless specified otherwise in the Supplementary Technical Requirements to allow for the future operation of the tap-changing transformers specified herein in parallel with similar units over their full tap range.

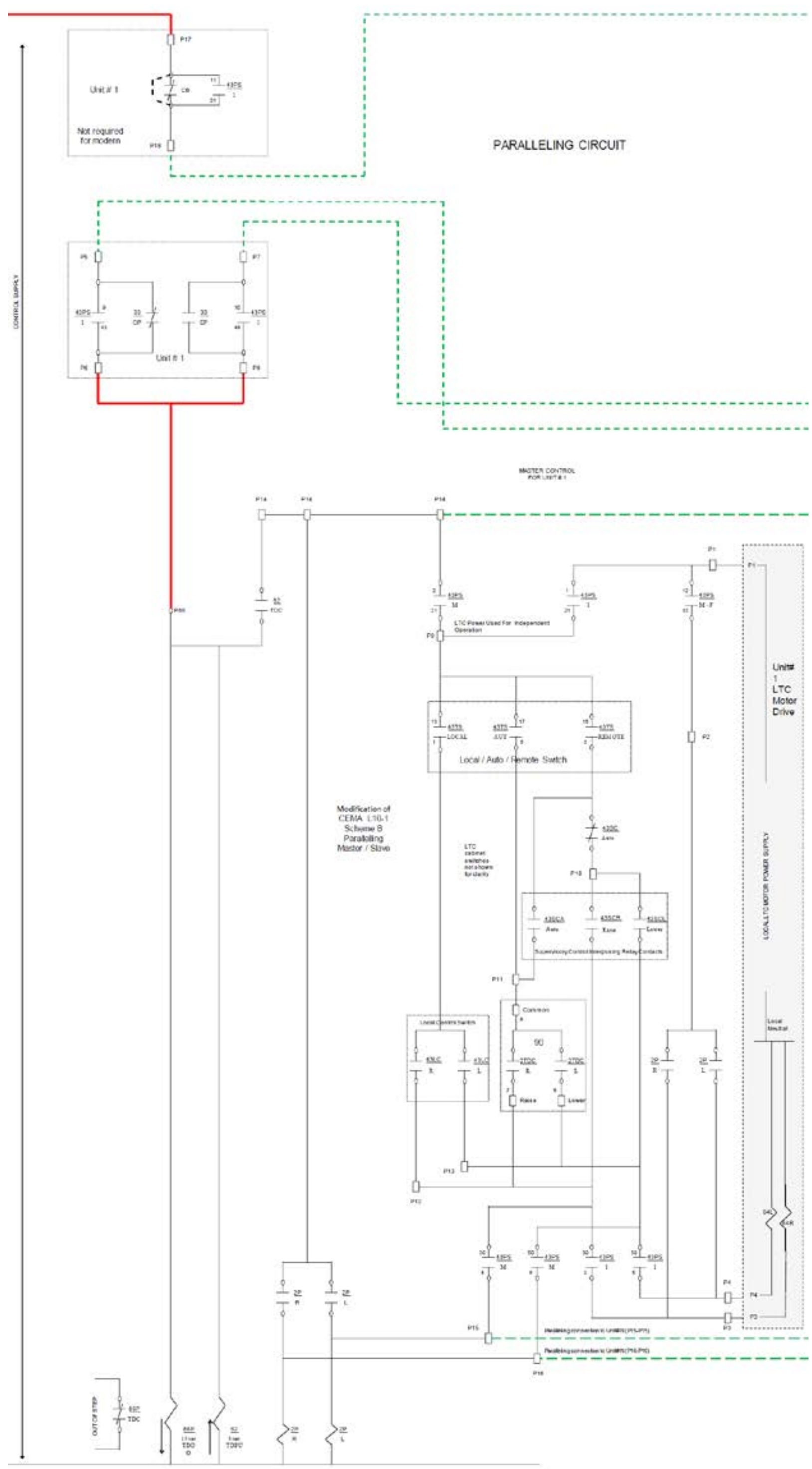
All control components for paralleling shall be supplied. Terminals for the Purchaser's connections shall be provided in the main control cabinet of the transformer.

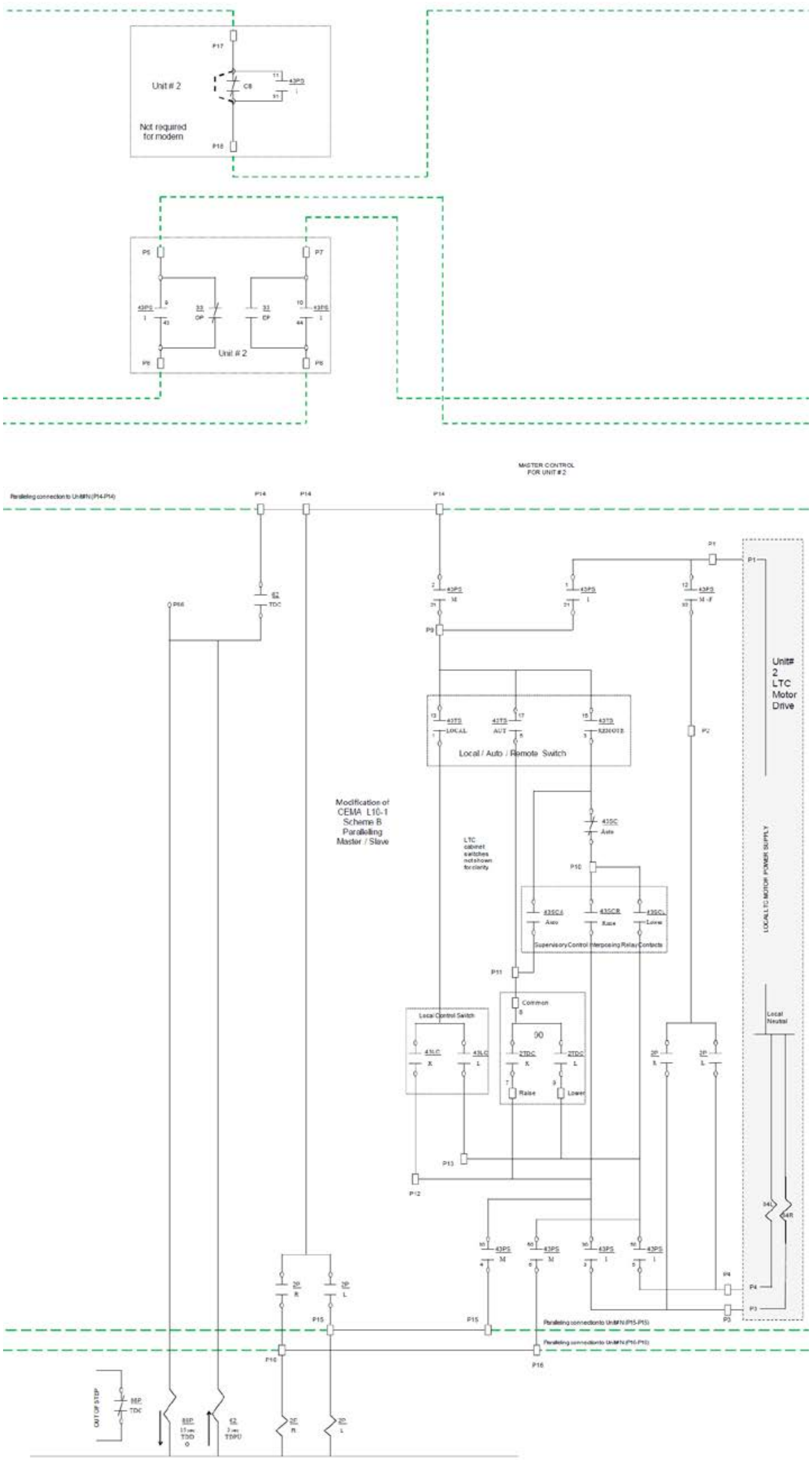
The modification of the EEMAC standard is shown below. Use this layout and numbering scheme to produce the paralleling schematic drawing.

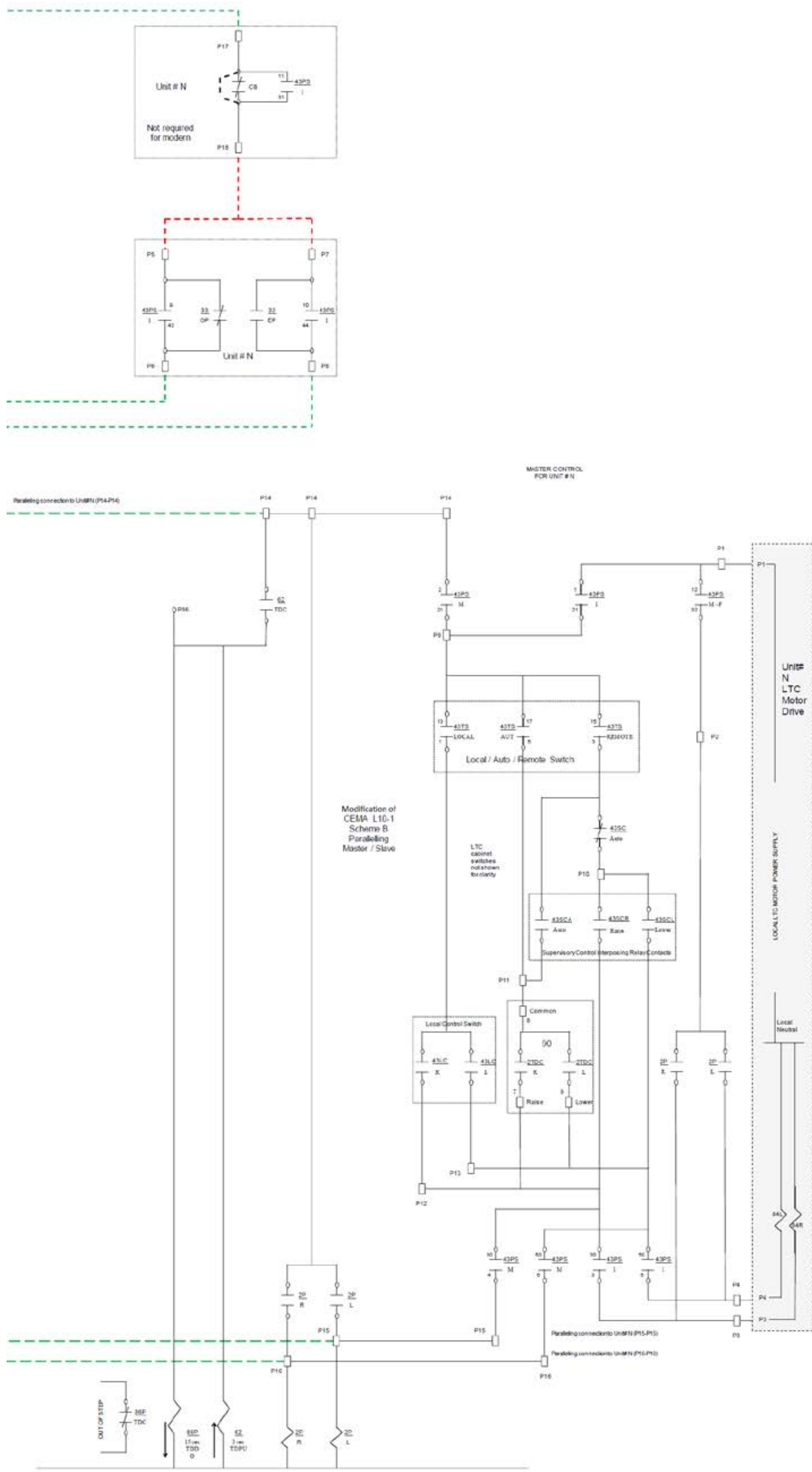
From the EEMAC standard: "In the master control (in-step) method, one unit is selected as a master which forces all units to operate at all times on the same tap position. Should any unit fail to move, the paralleling circuit is interrupted through the odd-even position switches to block further operation and provide an alarm signal. Units of different manufacture can be paralleled regardless of the speed of the tap changers. The paralleling circuit is common for all the units in the paralleled bank. The master-follower-independent switch for each unit can be located in a central control room or in the LTC control cabinet of each transformer. Any unit can be operated independently without changing any wiring. The local motor control power supply can be made different from that of the master control. The LTC motor control circuit should respond to a momentary initiating signal. Also it should have odd-even position switches, and a mechanically operated normally-closed contact if necessary."

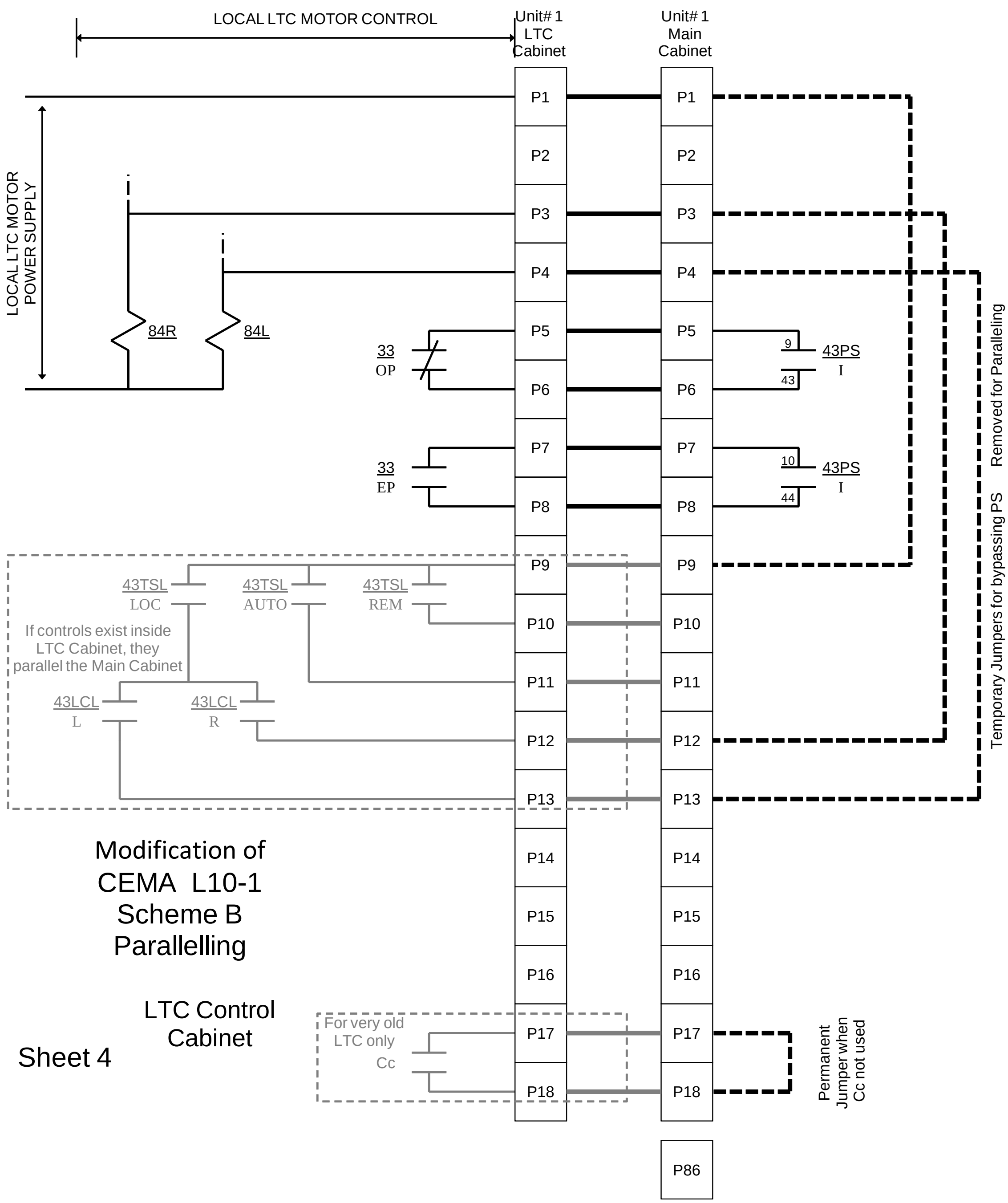
Include two extra contact pairs for connection to the Purchaser's SCADA system. The contacts shall be Master, Master, Master and Follower. These contacts are to be shown in the control schematics and wiring diagrams, and be wired to terminal blocks. They shall be grouped together with the other spare contacts.

Also include two extra contact pairs for each condition, Master, Follower and Independent. These contacts are to be shown in the control schematics and wiring diagrams, and be wired to terminal blocks. They shall be grouped together with the other spare contacts.


PARALLELING CIRCUIT
Local / Auto / Remote Switch
Modification of CEMA L10-1 Scheme B Paralleling Master / Slave
Unit# 1 LTC Motor Drive


Unit # 2
Not required for modem
Unit # 2
MASTER CONTROL FOR UNIT # 2
Unit# 2 LTC Motor Drive
Local / Auto / Remote Switch
Modification of CEMA L10-1 Scheme B Paralleling Master / Slave
Supervisory Control Interposing Relay Contacts
Local Control Switch
Common
Raise
Lower
OUT OF STEP


Unit # N
Not required for modern
Unit # N
MASTER CONTROL FOR UNIT # N
Unit# N LTC Motor Drive
Local / Auto / Remote Switch
Modification of CEMA L10-1 Scheme B Paralleling Master / Slave
LTC cabinet switches not shown for clarity
LOCAL LTC MOTOR POWER SUPPLY
Supervisory Control Interposing Relay Contacts
Local Control Switch
Common
Raise
Lower
Local Neutral
OUT OF STEP


LOCAL LTC MOTOR CONTROL
Unit# 1 LTC Cabinet
Unit# 1 Main Cabinet
LOCAL LTC MOTOR POWER SUPPLY
84R
84L
33 OP
33 EP
43PS I
43PS I
P1 P2 P3 P4 P5 P6 P7 P8 P9 P10 P11 P12 P13 P14 P15 P16 P17 P18
P86
43TSL LOC
43TSL AUTO
43TSL REM
If controls exist inside LTC Cabinet, they parallel the Main Cabinet
43LCL L
43LCL R
Removed for Paralleling
Temporary Jumpers for bypassing PS
For very old LTC only
Cc
Permanent Jumper when Cc not used
Modification of CEMA L10-1 Scheme B Parallelling
LTC Control Cabinet
Sheet 4

CEMA L10-1 Scheme B Parallelling Master / Slave

CONTACT DIAGRAM FOR 43PS
PARALLELING SWITCH {MASTER - FOLLOWER - INDEPENDENT }

CONTACTS 'X' DENOTES CONTACTS CLOSED		POSITIONS: MASTER PARALLEL	OFF	FOLLOWER PARALLEL	OFF	INDEPENDENT
1 — 21 — 2	1 - 21					X
	2 - 21	X				
3 — 30 — 4	3 - 30					X
	4 - 30	X				
5 — 50 — 6	5 - 50					X
	6 - 50	X				
For use by Purchaser's SCADA system 7 — 60 — 8	7 - 60	X				
	8 - 60	X				
For use by Purchaser's SCADA system 9 — 22 — 10	9 - 22	X				
	10 - 22			X		
11 — 31 32 — 12	11 - 31					X
	12 - 32	X		X		
13 — 43 44 — 14	9 - 43					X
	10 - 44					X
Spare A 15 — 65 66 — 16	15 - 65	X				
	16 - 66	X				
Spare B 17 — 23 24 — 18	17 - 23			X		
	18 - 24			X		
Spare C 19 — 39 40 — 20	19 - 39					X
	20 - 40					X

CEMA L10-1 Scheme B Parallelling Master / Slave

CONTACT DIAGRAM FOR 43TS
LOCAL TRANSFER SWITCH { LOCAL - AUTO - REMOTE }

CONTACTS		POSITIONS: LOCAL	AUTO	REMOTE
1 — 13 14 — 2	1 - 13	X		
	2 - 14	X		
3 — 15 16 — 4	3 - 15			X
	4 - 16			X
5 — 17 18 — 6	5 - 17		X	
	6 - 18		X	
Spare A 7 — 19 20 — 8	7 - 19	X		
	8 - 20	X		
Spare B 9 — 21 22 — 10	9 - 21			X
	10 - 22			X
Spare C 11 — 23 24 — 12	11 - 23		X	
	12 - 24		X	

LOC : LOCAL : Local control by manual switching
REM : REMOTE : Remote control from outside of the station
AUTO : AUTOMATIC : Automatic voltage regulation

L : LOWER
R : RAISE

43PS : Paralleling Switch in main cabinet
MASTER - OFF - FOLLOWER - OFF - INDEPENDENT
43TS : Transfer Switch in main cabinet
LOCAL - AUTO - REMOTE
43TSL : Transfer Switch in LTC cabinet
43SCx : Supervisory Control Interposing Relay Contacts supplied by Contractor
43SCA : AUTO
43SCR : RAISE
43SCL : LOWER
43LC : Local Control Switch (momentary) in main cabinet
LOWER - OFF - RAISE
Spring-return to Off
43LCL : Local Control Switch in LTC cabinet
2TDC : Time Delay Closing Contact from Automatic Voltage Regulating Relay (90)
2P : Paralleling Relays
33 : Mechanically Operated Even - Odd Position Contacts on LTC Motor Drive
EP : Contact Closed on Even Positions
OP : Contact Closed on Odd Positions
Cc : Mechanically Operated Contact on LTC Motor Drive,
Closed on Position
Opens during Operation
Required only if the 33's contacts are Overlapping (very old LTC)
Not required for modern LTC with break before make odd/even switches.
62 : Time Delay Relay for Lockout and Completion of Tap Change
Time Delay on Pull-in, and it should be set at approximately 2 seconds
84R & 84L : Raise & Lower LTC Motor Contactors
86 : Time Delay Relay for Out-of-Step Alarm
Time delay on drop-out, and it should be set longer than the time
required for the slowest unit to complete a tap change
90: Beckwith Voltage Regulating relay

Modified EEMAC Master / Follower Paralleling Scheme

34 CONFORMAL COATING

All electronic circuit boards not otherwise encapsulated and protected from moisture, shall have conformal coating applied to their circuit boards. This shall include, but not be limited to

(a) Messko breathers
(b) Digital ammeter
(c) Digital WTI

(d) Voltage regulating relay
(e) GIC monitoring devices
(f) Hydran or other gas analyzer
(g) Fibre-optic temperature sensor instruments
(h) RMV LTC Vacuum Interrupter Module
(i) Electronic relays, timers, controllers, transducers
(j) Any other electronic device with a non-encapsulated circuit board

If conformal coating is not an option available for a particular device, notify the Purchaser.

35 METERING

35.1 Transient Surge Monitoring (TSM)

On all 115 kV, 138 kV or 230 kV to 12.47 kV and/or 24.94 kV transformers, on sites without a building as specified in the Supplementary Technical Requirements, include a 12VDC, 2 Amp power supply which will be used to power a cell phone or modem.

35.2 Ammeters

Transformers rated 16.7 MVA or below, or those without a building as specified in the Supplementary Technical Requirements, shall be equipped with a Power Measurement Limited 7650 ION meter.

For 66 kV transformers and below supply product number:
p7650 b1 c 0 b 6 a0 a 0 a

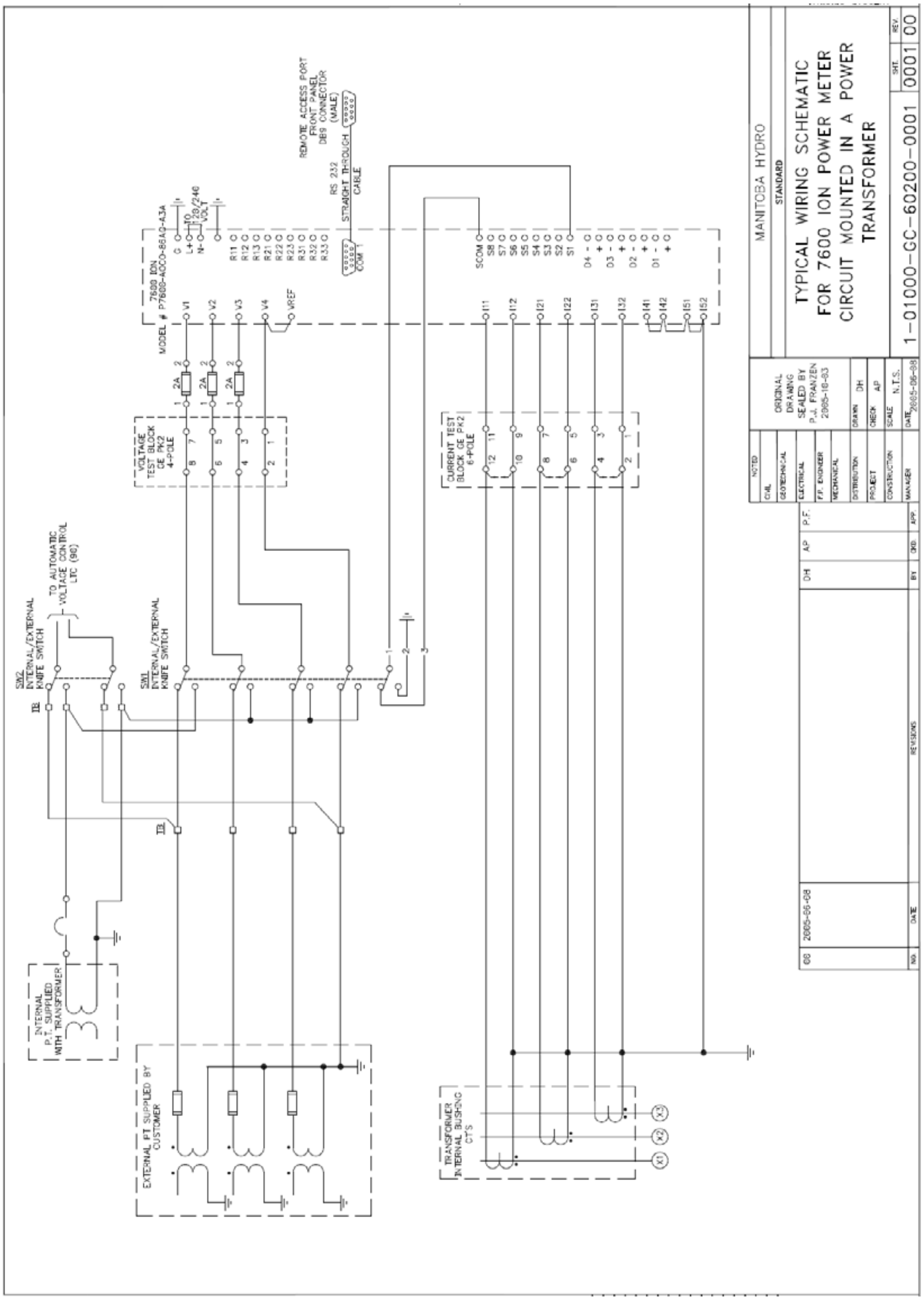
For 115 or 138 kV transformers without a building, supply a similar model but revenue metering approved, product number:
p7650 b1 c 0 b 6 e0 a 1 a

The ION meter shall use the factory default set-up to display instantaneous and peak demand current, voltage and power readings and provide the same quantities through digital serial communication ports for a SCADA interface. It shall use the MODBUS RTU communication protocol and shall be addressable and interconnected on a RS-485 bus.

The ION meter shall be installed inside the main control cabinet. Two current test blocks, 4-pole, shorting, G.E. Type PK or approved equivalent shall be provided between the current inputs (from the bushing current transformers) and the current sensing terminals of the ION meter. On all 115 kV, 138 kV or 230 kV transformers with a building, use the high voltage side metering current transformers if available. Otherwise use the low voltage side metering current transformers.

The Contractor shall supply one single-phase VT if specified elsewhere. The Purchaser may elect to bypass this VT and supply three single-phase VTs to the ION. A non-shorting, 6-pole PK block shall also be provided between the VTs and the voltage sensing terminals of the ION meter. The Contractor's VT always supplies the voltage regulating relay.

Knife switches shall be provided as a visual open point between the voltage inputs (from the VTs on the low voltage side of the transformer) and the voltage sensing terminals of the ION meter. For typical wiring, refer to **Purchaser's Drawing 1-01000-GC-60200-0001**.



35.2.1 Wye-Wye Connected Transformers

The Purchaser specifies these transformers as Yy6, but reconnects them as Yy2 in service. This is done by connecting the transformer LV to the system bus as:

X1 - b
X2 - c

X3 - a

To accommodate this, the metering CTs and VTs connected to the ION ammeter shall be connected as follows:

LV CT	ION Terminal	
Phase 1 non-polarity	I21	
Phase 1 polarity		I22
Phase 2 non-polarity	I31	
Phase 2 polarity		I32
Phase 3 non-polarity	I11	
Phase 3 polarity		I12

VT	ION Terminal
Phase 1 Contractor supplied	V2
Phase 1 Purchaser supplied	V2
Phase 2 Purchaser supplied	V3
Phase 3 Purchaser supplied	V1

Labelling of the control wiring on the control drawings and in the control cabinet shall remain the same as if this was not done. The phase 1 CT stays labelled as phase 1 but connects to the ION's phase 2 input terminal.

36 PRESSURE MONITORS

When specified in the Supplementary Technical Requirements, three (3) Qualitrol Multifunction Pressure Monitors, Model 930, shall be supplied, Qualitrol part number 930-008-01, drawing number CS47763. The pressure monitor systems shall monitor the transformer tank for slow pressure accumulation and fast pressure rise. The sensors shall be mounted:

(a) one on the HV side opposite Leg 2,
(b) one on the LV side opposite Leg 2, and
(c) one on the cover with its location chosen judiciously.

The two wall sensors should be placed near the magnetic centreline of the coils. The cover sensor position shall avoid manholes and handholes but be as close as practical to the centre of the cover. The locations are subject to the Purchaser's approval on the outline drawing.

The pressure sensors shall be mounted on 1" flanged ball valves with ¼" 18 NPT adapters. The flanged valves shall contain a Schrader valve or equivalent on the outlet side of the flanged valve, to allow for testing of the sensor by closing the main valve and injecting pressure into the Schrader valve. The ball valve shall allow for the removal and replacement of the transducer. The ball valves shall be as close as practically possible to the tank, to provide a quick response of any pressure wave from within the tank. This entire assembly must be protected by a weather-resistant cover box to prevent being damaged or tripped over as well as protected from rain and snow.

The pressure transducer ball valve handle should interfere with the closing of the protective box cover when the handle is in the closed position. Only when the ball valve handle is in the open position will the cover from the enclosure be able to be mounted and closed.

The pressure monitor systems shall be wired to provide a slow pressure alarm at 7.5 psi, a fail-safe power status alarm and a fast pressure trip. Each alarm and trip contact shall be terminated individually in the control cabinet.

The Pressure Monitors shall be mounted on a swing panel in the control cabinet. This will trip the breaker on fast pressure rise. The K2 relay shall be jumpered J5 (1, 2) to provide an auxiliary trip signal on fast pressure rise. These relays shall be sealed-in upon activation. The slow pressure rise shall be an alarm. The 4-20 mA output (0 to 30 psig) shall be wired out for use by the Purchaser. When a Qualitrol 509 ITM is supplied, the 4-20 mA shall be wired to it.

The slow pressure alarm setting is chosen based on the oil head pressure and the setting of the mechanical pressure relief device.

$$\text{Cover Sensor Alarm Point} = \frac{25°\text{C Oil head at cover} + \text{PRD operation point}}{2}$$

$$\begin{aligned}\text{Wall Sensor Alarm Point} = {} & \text{Cover Sensor Alarm Point} \\ & + \text{Oil Head Difference between cover and wall position}\end{aligned}$$

The power supply shall be DC.

37 GE HYDRAN M2

The GE Hydran M2 Fault Gas and Moisture Monitor system is required for all GSU transformers, transformers with GIC detection or when requested in the Supplementary Technical Requirements.

37.1 Options

Include the following optional features:

(a) One (1) 4-20mA isolated input;
(b) Three (3) 4-20mA isolated outputs;
(c) Five (5) dry output contacts for alarming,

37.2 Installation

Install as specified in section 17.10 GE Syprotec Hydran Bypass. The Syprotec Hydran M2 System shall be located on the lower header so that is easily accessible for maintenance and viewing. The M2 Hydran supply voltage is 120 Vac. The Contractor shall provide a dedicated branch circuit to supply the GE Hydran M2 monitor. The Contractor shall design the supply system within the cabinet to account for the Hydran load.

Each analog input/output, alarm contact and communication cable shall be terminated in the control cabinet.

The top oil temperature is fed from the Qualitrol 509 ITM to the 4-20 mA input. One gas level 4-20 mA output is fed to the APT Eclipse (clause 40). The other two 4-20 mA outputs are fed to the Qualitrol 509 ITM as gas level and moisture level.

37.3 Settings

37.3.1 Page 1:

Gas level to 100 ppm.
Alarm delay to zero value.
Hourly trend alarm Hi at 30 ppm.

Hourly Trend Alarm Hi-Hi set to value of 70 ppm. but leave the box unchecked or “OFF”. The value of 70 ppm. is chosen to prevent triggering the alarm accidentally by checking the box to “ON”.

Hourly Trend Alarm Delay set to zero % of the period.
Daily Trend Alarm Hi to 60 ppm. and check the box to “ON”.

Daily Trend Alarm Hi-Hi to twice the value of Hi alarm and check the box to “ON”.

Sensor temperature alarm Lo-Lo to 5ºC and check the box to

For GSU Transformers	For All Others
“OFF”	“ON”

Sensor temperature alarm Lo to 15ºC and check the box to

For GSU Transformers	For All Others
“ON”	“OFF”

Sensor temperature alarm Hi to 65ºC and check the box to “ON”.
Sensor temperature alarm Hi-Hi to 75ºC and check the box to “OFF”.
Sensor temperature alarm delay to 30 minutes.

37.3.2 Page 2:

Temperature Set Point to 35ºC.
Set Point Span to 10ºC.
Set Period A to 120 minutes.
Set Period B to 24 Hours.
The boxes shall be "OFF" for all other settings on Page 2.

37.3.3 Base Plate Temperature Alarm: Sensor# 1 Alarm Setup

Lo Alarm	15ºC.
Hi Alarm	85ºC.
Alarm Delay	30 minutes.

37.3.4 Low Battery Alarm

Alarm Low-Low to 2.45 V.
Alarm Low to 2.75 V.
Delay to 50 hours.

38 WINDING AND OIL TEMPERATURE INDICATORS

Power transformers and shunt reactors shall have a winding temperature indicator (WTI). All power transformers, shunt reactors and grounding transformers shall have an oil temperature indicator (OTI).

38.1 Quantity

A WTI shall be provided for each loaded secondary winding rated 1.0 MVA or greater.

For 3 phase transformers, only one of the three phases requires a WTI unless otherwise specified in the Supplementary Technical Requirements.

For three circuit transformers with the tertiary winding loaded and for four and six-circuit transformers, a WTI shall be provided for each loaded circuit.

Only one OTI is required for each transformer.

38.2 Contacts

The WTI shall be provided with contacts that perform the following functions:

(a)

For HVDC Station	For All Others
Start the transformer cooling fans of each cooler in three stages. The three stages shall be set at 30°C, 40°C and 50°C and these three contacts shall be in the non-fail safe mode.	Start the transformer cooling fans or pumps as required to conform to transformer rating;

(b) close an alarm contact when the winding temperature reaches 105ºC (re-open at 95 to 100 ºC); and

(c) close a breaker tripping contact when the winding temperature reaches 120ºC (re-open at 110 to 115 ºC).

The OTI shall be provided with two (2) alarm contacts. For power transformers and grounding transformers, the first alarm shall close at 90°C and re-open at 80 to 85°C. For shunt reactors, the the first alarm shall close at 95°C and re-open at 85 to 90°C. The second alarm will be set 10°C higher for future use.

38.3 Thermal Well

The thermal well shall be located in the top oil of the transformer and on a side or end wall. It shall not be located on the cover because this prevents maintenance while the transformer energised. If the hotspot is not located at the top oil, the location shall be suggested by the Contractor for approval by the Purchaser.

The well shall be Qualitrol type Thermal Plate 2WTL (or approved equivalent) which comes with two heaters, one of which may be ignored. The well shall be mounted horizontally and not on an angle, to prevent the risk of water collection.

The unused well(s) shall be plugged with brass plugs, Qualitrol PN 167-50-29F CS-31450. Both analogue and electronic indicators will normally use two of the three wells.

If the manufacturer installs additional wells for testing, these wells must be removed and plugged after test.

38.4 Re-Connectable Windings

If the WTI is part of the circuit containing re-connectable windings, the control drawings shall show the WTI CT connections for both configurations.

38.5 Analogue Indicators

Dial-type indicators shall be provided with a dial and shall include a heating element either in the well or in the gauge, energised from a current transformer.

38.5.1 Model

Winding and oil temperature indicators shall be provided if not otherwise specified in the Supplementary Technical Requirements. Analogue or mechanical gauge shall be AKM AB Kihlstroms Manometerfabrik (Qualitrol), or approved equivalent.

1) Initial Selection	**35Gen2 WTI**	**34/Gen2 OTI**
2) Measurement	06 (0 - 160°C)	05 (-20 ,+130)
3) Switch Selection		
Quantity	4	2
Type	SPDT MBO	
Adjustable	None	
Differential		
Differential	6 +/- 1°C	
4) Temperature sensing		
Probe	16	
Capilliary	7/8” - 14 UNF Male	
5) Input / Output		
Cable entry	G3/4 Adapter / M20 Gland	
Remote Output	TD111 - 4-20 mA	
6) Environment		
Protection Class	IP56 - Jetted Hose Water	
Lens Material	Tempered Glass	
Case Finish	Munsell 5Y7/1 Powder Coat	
Mounting	Standard	
7) Notes:		
Polar version for -50°C ambient temperature operation		
NO switches		
If available, the OTI range should be -30 to +110 or +120°C		

Note that the internal AKM WTI resistor is limited to 2.3 Amps continuous, and 10 Amps for five seconds. When considering the required overloading capability of the transformer, this means that the internal resistor is not useable for some applications. In those cases, a separate external resistor will be needed for the heater coil.

For transformers with three or four loaded circuits, three WTI are required.

38.5.2 Mounting

The winding and oil temperature indicators shall be mounted such that transformer vibration will not cause inadvertent motion or inadequate operation.

The indicator shall be clearly visible and accessible from the ground but shall be mounted no lower than the bottom of the main control cabinet. It shall not be mounted on the top of the control cabinet.

38.5.3 Calibration

An adjustable resistor shall be provided to adjust the winding temperature indicator well temperature to compensate for the winding hotspot gradient. A separate means shall be provided for calibration of the above winding temperature equipment and associated current transformer(s).

Winding temperature indicator shall be calibrated to the maximum MVA rating of the transformer. On all units, an information plate with a complete description of the steps involved in setting the WTI gauge shall be provided. In addition to the step by step description, the information plate shall include all the calibration information such as the winding hotspot gradient, injecting current into the WTI circuit and the voltage that appears across the heating element for the winding temperature indicator well. The information plate shall be provided adjacent to the adjustable resistor in the WTI circuit. A WTI calibration data sheet must be included in the transformer test report.

Sample WTI Nameplate for Analogue Indicator

WTI SETTINGS FROM TEST REPORT

TESTED AVERAGE GRADIENT:	15.8 °C
HOTPOT MULTIPLIER:	1.21
HOTSPOT GRADIENT:	15.8 x 1.21 = 19.1
INJECTION CURRENT:	1.8 A
RESISTOR VOLTAGE:	900 mV

TO CALIBRATE:

- OPEN SWITCH X
- CONNECT VOLTMETER ACROSS RESISTOR R
- SUPPLY INJECTION CURRENT AT T1—T2
- ADJUST R TO OBTAIN VOLTAGE ACROSS RESISTOR
  (AT CONSTANT SUPPLY CURRENT)
- OBSERVE WTI TEMPERATURE
  (IT WILL RISE BY HOTSPOT GRADIENT)
- READJUST R IF NECESSARY
  (HIGHER RESISTANCE = HIGHER TEMPERATURE)

A heater coil calibration curve shall be provided in the test report and in the Instruction Manuals.

38.6 Electronic Indicators

38.6.1 Model

An electronic winding temperature indicator shall be provided if specified in the Supplementary Technical Requirements. The model is specified in the Supplementary Technical Requirements. If no specific make and model is listed, it shall be the Qualitrol 509 Intelligent Transformer Monitor (ITM).

Arrangement of the inputs and outputs are to be arranged logically and are subject to approval during the Design Review.

For transformers specified with fibre-optic sensors, these sensors may be fed either to the ITM or to a T/Guard instrument, as specified in the Supplementary Technical Requirements. If fed to an ITM, order the ITM 509-DW (Direct Winding) system as described in the Supplementary Technical Requirements. Further details can be found in clause 39 FIBRE-OPTIC TEMPERATURE PROBES.

Power supply shall be DC for stations with a building.

For GSU Transformers	For All Others
Per Supplementary Requirements	Per Supplementary Requirements

For HVDC Station	
Per Supplementary Requirements: The Contractor shall supply two panel mount electronic temperature monitors as follows: Electronic temperature monitor A (ETM/A) – Qualitrol Series 509-DW (Direct Winding), Part Number ITM 509-00050984 (Main Tank Oil Level) and Electronic temperature monitor B (ETM/B) - Qualitrol Series 509-DW (Direct Winding), Part Number ITM 509-00050985 (Tap changer Oil Level).	

38.6.2 Mounting

The indicator shall be mounted such that transformer vibration will not cause inadvertent motion or inadequate operation.

For HVDC Station	For All Others
The indicator shall be mounted in its own cabinet as described in 38.6.3 ITM Cabinet HVDC Station .	The indicator shall be mounted on a swing panel, at eye level or lower in the main control cabinet. The cabinet door shall have a cut-out with a glass or UV resistant polycarbonate plate, adjacent to the indicator, so that it may be viewed without opening the cabinet door.

38.6.3 ITM Cabinet HVDC Station only

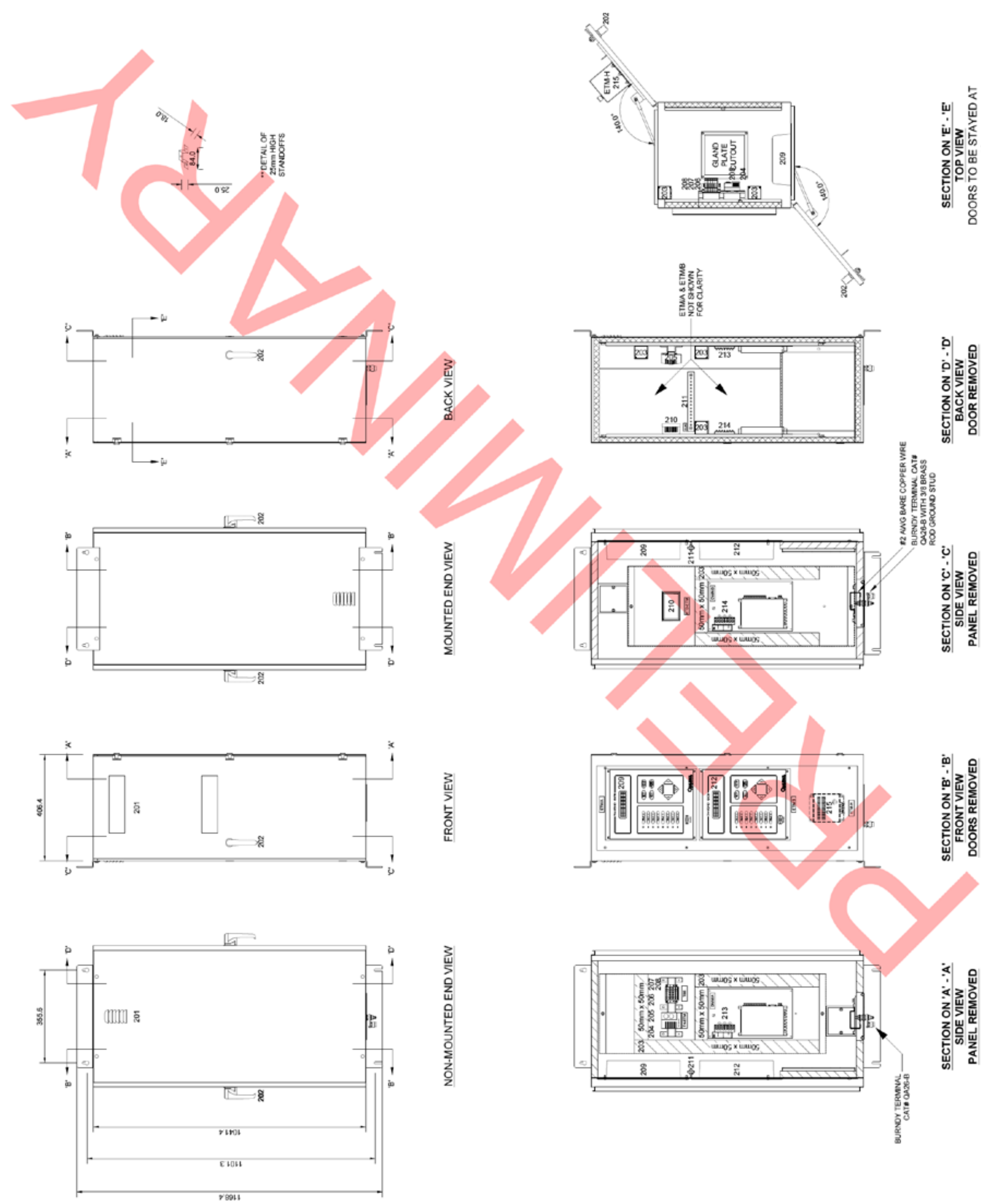
The two ETMs shall be mounted in a separate stand alone control cabinet (NEMA 4 enclosure) on anti vibration mounts to the side of the transformer main control cabinet. The bottom of the ETM cabinet shall be 600 mm to 750 mm above the bottom of the main control cabinet.

The ETM cabinet shall be supplied by Inventronics part number 309008-2.

The ETM cabinet shall be provided with the following:

Hoffman heater - part # DAH2001A ;
Stego hygrotherm ETF 012 - part # 01230-00 ;
6 Entrelec M6/8 RS screw clamp spring terminal blocks.

A nameplate shall be installed inside the fibre optic enclosure which identifies the fibre optic manufacturer, each probe’s location and the corresponding terminal. (e.g. Probe # 1 - H2 coil, Probe # 2 - H2 oil duct, Probe # 3 - top oil). The test report and instruction manual shall contain a drawing of this nameplate and a drawing showing the location of the installed probes.


BACK VIEW
MOUNTED END VIEW
FRONT VIEW
NON-MOUNTED END VIEW
SECTION ON 'E' - 'E'
TOP VIEW
DOORS TO BE STAYED AT 140°
SECTION ON 'D' - 'D'
BACK VIEW
DOOR REMOVED
SECTION ON 'C' - 'C'
SIDE VIEW
PANEL REMOVED
SECTION ON 'B' - 'B'
FRONT VIEW
DOORS REMOVED
SECTION ON 'A' - 'A'
SIDE VIEW
PANEL REMOVED
ETMA & ETMB NOT SHOWN FOR CLARITY
GLAND PLATE CUTOUT
DETAIL OF 25mm HIGH STANDOFFS
#2 AWG BARE COPPER WIRE
BURNDY TERMINAL CAT# QA26-B WITH 3/8 BRASS ROD GROUND STUD
BURNDY TERMINAL CAT# QA26-B
PRELIMINARY

FABRICATION

1. ETM CABINET TO BE SUPPLIED FROM INVENTRONICS.

TERMINALS

1. ALL TERMINALS TO BE FITTED WITH FUNCTION LABELS AND DECAFIX MARKERS.
2. HIGH VOLTAGE TERMINALS TO BE SHROUDED AND FITTED WITH WARNING LABELS.
3. TERMINALS TO BE FITTED WITH CROSS CONNECTOR AND CT SHORTING LINKS WHERE SHOWN ON TERMINATION DIAGRAM.

GENERAL CONDITIONS

MIN/AVERAGE/MAX AMBIENT TEMPERATURES: -50°C/+30°C/+40°C. TO BE SUITABLE FOR AN OPERATIVE LIFE OF 30 YEARS. SNOW LOADING IN ACCORDANCE WITH NATIONAL BUILDING CODE OF CANADA. TO BE THERMALLY INSULATED FOR USE AT TEMPERATURES DOWN TO -50°C USING INSULATION

WEIGHT APPROX 56.7kg KIOSK FOR OUTDOOR USE AND FOR TANK MOUNTING WITH THE USE OF ANTI-VIBRATION MOUNTS.

CONSTRUCTION TO ESI 50-18 ISSUE 2. WELDED SHEET STEEL CONSTRUCTION GIVING PROTECTION TO IP55 OF IEC947-1. STEEL TO BE SUITABLE FOR USE AT TEMPERATURES DOWN TO -50°C.

PAINT SPECIFICATION AS FOLLOWS :
SWEEP BLAST ; TWO PACK EPOXY PRIME WHITE.
COLOR: EQUIPMENT GREEN MUNSELL 9GY 1.5 / 2.6.
INSIDE PANELS - GLOSS WHITE. ; INSIDE CASE - ANTI-CONDENSATION WHITE.
FINISH TO BE SUITABLE FOR 10 YEARS MAINTENANCE FREE.
ALL EXTERNAL FIXINGS INCLUDING HINGES AND STUDS TO BE OF STAINLESS STEEL.

ALL WIRING SHALL BE VW-1 FLAME RETARDANT TYPE "SIS"

CASE AND DOORS 2mm THICK MILD STEEL. ; MOUNTING AND GLAND PLATES 3mm THICK MILD STEEL.
ALL EXTERNAL SEAMS TO BE FULLY WELDED. , DOORS TO BE CAPABLE OF LIFTING OFF.
DOORS TO BE CAPABLE OF LIFTING OFF. ; LOWER HINGE PIN TO LOCATE BEFORE UPPER HINGE PIN.
DOORS TO BE PADLOCKABLE WITH 9.6mm DIAMETER SHACKLE PADLOCK.
INNER SWING FRAMES TO BE PADLOCKABLE WITH 6mm DIAMETER SHACKLE PADLOCK.
ALL DOORS TO BE FITTED WITH 8mm DIAMETER STOPS WHEN OPEN TO 140°USING HOOK AND EYE ARRANGEMENT.

LABELS

ALL LABELS ARE TO BE MADE FROM TRAFFOLYTE.
LABEL SIZES ARE AS DRAWN. LABELS ARE WHITE PRINT ON BLACK BACKGROUND.
OUTDOOR LABELS TO BE OF 2mm STAINLESS STEEL WHITE ON BLACK FINISH. EXCEPT FOR WARNING LABELS WHICH ARE TO BE BLACK ON YELLOW.

	LABEL INSCRIPTION : LABEL DESCRIPTION
201	
202	
203	
204	
205	TH-ETM: HYGROTHERM FOR ETM-H
206	TBE: TERMINAL BLOCK DESIGNATION
207	
208	
209	ETM/A : ELECTRONIC TEMPERATURE MONITOR 'A'
210	RTD-ETM : RTD FOR ETM CABINET
211	
212	ETM/B : ELECTRONIC TEMPERATURE MONITOR 'B'
213	DWM/A : DIRECT WINDING MODULE 'A' FOR MEASURING WINDING HOTSPOTS VIA FIBRE OPTIC
214	DWM/B : DIRECT WINDING MODULE 'B' FOR MEASURING WINDING HOTSPOTS VIA FIBRE OPTIC
215	ETM-H : HEATER FOR ETM CABINET

38.6.4 Additional RTD

An additional three-lead type hot spot resistance temperature detector shall be provided (100 ohms at 0ºC), Qualitrol Part No. 103-059-02 CS-41840 (This is a special part number for Manitoba Hydro), in its own thermal well for recording the transformer's hot-spot winding temperature by other means on the Purchaser's equipment.

RTDs shall be protected by a suitable enclosure to avoid damage. The enclosure shall allow for easy access, with a maximum of four (4) fasteners, to remove and validate the RTD on a periodic basis.

38.6.5 Ambient Temperature Well

If an ambient temperature RTD sensor is specified, it shall be protected by an enclosed five-sided enclosure from sun, wind and physical damage. The Qualitrol 103-054-01 ambient temperature 100 ohm RTD is acceptable.

38.6.6 Calibration

Winding temperature indicator shall be calibrated to the maximum MVA rating of the transformer. On all units, an information plate with a complete description of the steps involved in setting the WTI gauge shall be provided. In addition to the step by step description, the information plate shall include all the calibration information such as the winding hotspot gradient, injecting current into the WTI circuit and the voltage that appears across the transducer. The information plate shall be provided in the cabinet. A WTI calibration data sheet must be included in the transformer test report.

Sample WTI Nameplate for Electronic Indicator

WTI SETTINGS FROM TEST REPORT

TESTED AVERAGE GRADIENT:	15.8 °C
HOTPOT MULTIPLIER:	1.21
HOTSPOT GRADIENT:	15.8 x 1.21 = 19.1
INJECTION CURRENT:	4.8 A
TRANSDUCER VOLTAGE:	1600 mV

TO CHECK CALIBRATION:

- OPEN SWITCH X
- CONNECT VOLTMETER TRANSDUCER T
- SUPPLY INJECTION CURRENT AT T1—T2
- ADJUST CURRENT TO OBTAIN VOLTAGE ACROSS TRANSDUCER (AT CONSTANT SUPPLY CURRENT)
- OBSERVE WTI TEMPERATURE (IT WILL RISE BY HOTSPOT GRADIENT)

REFER TO ELECTRONIC GAUGE MANUAL FOR CALIBRATION INSTRUCTIONS

38.6.7 Thermal Well: Provision for Conversion to Analogue Indicator

The thermal wells and the main control cabinet shall be designed for provision to convert the oil and winding temperature indicators to an analogue type as described in the above section 38.3 Thermal Well on analogue indicators.

The well shall be Qualitrol type Thermal Plate 2WTL (or approved equivalent) which comes with two heaters, one of which may be ignored.

The WTI CT(s) shall also be sized to allow for its use with a heater coil. The Purchaser would supply the gauges, leads and well materials.

39 FIBRE-OPTIC TEMPERATURE PROBES

If required, these will be stipulated in the Supplementary Technical Requirements.

39.1 Type

Probes, connectors, tank-wall feed-throughs, fibre-optic cables and read-out instruments are to be supplied by the following supplier (or approved equivalent) unless stated otherwise in the Supplementary Technical Requirements:

Neoptix Inc. (now owned by Qualitrol)
1415 Charest Boulevard Ouest
Suite 220
Quebec City, Quebec G1N 4N7

Canada
Telephone: (418) 687-2500
FAX: (418) 687-2524
http://www.neoptix.com

39.2 Read out Instruments

Read-out instruments are only required if requested in the Supplementary Technical Requirements. Supply one of the three options below, as specified in the Supplementary Technical Requirements.

39.2.1 Option 1: Qualitrol T/Guard 408XT

Unless otherwise specified, the read-out instrument shall be the T/Guard 408XT (latest version) Fibre Optic Thermometer System with 16 sensor inputs. It shall be configured with the following options:

408XT-16-SP1-EP1-M2
16 channel
DNP 3
IEC 61850 & DNP 3

Also supply:
RS485 to RS-232 converter;
RS-485 to USB converter, Neoptix part number NXP-349, or equivalent;
RJ45 network cable for connection to a laptop.
These accessories shall be stored in the control cabinet.

39.2.2 Option 2: Qualitrol T/Guard2

If specified in the Supplementary Technical Requirements, the read-out instrument shall be the T/Guard2 (latest version) Fibre Optic Thermometer System with 8 sensor inputs. It shall be configured with the following options:

TG2-8-A1-C244-Rx where x is the output relay cable length
8 channel
0-10 Volt analogue outputs
RS-485
DNP 3 & MODBUS
IEC 61850 & DNP 3

The 1 GB data-logging, SD card shall be supplied.

In lieu of the DIN rail power supply, supply the tabletop version, Neoptix part number TGP-TP. Alternatively, supply a 24 VDC, 2 Amp power supply, wired to the T/Guard.

Also supply:

RS485 to RS-232 converter;
RS-485 to USB converter, Neoptix part number NXP-349, or equivalent;

These accessories shall be stored in the control cabinet.

39.2.3 Option 3: Qualitrol ITM 509 DW

The ITM 509 DW is an electronic winding temperature indicator with additional input modules for fibre-optic sensors. Depending on the number of fibre-optic cables, either one or two ITM and one or two Fibre-Optic Panels, part no. PNL-658-3 will be required. See section 38 WINDING AND OIL TEMPERATURE INDICATOR for additional details.

39.3 Fibre-Optic Cable

The fibre-optic cable shall have a double Teflon spiral-wrap jacket.
Supply T2S-xx-yy-1 Fibre-optic temperature probes.

Typically, approximately sixteen (16) probes are installed. The actual quantity is specified in the Supplementary Technical Requirements. This may include probes to determine the winding hotspots, the top oil temperature, the internal core temperature and lead temperatures. Some probes may be used for redundancy. The exact locations shall be agreed upon after the award of the Purchase Order(s), probably at the time of Design Review.

39.4 Optical Feedthroughs

Supply the following for feeding the fibre through the tank wall:

Tank wall plate and junction box (Jbox) for the appropriate number of feedthroughs up to n=16, Neoptix part number TWP-n-M0-D12-F0-J1;
Optical Feedthroughs, Neoptix part number OFT-1, one for each fibre;
Fiber Optic Extension Cable Bundle, between feedthroughs and instrument, Neoptix part number BXT-Y-XXX.

39.5 Mounting

39.5.1 T/Guard 2 or 408 Systems

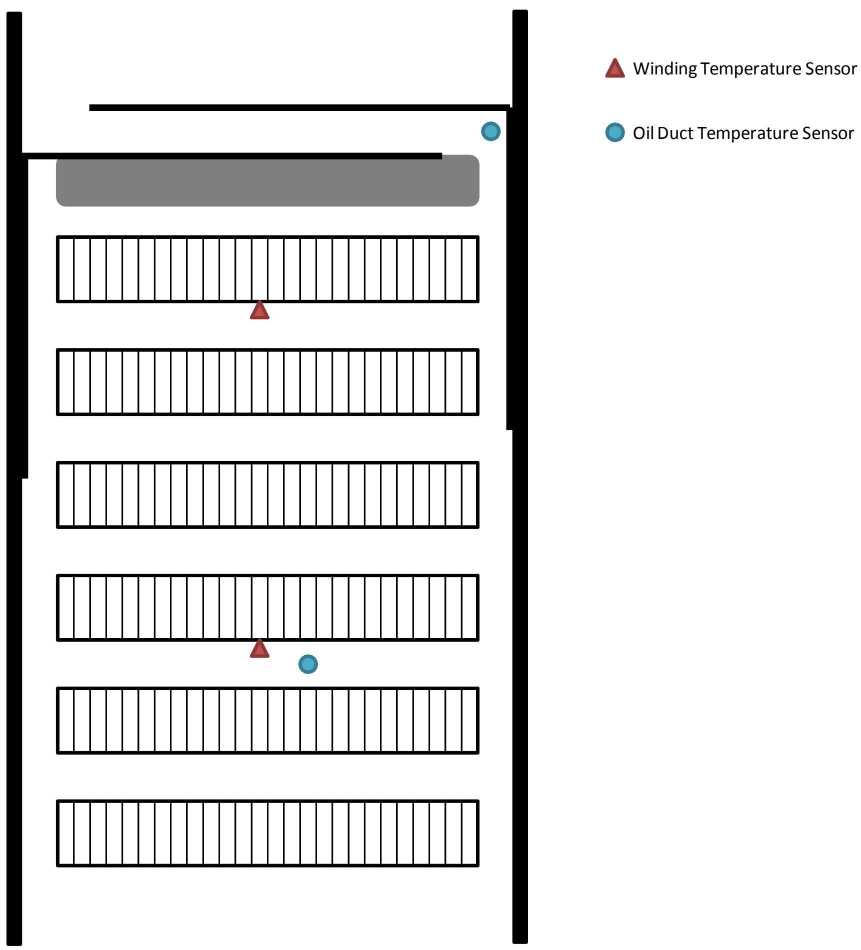
These devices shall be mounted on the rear wall of the main control cabinet. The fibres shall be protected from being damaged.

39.5.2 ITM 509 DW

When supplying dual ITM 509 DW as specified in the Supplementary Technical Requirements, a separate cabinet shall be supplied for the fibre-optic readout instrument. It shall be mounted beside, or on the side of, the main control cabinet. Separate conduit shall be supplied for the exclusive use of the fibre-optic cables, routed between the junction box and this fibre-optic cabinet.

39.5.3 Coil Oil Duct Sensor Placement

Oil duct sensors placed at the top of the coil shall be on the vertical oil exit point after all of the oil flow has summed together. This may be adjacent to the stress ring or flanged collar as shown below.



Typical Oil Duct Sensor Placement

39.6 Routing

Optical fibres shall be routed inside the tank such that they will not be exposed to damage by personnel who are working in the tank. All excess fibre shall be neatly coiled, supported and protected from movement and damage.

External fibre shall be routed in conduit separate from all other wiring.

39.7 SCADA

A connection back to the main transformer control cabinet shall be provided for connecting the read-out instrument to the Purchaser's on-line SCADA monitoring system. This is required so that there is no need for the Purchaser to run conduit to the fibre-optic cabinet. Depending upon the instrument provided, this may be either RS-485 or RJ45 cable. For sites with a building, a RS-485 or RJ45 analogue to fibre converter will also be required.

39.8 Nameplate

A nameplate shall be installed in the control cabinet adjacent to the fibre-optic terminals which identifies each probe's location (e.g. H2 coil, H2 oil duct, top oil). The test report and Instruction Manuals shall contain a drawing of this nameplate and a sketch showing the location of the installed probes.

40 GIC MONITORING

If specified in the Supplementary Technical Requirements, Geo-magnetically Induced Currents (GIC) shall be measured and monitored.

Power supplies for this equipment shall be DC when practical.

The monitoring system will:

(a) Notify supervisory control that an event is occurring
(b) Indicate the magnitude of the event;
  i) dc current
  ii) 2nd and 5th harmonic content
  iii) internal temperatures
  iv) hydrogen gas production rate
(c) Log events capturing these quantities

40.2 APT Eclipse

Supply an Advanced Power Technologies Eclipse complete with HECT Hall effect transducer mounted on the neutral terminal.

Eclipse - 041Y
- panel mount
- 4 analogue outputs
- DNP3 & fibre ST connection
- 24 digital inputs
- 2 analogue inputs 2 High-speed CT
- GIC detection (1 High-speed HECT is included with the Eclipse)

Supply one (1) additional Eclipse HECT-002 Hall effect transducer with solid core, interface and mounting kit. The HECT CTs shall be placed on the external

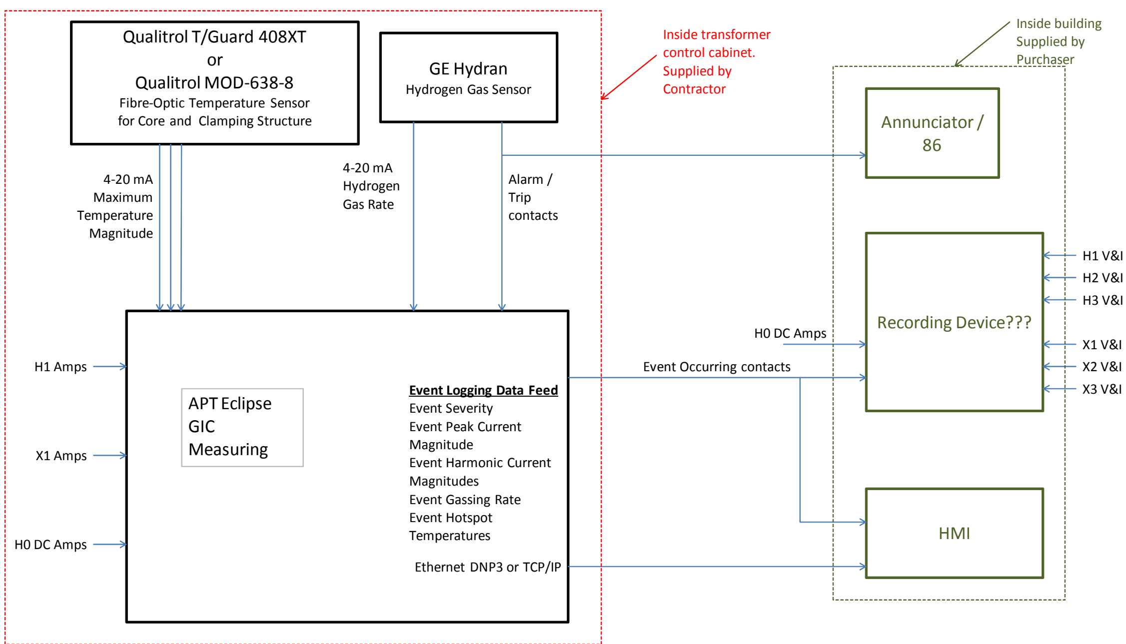
4” H0 busbar. The second HECT shall be used to interface with a waveform recorder supplied by the Purchaser. The Contractor shall wire this second HECT to the main transformer cabinet terminal blocks.

For power transformers, high-speed CTs shall be looped around the leads of the H1 and X1 metering CTs.

For shunt reactors, high-speed CTs shall be looped around the leads of the H1 and H2 metering CTs (or H01 and H02).

The high-speed CTs shall use multiple primary turns to improve their accuracy.

The Eclipse will be the main communicating device to the station, with the Qualitrol T/Guard and GE Hydran communicating to the Eclipse through its analogue and digital inputs.



Analogue inputs shall be used with shunting resistor (as per APT Application Note 25) for (4) four 4-20 mA outputs:
(a) Three (3) from the Qualitrol T/Guard 408XT, for recording temperature;
(b) One (1) from the Hydran for hydrogen gas production rate.

Digital inputs shall be used for digital outputs from the Qualitrol T/Guard 408XT to indicate clamping structure overheating.

While the Eclipse is designed for winding temperature indication, the Purchaser is not using it for that function.

40.3 Qualitrol T/Guard 408XT

The GIC monitoring shall also include eight (8) fibre-optic sensors and a Qualitrol T/Guard 408XT, model 408XT-08-SP1-EP1-M4 with 8 channels, IEC 61850 & DNP 3 serial and ethernet protocols and 4 GB memory.

Also supply:

RS485 to USB converter, Neoptix part number NXP-318, or equivalent;
RS-232 extension cable, Neoptix part number NXP-304, or equivalent;
Two (2) metre USB extension cord;
RJ45 network cable for connection to a laptop.

The remainder of the fibre-optic requirements are described in clause 39 FIBRE-OPTIC TEMPERATURE PROBES. These sensors shall monitor the core and clamping structure temperatures during a geomagnetic event. Their locations shall be chosen during the design review process. Typical locations are on the core, tie-plates, and clamps but may also include the tank.

For transformers already provided with a Qualitrol 509 ITM and sixteen (16) fibre-optic sensors using two (2) Qualitrol MOD-638-8, the Qualitrol T/Guard 408XT is not required. Instead, use the relevant analogue 4-20 mA outputs from the Qualitrol MOD-638-8 to feed the Eclipse. The MOD-638-8 is capable of using both its communications port to communicate with the Qualitrol 509 and the analogue outputs to communicate with the Eclipse at the same time.

40.4 Hydran

A GE Syprotec Hydran M2 Fault Gas and Moisture Monitor system shall be included as specified in clause 37 GE HYDRAN.

For transformers already provided with a GE Hydran, whether connected to a Qualitrol 509 ITM or not, a separate Hydran is not required for this GIC application. Instead use one of the three 4-20 mA outputs for connection to the Eclipse.

40.5 Mounting

The Eclipse may be mounted higher up on a swing panel in the main control cabinet. The cabinet door does not require a cut-out for viewing the Eclipse without opening the door. Alternatively, the APT Eclipse can be installed in the same separate cabinet as the Qualitrol 509 ITM if desired.

41 FORCED COOLING

41.1 Rating

Forced cooling equipment shall be supplied where specified in the Supplementary Technical Requirements. Each successive cooling method employed shall increase the ONAN capacity nominally by one-third, i.e., 100%, 133.3% and 166.7% respectively, unless specified otherwise.

41.2 De-rating

41.2.1 Separate Radiators and Pumps

Where a transformer has a single forced cooled rating and no self-cooled rating, the failure of one (1) pump, or a group of fans, shall not reduce its rated capacity by more than 30%, otherwise, the Contractor shall state the rating(s) on the loss of one pump.

41.2.2 Integral Coolers

As the Transformer will have only a single forced cooled rating and no self-cooled rating, any one cooler out of service (pump and fans) shall not reduce the transformer's rated capacity. The Transformer shall also be suitable for energization from a de-energized condition with the oil at -50°C and shall accept full load at -40°C tap changer oil temperature. At a pump oil temperature between -40°C to -20°C, two pumps shall be allowed to operate, at an oil temperature of -20°C and above, the remaining pump(s) shall be allowed to operate. The transformer shall be equipped and operate in-service with N+1 coolers, where N is the number of coolers required to meet the rated MVA at the winding temperature rise. During in-service operation of the transformer, the spare cooler shall be in operation and not cause the oil velocity to exceed the limits that could cause static electrification.

The Contractor shall provide the oil and winding rise with and without the spare cooler in operation when operating at 100% of the nameplate rating.

41.3 Fans

Weatherproof, enclosed type, transformer mounted fans shall be provided for all transformers and related equipment that employ forced air cooling. The fans shall be equipped with hot-dipped galvanised guards. Galvanised parts of the fans shall not be painted.

All fans supplied on a transformer shall be identical. Fans shall not be mounted on the bottom of the radiators.

NOTE: Thermal overloads inside of fan and pump motors are not acceptable. The motor starters perform this function.

41.4 Pumps

Forced-oil systems shall include two or more oil pumps, located in the bottom oil piping, with flow-failure or equivalent devices at each oil pump. The pumps shall be designed and connected with a lockable shut-off valve on both sides so that any one pump can readily be removed and replaced without taking the transformer out of service and without draining the cooler. All oil flow pipe work between isolating valves must be equipped with a drain valve and vent for removal if required. The cooling system shall be designed to prevent entry of air on the suction side of the pumps. Each pump and motor shall be completely enclosed in the oil circulating system so that both stator and rotor windings are submerged and bearings continuously lubricated by transformer oil.

Pumps shall be Cardinal Pumps (or approved equivalent) with the Techsonics Bearing Wear System to determine when the pumps should be scheduled for maintenance before excessive bearing wear or failure occurs.

The Contractor shall ensure that these pumps will meet all the requirements of design and operation described in these Technical Requirements. If the requirements of these Technical Requirements cannot be met, the Contractor shall advise the Purchaser prior to finalizing the design.

NOTE: Thermal overloads inside of fan and pump motors are not acceptable. The motor starters perform this function.

For each pump, an oil flow gauge, Qualitrol type 092-300-03 with two suitable normally open contacts for the Purchaser's use shall be provided. The first normally open contact shall be for indication when the pump fails. The second separate normally open alarm contact shall be provided to indicate when all pumps fail.

Each pump shall be fitted with a dry brass thermal well and a 100 ohm Platinum Omega type PRTF-18-2-100-1/4-4-E 3 wire RTD to indicate pump oil temperature to determine the operation of the pumps. The dry thermal well shall not be made out of stainless steel. A temperature panel mount controller with temperature display and 4-20mA output shall be used in conjunction with the RTD to control the operation of the pump in cold weather.

Transformers fitted with pumps shall verify that under the normal start-up sequence with ambient oil, the sudden surge from the pumps will not trip the pressure monitor system contacts.

41.5 Directed Oil Flow Pipe Connections

For directed oil flow cooling, insulated oil pipe flow connection(s) inside the transformer tank must be accessible via a suitable manhole. It shall be possible to replace the pipe sealing material without de-tanking the core and winding assembly.

41.6 Control Equipment

Forced air or oil cooling equipment shall include the following control equipment mounted within a control cabinet:

For GSU Transformers **For HVDC Station**	**For All Others**
a) One (1) fused safety switch per stage of fans, and per stage of pumps. Safety switch handle must be padlockable in the “OFF” position. Isolation points shall be visible through a window in the safety switch.	a) One (1) fused safety switch or moulded case circuit breaker per stage of fans, and per stage of pumps.

For GSU Transformers For HVDC Station	For All Others
b) Motor protective circuit breaker with starter shall be supplied for each motor and have the following functions and options. Actuating handle padlockable in the "OFF" position. Adjustable electronic overload protection. Trip-Indicating Auxiliary alarm contact. The level of motor branch circuit protection/coordination shall meet the IEC Type 2 requirements. The PKE model made by Eaton Moeller is an acceptable unit and has all of the above functions and options.	b) Motor protective circuit breaker with starter shall be supplied for each motor and have the following functions and options. Adjustable electronic overload protection. Trip-Indicating Auxiliary alarm contact. The level of motor branch circuit protection/coordination shall meet the IEC Type 2 requirements.

c) Manual-off-automatic selector switch to control the operation of each stage of fans, and each stage of pumps.

d) Suitable terminal blocks per section 32.6 Termination to accommodate all wiring and cables.

e) Loss of stage alarm(s).

f) Loss of control supply alarm(s).

g) Miscellaneous controls as required.

h) An auxiliary NC dry contact(s) supplied from the Purchaser's fire detection equipment to interrupt the cooling fan and pump power supplies. This will be used to turn off the fans and pumps in the event a fire is detected.

For GSU Transformers For HVDC Station	For All Others
i) An auxiliary pick-up relay to effect shut down of pumps when an internal fault condition is sensed. Pump shutdown shall be initiated via a remote dry contact (G.E. type HEA hand reset, lockout, auxiliary relay) to be supplied by the Purchaser.	

41.7 Connections

Fans and pumps shall be equipped with heavy duty weatherproof plugs and receptacles, Pyle fittings or equivalent, plus necessary weatherproof conduit and fittings and wiring between the control cabinet and various equipment. The pumps and fans shall be connected using a flexible cable with a Krentz Vent, Joy, Crouse Hinds Arktite® or approved equivalent heavy duty circuit breaking type plug to the receptacles mounted on the tank.

41.8 Integral Coolers

When requested in the Supplementary Technical Requirements, "Unifin" (or approved equivalent) “Run Clean” type coolers shall be provided. The cooler shall have no more than 8 fins per inch, with the swing out fans in the open position there shall be 95% of the cooler fins exposed for cleaning.

41.8.1 Mounting

Each cooler shall be of the detachable type mounted on a common free-standing frame, with removable feet for in-service operation, with all of the other coolers and mounted directly on the tank or on headers. The individual coolers shall be mounted a minimum of 1500 mm from the tank wall and 150 mm apart to allow for cleaning and mounting of the deluge supports. It shall be possible to padlock the top and bottom shut-off valves in the open and closed positions with the position of the valve being readily identifiable. These shut-off valves shall be operated either from ground level or when standing on top of the transformer cover.

Each pump shall be located in the bottom pipe and shall be designed and connected with a shutoff lockable ball valve on both sides so that it can readily be removed and replaced without taking the Transformer out of service and without draining the cooler. The lockable ball valve shall be made for locking with a padlock having an 8mm shackle.

All transformers must have the ability to isolate the main tank via an isolating ball valve to permit the removal of coolers, common oil flow headers and any other associated pipe work used for oil flow. All oil flow pipe work between isolating valves must be equipped with a drain valve and vent for removal if required.

Each cooler package shall be arranged such that it can be readily removed for repair. The cooler package design shall also permit access for inspection and maintenance of the cooling coil.

Coolers shall be capable of withstanding full vacuum and shall be properly supported and braced to prevent movement by wind or vibration during operation.

For HVDC Station	For All Others
The top oil pipe work shall include a check valve to prevent backflow from the other coolers when one or more oil pump(s) are not in operation.	A check valve is not required but may be the solution to operation with one cooler out of service.

41.8.2 Accessories

The Transformer shall be provided with cooler packages that are a fully integrated cooler system. Each cooler package shall be complete with:

a) NPT threaded drain and vent plugs,
b) top and bottom shut-off valves,
c) lifting lugs,
d) pump,
e) top and bottom headers fitted with two Omega PRTF-18-2-100-1/4-4-E 3 wire RTDs (100 Ohms Platinum at 0°C), complete with dry brass thermal well for monitoring the top and bottom cooler temperatures. These RTDs will be wired to a differential temperature controller for monitoring the cooling efficiency of each of the coolers.
f) temperature based controller for pump operation under cold oil temperatures,
g) instrumentation including, but not limited to no-flow alarm, pump fail, motor overload,
h) hinged cabinets for fan motors that allow for easy access for cleaning of cooler fins with the fan motors mounted external to the hinged cabinet,
i) weatherproof enclosed type fan motors with guards and heaters, and
j) pressure relief installed in the bottom of the cooler header.

Each cooler shall be provided with an Aquatrol Inc. Series 55 safety relief valve with a 1/4” valve size and a set point pressure of 30 psi to vent pressure build up in the coolers when they are isolated from the main tank. Special attention must be paid to placement of the safety relief valve to ensured that check valves and isolating valves are closed that any pressure build up is vented. The 1/2” outlet valve shall be plumbed back with a bleeder to a convenient location on the discharge side of the pump such as the top of the tank or main conservator and shall be subject to approval by the Purchaser.

Auxiliary contacts from the motor starter of each fan shall be wired to individual terminal blocks for fan fail alarms. Both pump and/or fans shall initiate an individual failure alarm when tripped by the overload protection or manually turned off by the cooling selector switches.

The position of all cooling selector switches and any other operational switches shall point upward during transformer normal operation.

41.8.3 Fans

Each cooler shall be equipped with three fans and shall operate with three stages of cooling; the first stage at 30°C operating the top fan from each cooler, the second stage at 40°C operating the middle fan from each cooler and the third stage at 50°C operating the bottom fan from each cooler. The staging of fans is not for multiple MVA ratings but is strictly to reduce thermal cycling of the transformer.

The fans shall be capable of operating in cold weather at an ambient temperature of -50°C without the assistance of internal heaters for the fan motors. Fan motors and blades must be capable of operating in the forward direction and a couple hours daily during low loading in the reverse direction to prevent fouling of the cooler fins.

41.8.4 Plugs

Each individual fan and pump shall be equipped with a flexible cable with Meltric decontactors, type DS60, poly-blue, 3-phase and ground connectors with FH111 handles and switch rated plugs. The flexible cables shall be a four conductor type SOOW, extra flexible, 50°C to 105°C temperature rated, 208V rated cable. The individual Meltric decontactor switch rated receptacles shall be mounted at a downward 30° angle on the tank wall using metal box (MB334-34LS-34RS) and nylon angle (MP2). The Meltric decontactors shall be Nema 4X rated with a lockable mushroom pawl and with 2 auxiliary/pilot contacts. The 3 fans and pump per cooler shall be uniquely keyed with unique colored gaskets to avoid cross connections into the incorrect receptacle.

Exact Meltric part numbers shall be supplied by the Purchaser. Note that these connectors require a minimum #10 wire.

All necessary weatherproof conduit / raceway, fittings, and wiring between the control cabinet and various equipment shall also be provided by the Contractor.

41.8.5 Controls

Forced air and oil cooling equipment shall include the following control equipment mounted within the control cabinet and comprising of:

a) 12 Amp power base c/w terminal block and auxiliary contact block, Schneider Electric LUB12 and LUCM12BL for the pumps.
b) 12 Amp reversing power base c/w terminal block and auxiliary contact block, Schneider Electric LU2B12FU, LUCM05BL and LUA1C11 for the fans,
c) Manual line starters for motor protection and lockable isolation, including individual thermal overload relays or integral manually reset motor overload protection, as required,
d) Advanced control unit with the appropriate overload setting shall be provided, Schneider Electric type LUCB,
e) Suitable terminal blocks to accommodate all wiring and cables,
f) Fans to have a reversing module and programmable 24 hour day timer variable for multiple on/off operations for fan rotation reversal, Schneider Electric Zelio smart relay SR2PACK2FU.
g) Control transformer and miscellaneous controls as required, and
h) 208Vac power supplied to each pump and fan cooler shall be protected by a three pole Cooper Bussmann compact circuit protector model CCP-3-30CF complete with Low-Peak® CUBEFuse® with indication, time-delay Class J performance fuses.

41.9 Data for Instruction Manuals

The following shall be included in the Instruction Manuals for transformers with forced oil flow.

(a) An oil circuit drawing showing mechanical details such as:
   i) pumps (on/off), baffles, valves, flapper valves (open/closed), headers, etc;
   ii) how pumped oil is kept separate from the bulk tank oil
   iii) (tank baffle, in clamps etc.);
   iv) which windings have oil pumped through them;
   v) the oil flow path under ONxx and ODxx ratings
   vi) (both OD ratings if applicable);
   vii) the oil flow path if one pump fails;
   viii) the rating of the transformer;

(b) Transformer capacity when one pump fails.

(c) Pump characteristic curve of flow rate versus oil head. This shall be the curve for the specific pump design and not a generic curve from the pump manufacturer’s catalogue. The operating point shall be indicated on this curve. This is required for future pump replacement. The manufacturer’s model number, serial numbers and other necessary characteristics such as number of vanes shall also be listed.

42 FORCED COOLING PROVISION

Where provision for forced cooling is specified in the Supplementary Technical Requirements, the following equipment shall be provided:

(a) bushings, tap-changers and all other current carrying components consistent with the top MVA rating,
(b) oil and winding temperature indicators and relays,
(c) current transformer,
(d) hot well and operating bulb, and
(e) conduit and receptacles.

There shall be provision for mounting fans and provision in control cabinet for adding necessary control equipment, all as described elsewhere in the Contract.

43 MATERIALS TO BE SUBMITTED FOR SAMPLING

Samples of certain materials used in the manufacture of the transformer and its accessories shall be provided. Gasket and current transformer lead wiring samples are required from a secure batch and will be tested and approved for use on each batch as described below. Samples of all other materials are intended for future analysis if a problem develops with the transformer.

43.1 Samples from a Secure Batch

These are required for all transformers and reactors.

Tests performed on each sample by the Purchaser will include, but not be limited to, visual inspection, mechanical tests and compatibility tests by immersing the sample in transformer oil at a temperature of 110ºC for 28 days.

Approval of the sampled material shall apply only to the sampled batch and shall not be construed as a blanket approval of the material. Subsequent samples from different batches shall be submitted separately to the Purchaser for testing and approval.

Once the materials have been approved by the Purchaser, the Contractor shall allocate sufficient materials as required for exclusive use for the Work.

A completed copy of the following form**Error! Reference source not found.** shall be submitted with each sample to the Purchaser.

Manitoba Hydro - Standard Specification
Material Test Sheet

Manitoba Hydro PO#:	SPEC ID#:
Transformer Serial#:	
Sample submitted by:	
Contact Person:	Phone #:

Material Manufacturer:
Material Description:
Batch#:

Manitoba Hydro Sample Control #:	Network#:
Manitoba Hydro Test Lab Results and Comments:	

ACKNOWLEDGEMENT	
To:	
The sample provided has been tested and approved for the use only on the equipment listed. No substitution or replacement of material shall be made without Manitoba Hydro's approval.	
Signature of Manitoba Hydro Representative:	Date:

43.2 Gasket Material

Samples of the gasket/'O-ring' material shall be submitted by the Contractor to the Purchaser for testing and approval at least **twelve (12) weeks** prior to the materials being used in manufacturing.

Samples submitted for the Purchaser's approval shall be at least 100 mm x 100 mm in size for flat type gasket material and a minimum length of 100 mm for 'O-ring' type material.

43.3 CT Wiring

A sample of the current transformer lead wiring, with a minimum length of 1 m, shall be submitted by the Contractor to the Purchaser for testing and approval at least **sixty (60) days** prior to its use in manufacturing.

44 LANGUAGE, DIMENSIONS, WEIGHTS AND GRAPHICAL STANDARDS

All documents and communication under the Contract shall be made/submitted in the English language.

The design of the Work shall be executed in the International system of Units (SI) wherever practicable. Dimensions shall be shown in millimetres and metres and weights shall be shown in kilograms.

All graphical symbols and device function numbers for electrical equipment should conform to the editions of ANSI/IEEE 315 and ANSI/IEEE C37.2 current at time of proposing. However, if equivalent symbols are used, a complete description of them in legend form shall be included on the drawing(s) on which they appear.

45 MANUFACTURE AND DELIVERY SCHEDULE

The Contractor shall submit to the Purchaser **within six (6) weeks** of the award of the Contract, a time chart or schedule containing the following information:

(a) anticipated dates for completion of design and working drawings,
(b) anticipated dates for completion of orders for materials required for the equipment,
(c) anticipated dates for start and completion of manufacturing, assembly of the equipment, and start of testing,
(d) anticipated date for completion of delivery of the equipment (and where applicable, unit sections thereof) to the designated delivery point, and
(e) any other information as may be requested in writing by the Purchaser.

All manufacture and delivery schedules shall be provided in accordance with the following.

45.1 Schedule

The Critical Path Method (CPM) shall be used to control the planning and scheduling of the Work.

The detailed critical path diagram shall show the schedule for engineering drawings submission, the placing of Purchase Orders for materials, receipt of materials, factory manufacture, and factory testing. This detailed critical path network shall clearly depict and describe the sequence and interdependence of all of the Contractor's activities in sufficient detail to satisfy the Purchaser that the Work has been thoroughly planned and scheduled to meet all the requirements of the Contract. Report updates shall be provided to the Purchaser on a regular monthly basis.

The Contractor's detailed critical path network incorporating the work dates, once processed and approved by the Purchaser, shall become the official CPM Schedule for the Work. These work dates incorporated into the official CPM Schedule shall not be altered at any time except to reflect any time extensions granted by the Purchaser in accordance with the Contract requirements or as otherwise approved by the Purchaser.

Approval of the official CPM Schedule by the Purchaser shall not relieve the Contractor from meeting any of the requirements of the Contract.

The Contractor shall designate a schedule co-ordinator to liaise with the Purchaser. The schedule co-ordinator shall have the authority to control the scheduling of the Work including the rescheduling of any portions of the Work as may be necessary to meet the requirements of the Contract. The schedule co-ordinator shall be available as required by the Purchaser for discussions pertaining to the planning and scheduling of the Work.

Should any of the Contractor's activities as reflected by the updated printouts show negative float, the schedule co-ordinator shall submit, within ten (10) days to the Purchaser for approval, a detailed report setting out the remedial action(s) to be taken by the Contractor to eliminate the negative float conditions. The cost of such remedial action(s) shall be borne entirely by the Contractor.

If, in the opinion of the Purchaser, the Contractor fails to provide any or all of the data as required herein, the Purchaser will notify the Contractor to this effect. If the Contractor fails to provide the required data within fifteen (15) days of the issuance of such notice, the Purchaser will dispatch CPM scheduling specialists to the Contractor or it's subcontractors' factories or sites, as applicable, to expedite the provision of the required data by the Contractor.

46 MATERIALS AND WORKMANSHIP

46.1 General

All materials shall comply with the latest standards of the American Society for Testing and Materials (ASTM) or the Canadian Standards Association (CSA), unless otherwise specified.

Materials and workmanship throughout shall be the best of their kinds. The design of the Work shall be such that installation, replacement, and general maintenance may be undertaken with a minimum of time and expense. Each component shall be designed to be consistent with its duty and liberal factors of safety shall be used throughout the design.

All joints and fastenings shall be so devised, constructed and registered that the component parts shall be accurately positioned and constrained to fulfil their required function. Heads of all bolts and nuts shall register flush on the surfaces which they fasten.

All plastic tie wraps used externally shall be black ultra-violet treated type and shall not deteriorate when immersed in transformer oil. Tie wraps are not acceptable internally.

46.2 Interchangeability

Wherever possible, all similar parts of the Work shall be made to gauge and shall also be made interchangeable.

All spare parts shall be interchangeable with, and shall be made of the same materials and workmanship as the corresponding parts of the Work supplied under the Contract.

46.3 Castings and Forgings

All castings shall be true to pattern, free from defects and of uniform quality and condition. Surfaces of castings which do not undergo machining shall be free from foundry irregularities.

Steel forgings shall be in accordance with the latest issue of the Standard Specifications for Carbon Steel and Alloy Steel Forgings, ASTM A668. Where these forgings are required for welding, the chemical composition shall be varied to meet the requirements of ASTM A668.

46.4 Plate and Structural Steel and Aluminium

Structural steel, rolled shapes, bars, etc., shall comply with the latest issue of the Specification for Structural Steel ASTM A36, or with CAN/CSA-G40.20/G40.21-M.

Plate steel shall be of a designation and quality suitable for the function it is intended to perform. Insofar as it is compatible with its function, plate steel shall comply with ASTM A283 Grade C structural quality or CAN/CSA G40.20/G40.21-M. Scaling and rust pitting of the steel plate must be removed prior to painting. Steel plate with excessive scaling and rust pitting will not be accepted.

All structural aluminium material shall comply with ASTM Aluminium Alloy Standard 6061-T6 temper.

46.5 Welding

The arc-welding process shall be used in accordance with CSA W59-M and Section VIII of the American Society of Mechanical Engineers Code for Unfired Pressure Vessels, latest edition, as they may apply. Construction shall be undertaken by a fabricator fully approved by the Canadian Welding Bureau, to the requirements of the latest issue of CSA W47 or its equivalent. All welds shall be seal and continuous seam. All corners and edges shall be free from burrs and smooth to the touch. All welding rods shall conform to the requirements of the latest issue of CSA W48.

46.6 Workmanship

Structural steel fabrication and workmanship shall be in accordance with CAN/CSA-S16.1, latest revision. Structural aluminium fabrication and workmanship shall be governed by CSA CAN3-S157-M, latest revision.

47 CONTRACTOR’S DRAWINGS

47.1 Contractor’s Drawings Submission

Within fourteen (14) weeks after the award of Contract, and before commencing manufacture, the Contractor shall submit drawings for the Purchaser’s approval. An AutoCAD (or DXF) and a PDF electronic drawing file shall be submitted for each drawing.

All drawings are to be produced on the AutoCAD 2008 system (or earlier) and the AutoCAD drawing files shall be submitted by way of email to the persons specified in the Purchase Order.

All drawings submitted for approval shall be dated and marked “Preliminary” until such time as final approval has been obtained from the Purchaser.

The Purchaser will reject drawings of unsuitable standards and these drawings shall be redrawn by the Contractor within the specified schedule.

All drawings must be properly approved and certified to be correct by the Contractor before submission to the Purchaser.

47.2 Purchaser’s Checking and Approval of the Contractor’s Drawings

The Contractor shall allow a total of **thirty (30) working days**, from receipt of the drawings, for review and commenting of drawings without affecting the delivery schedule. The **thirty (30) working days** are for the initial review and one subsequent review of the drawings. Should further reviews be required, the Contractor shall ensure that the delivery of the transformer is not affected.

After checking, the Purchaser will return to the Contractor one print marked with the Purchaser's comments and stamped "Approved", "Approved, Subject to Changes Noted" or "Not Approved", upon receipt of which the Contractor shall modify each drawing as required and resubmit in one of the media specified above within **fifteen (15) working days**.

All drawings returned to the Contractor stamped "Not Approved" shall be deemed to be technically unacceptable and manufacturing of the equipment shall not proceed.

Manufacture shall not commence until the Contractor's drawings have been approved by the Purchaser, and thereafter, no change shall be made on any drawing so approved without the written permission of the Purchaser. Upon authorization of subsequent revisions, the Contractor shall resubmit any change, clearly shown on each drawing in one of the specified media, to the Purchaser for re approval.

Approval of the Contractor's drawings by the Engineer shall not release the Contractor from liability for errors or omissions thereon nor from any loss, cost, damage or expense which may result from any such error or omission or from entire responsibility for the complete and accurate performance of the Work in accordance with the Purchaser's drawings and the Contract, neither shall such approval release the Contractor from any liability placed upon it by the Contract.

The Contractor shall supply to the Purchaser an AutoCAD and a PDF electronic file after approval of each drawing.

The Contractor shall ensure that the final approved drawings furnished to the Purchaser show the shipped condition of the equipment or structure. Any changes to be made on site shall be clearly marked thereon.

47.3 Minimum Standards for Drawings Produced and Submitted by Fabricators, Manufacturers and Construction Companies

Minimum drawing standards for Contractor's drawings shall be in accordance with the "MINIMUM STANDARDS FOR DRAWINGS PRODUCED AND SUBMITTED BY FABRICATORS, MANUFACTURERS AND CONSTRUCTION COMPANIES" included in Appendix A. For AutoCAD drawings, note especially the limitations on shape files and lettering described in the Appendix.

All drawings shall be properly cross-referenced and shall bear:

- Purchaser's Name;
- Request for Proposal#;
- SPEC ID#;

- Purchase Order#;
- Purchase Order Item#;
- Station name;
- Contractor's serial and shop order#;

An area 120 mm wide by 70 mm high located immediately above the title block shall be left blank for the Purchaser's use. The Purchaser will use this space to add the Purchaser's drawing registration number and approval stamp.

47.4 List of Drawing Details

(a) The Contractor's Equipment drawings shall show the following:

i) the outline of the Equipment, clearances of live parts, projections, sufficient dimensions, weights and centre of gravity for the design of the necessary foundations and electrical connections;
ii) description, type, size and location of all accessories and major components;
iii) rating plate information; and
iv) control equipment layout, schematic and wiring diagrams, description and rating of devices.

Deviations in dimensions and weights from proposal data will be acceptable only if they do not exceed 10%.

The Contractor shall furnish such data with regard to characteristics of the Work so as to enable the Purchaser to utilise the Work to the best advantage. Drawings of windings, connections and information as may be required to make emergency repairs, such as replacement of windings, etc., shall be supplied if requested by the Purchaser.

(b) **Outline**

i) clearances of live parts
ii) projections
iii) headroom
iv) weights
v) centres of gravity
vi) sufficient other dimensions to enable the Purchaser to design the necessary foundations and electrical connections
vii) internal bushing connection details including bolt pattern and size
viii) maximum allowable tank deflection
ix) show all views of the Equipment along with all major accessories
x) all dimensions that are specified in the Contract height of control box
xi) jacking steps
xii) switch handles

xiii) etc.

Should these requirements result in two drawings for the outline, this is acceptable to the Purchaser.

Sufficient dimensions shall be provided to enable the Purchaser to design the necessary foundations and electrical connections.

Drawings must be drawn to scale.

(c) **Shipping**

i) centres of gravity for transport
ii) dimensions
iii) weights
iv) shipped oil/dry-air filled
v) weights of components
vi) identification of all parts removed for shipment

Drawings must be drawn to scale.

(d) **Tank and Cover**

The tank and cover shall show manhole / handhole locations.

(e) **Accessories and Major Components**

i) description
ii) type
iii) size
iv) location

(f) **Special Details**

i) internal bushing connections
ii) bushing cover flange
iii) manhole/handhole flange
iv) piping assembly
v) oil flow
vi) forced cooling
vii) etc.

(g) **Rating Plate Information and Connection Diagram.**

(h) **Schematics and Wiring Diagrams**

i) control equipment layout
ii) description of devices
iii) rating of devices

(i) **Detailed Grounding Drawings**

i) primary and secondary neutral bushings
ii) surge arresters where applicable

(j) **Detailed Oil Flow**

Refer to the Technical Requirements.

(k) **Gas Piping**

(l) **Internal Arrangement**

i) core and coil mounting details
ii) accessibility to current transformers
iii) location of bushing leads
iv) position of tap-changer
v) vital clearances
vi) etc.

The internal arrangement drawing is required to allow for proper internal inspection and assembly of the Equipment in the field. It is for information only; will be kept confidential and will not be shared with third parties.

48 INSTRUCTION MANUALS

48.1 General

For guidance of the Purchaser's construction, commissioning, operating and maintenance personnel, the Contractor shall prepare Instruction Manuals for all the equipment supplied, describing in detail the construction of each part of the equipment and the recommended procedures for installation, operation, service and maintenance.

An advance copy of the Instruction Manuals shall be submitted to the Purchaser for approval and comments **a minimum of eight (8) weeks** before the delivery/loading of the Work. After approval, eight (8) copies of the Instruction Manuals for each station shall be submitted, bound in durable 3-ring binders. A copy of the Instruction Manuals and special instructions regarding shipping, storing and handling requirements shall be enclosed in a sealed weatherproof pouch and attached to the equipment.

The Contractor shall allow a total of **ten (10) working days** from the receipt of the Instruction Manuals for the Purchaser's review and comments. The **ten (10) working days** are for the initial review of the Instruction Manuals only. Should further reviews be required, it is the responsibility of the Contractor to ensure that the delivery of the transformer(s) is not affected.

The Instruction Manuals shall be submitted **five (5) working days** prior to delivery of the Work and provision shall be made for additions and deletions which may be dictated by operational experience. Where these amendments are indicated to be necessary during the initial operation before acceptance, the Contractor shall supply the amended sections. **Failure to provide the Instruction Manuals five (5) working days prior to delivery shall result in an assessment of 0.5% of the contract price for the transformer.**

NOTE: The Purchaser's qualified personnel and/or third parties, with the aid of the Contractor's Instruction Manuals, are expected to maintain and repair the equipment. Reliance cannot be placed on any other form of assistance, therefore explicit, easy to understand Instruction Manuals are vitally important.

NOTE: Refer to the Technical Requirements for further specific data requirements to be included in Instruction Manuals.

48.2 Instruction Manual Details

The Instruction Manuals shall contain, at the minimum, the following information listed herein in no special order of preference:

(a) **Outside of Binder and Title Page**
Each copy of the Instruction Manuals shall be clearly titled to show the part of the Work concerned:

i) Purchaser's Name: Manitoba Hydro
ii) Request for Proposal #
iii) SPEC ID#
iv) Purchase Order #
v) Purchase Order Item #
vi) Station Name
vii) Contractor's Name
viii) Contractor's Order #
ix) Contractor's Reference #
x) Contractor's Address
xi) Date of Issue

(b) **Section 1**
i) Table of Contents
ii) General Information

iii) Principles of Operation
iv) As required by CAN/CSA-C88-M90 section 18 f, g, h, i.
v) X0/X1 ratio of the transformer and the asymmetry factor(s) used to determine the fault currents.

(c) **Section 2**
i) Instructions for Shipping, Storage and Handling
ii) Long-term and Short-term Storage
iii) Cold Weather Starting Below -20ºC
iv) Environmental Data
v) Personnel Safety
vi) Handling Instructions
vii) All Applicable Material Safety Data Sheets (MSDSs)
viii) Instructions for Erection and Assembly of Parts
ix) Instructions for Testing and Commissioning

(d) **Section 3**
i) Operating Instructions
ii) Descriptive Bulletin on all Accessories
iii) Details of Load-tap-changing Equipment and Controls

(e) **Section 4**
i) Maintenance Instructions Complete with Sketches and/or Photographs
ii) Repair
iii) Dismantling
iv) Settings of Critical Clearance and Adjustments
v) Oil
vi) Gaskets complete with instructions on gasket installation procedure
vii) Lubrication
viii) Pressure Tests
ix) WTI heater coil calibration curve
x) Guide to Inspection Frequency and Troubleshooting
xi) Materials List
xii) etc.

(f) **Section 5**
i) Contractor's recommended spare parts and a detailed list of renewable parts complete with the manufacturer's catalogue or part numbers suitably identified by illustrations or by assembly and subassembly drawings

ii) Complete Gasket Listing

(g) **Section 6**

i) List of Drawings

ii) Complete set of all approved drawings (preferably to a reduced scale)

iii) A chart or table indicating the level to which the conservator tank should be filled during an outage for different oil temperatures

iv) 8" x 10" colour photographs of the core and coil of the Equipment. These photographs shall show a top and all four side views of the assembled unit. There shall be an adequate number of photographs to show detail. This should include, but not be limited to:

1) full frontal on all four sides;
2) angle view from all four corners showing details on sides;
3) top view from one, two, three or all four sides as necessary;
4) bottom view showing base and tie-rod details;
5) close-up views of special details such as lead routing.

v) Complete set of 8” X 10” colour photographs of the fully assembled transformer. These photographs shall show a top and all four side views of the assembled transformer. There shall be an adequate number of photographs to show detail.

49 SHIPPING

49.1 Release

Shipment shall be made by the Contractor only when release has been given in writing by the Purchaser or the Purchaser’s representative.

Release shall be subject to the receipt of:
(a) Instruction Manuals,
(b) certified test reports,
(c) any failure or non-compliance reports, and
(d) confirmation of no shortages prior to the shipping of the transformer.

49.2 Preparation

The Contractor shall prepare all materials and articles for shipment in such a manner as to protect them from damage in transit and shall be responsible for and make good any and all damage due to improper preparation for shipment and transportation.

Parts shall not be shipped in a container to the delivery location because Manitoba Hydro has no facilities to unload a container.

All glass, Plexiglas, polycarbonate, etc. windows and covers shall be protected from breakage and scratches during shipment.

NOTE: Bulk oil shipment shall be made by tank truck or by tank car, as applicable, when the Equipment is shipped filled with dry air.

49.2.1 Heavy Parts

Parts of the Work exceeding 545 kg in mass shall be clearly marked with their masses to facilitate arrangements for handling and lifting. All heavy parts shall be prepared for shipment so that slings for handling may be attached readily while the parts are on the railcar or truck. Sling lift points shall be marked on the crate. Where it is unsafe to attach slings to the box, boxed parts shall be packed with slings attached, and the slings shall project through the box or crate so that attachments can be readily made.

49.2.2 Finish

All finished ferrous mating surfaces shall be coated with rust preventative compound and all finished non-ferrous metalwork, or any device subject to damage, shall be suitably wrapped or otherwise protected from weather or other damage during shipment.

49.2.3 Bushings, Arrester and Insulators

Bushings and insulators shall also be suitably wrapped or otherwise protected against damage during shipment. Oil filled bushings shall be shipped in crates with the head elevated at a minimum of 10º above the horizontal.

NOTE: Surge arresters, if supplied by the Contractor, shall be shipped to Manitoba Hydro Waverley Service Centre, 1840 Chevrier Boulevard, Winnipeg, Manitoba, Canada, for testing by the Purchaser. The surge arresters shall be shipped in wooden crates clearly marked showing the Request for Proposal #, SPEC ID#, Purchase Order #, Purchase Order Item # and Station name (as applicable). Surge arresters shall only be shipped to Manitoba Hydro (for testing) once they have been satisfactorily fitted/installed onto the power transformer in question.

49.2.4 Sealing

All ventilating and other openings shall be blanked off to prevent entrance of foreign materials of any kind during the shipping, storage and installation period.

Radiators, large pipes, headers and conservator tanks removed for shipment shall be purged with dry air and sealed to prevent the entrance of moisture.

49.2.5 Match Marking

If required, the Equipment shall be match marked and disassembled for shipment. The match marks shall agree with those shown on the assembly drawings and material lists. Where piping and accessories will be removed for shipment, each piece shall be identified and cross-referenced to a detailed assembly drawing to facilitate identification of components when being unpacked for installation.

49.2.6 Internal Bracing

If shipping braces are required, they shall be painted red. Their locations and any special instructions for their removal or repositioning prior to putting the Equipment into service shall be clearly indicated on the appropriate Outline and Internal Assembly drawings and clearly stated in the Instruction Manuals.

A warning plate shall be placed inside the control cabinet stating that internal shipping braces have been used and that the braces must be removed before the Equipment is put into service.

49.2.7 Shipping with Oil

Equipment shipped with oil over core and coils shall be equipped with an oil level shipping gauge and a pressure-vacuum regulator with gauge and shall be positively sealed against possible entrance of moisture. The gas space above the oil shall be filled with dry air and allow for expansion and contraction due to temperature changes. Topping up oil shall be provided in bulk, details of which will be finalized at the time of shipment. Under no circumstances shall oil be shipped in the conservator tank.

49.2.8 Shipping without Oil

If the Purchaser requires the Equipment to be shipped without oil, the Contractor shall take precautions to keep moisture out of the Equipment's interior during shipment and for a storage period of six (6) months after arrival at the designated location. Equipment shall be shipped filled with dry air and shall bear a warning sign attached in a conspicuous location stating that the Equipment has been shipped dry air filled. Permanent mounting brackets for dry air cylinder bottles shall be provided on the tank wall. A list of the gas equipment supplied and the necessary operating instructions for same shall be attached to each Equipment.

49.2.9 Oil Delivered by Tanker

Oil delivered by tanker will be tested prior to filling the transformer. The tanker will be held at site for 24 hours while the oil is tested at a Manitoba Hydro lab. If it is satisfactory, per the Technical Requirements, the transformer will then be vacuum filled. There shall be no extra charge for holding the tanker until oil filling and top-up is complete. If the oil is not satisfactory it shall be rejected and there shall be no extra charge for the replacement oil and tanker.

49.2.10 Auxiliary Equipment

Any auxiliary equipment not designed for indefinite outdoor storage shall be packed separately and the container clearly marked for indoor storage. Parts requiring special precautions for outside storage shall have an instruction plate or a durable sealed weatherproof pouch attached containing relevant information and labelled “Storage Instructions”.

49.2.11 Spare Gaskets

Two spare sets of gaskets shall be provided. The first set is a complete set of gaskets, marked individually but assembled as one package, to be stored for future use by the Purchaser. The second set is a partial set for any gasketed joint assembled during site assembly. This includes all handholes, manholes, bushings and radiators, and anything else that is removed for shipping. This second set will be used when assembling the transformer at site.

49.2.12 Instruction Manuals and Special Instructions

A copy of the Instruction Manuals and any special instructions regarding shipping, storage, and handling requirements shall be enclosed in a sealed weatherproof pouch and attached to the equipment.

49.2.13 Impact Recorders

Unless specified otherwise, Equipment to be shipped by rail shall have three (3) three-dimensional recorders installed. Two (2) recorders shall be on the main tank cover and the other shall be mounted on the rail car or as specified by the Purchaser’s representative. The impact recorders will be removed by the Purchaser only. Charts shall be marked for “end of journey” and after inspection of the chart readings, the recorders and charts will be returned by the Purchaser to the shipping address indicated on the recorders.

Transformers shipped by truck shall have one analogue impact recorder mounted on the transformer.

The Contractor shall supply the initial settings of the impact recorder when the item is shipped. This shall include the G’s per division for each scale and the speed of the recorder so that the recorder data may be evaluated upon arrival. The Contractor shall indicate with a line on the strip chart the “start of journey”. This line shall be dated and signed by the Contractor’s representative.

If a digital recorder is used, the Contractor shall supply the Purchaser with a copy of the software and any hardware or software keys so that the data may be evaluated upon arrival. The Contractor may send a representative to evaluate the data concurrently.

If digital recorders are used, there shall be an additional mechanical impact recorder installed on the main tank cover.

49.2.14 Identification Tagging

All major components, boxes, bundles and packages containing accessories shall be plainly marked or securely tagged as follows:

(a) Description of Equipment;
(b) Station Name;
(c) Purchase Order #;
(d) Purchase Order Item #;
(e) Request for Proposal #;
(f) SPEC ID#;
(g) Contractor;
(h) Equipment Serial and shop order #.

49.3 Handling Charges

Handling charges will be assessed against the Contractor if marking, bundling and shipping instructions are not followed exactly.

50 SHIPPING DOCUMENTS

50.1 Notification

The Contractor shall prepare and forward to the Purchaser two (2) copies of an itemised list of the materials, equipment and articles included in each shipment and provide data on the oil as required below.

These two (2) copies shall be forwarded as follows:

(a) one (1) copy, transmitted via email prior to shipment, to the person(s) indicated in the Purchase Order.

(b) one (1) copy to accompany the shipment.

50.2 Oil

If oil is supplied, the Contractor shall submit to the Purchaser two (2) copies of the detailed oil specification, including all physical and chemical properties as listed in Table 1 of CAN/CSA-C50-97.

50.3 Dewpoint

If Equipment is shipped filled with dry air, the Contractor shall state the dewpoint, pressure and temperature of the dry air allowing 24 hours for settling after it has been introduced into the tank. Dewpoint test results shall be included in the certified test report and indicated on the shipping documents.

50.4 Short-Shipping

Prior approval is required for shipping with shortages. Short-shipments must include all of the documents and details as required for the primary shipments and must be tagged as described in Section 49 SHIPPING. The Contractor must notify Manitoba Hydro in advance of the shipment as described above with details describing the short-shipments.

51 FOUNDATIONS AND STRUCTURES

The Purchaser will supply and install all concrete foundations, supporting structures and foundation bolts necessary for holding down or fixing the equipment to the concrete foundations. Where the design of the equipment is such as to require special clamps to be used with the foundation bolts in fixing the equipment, the clamps shall be supplied by the Contractor.

All other necessary bolts for fixing the equipment to its supporting structures shall be supplied by the Contractor.

SUPPLEMENTARY TECHNICAL REQUIREMENTS 039857

TABLE OF CONTENTS

SUPPLEMENTARY REQUIREMENTS

SPEC ID# 1 90 MVAr 550 kV Shunt Reactor

1. Delivery Location	Dorsey Converter Station 6 km Northwest of Winnipeg on Provincial Hwy# 236 (7 km West of Hwy# 6) GPS: 49°59'18"N, 97°25'43"W
2. Delivery Date	2018 10 30 First issue of drawings required by 2017 0922
3. Station Type	Terminal Station, HVDC Station
4. Type of Site	With a Building
5. Quantity	Three (3) single-phase
6. Transformer Type	Outdoor, reactive VAr control shunt reactor grounded through a grounding reactor
7. MVAr Rating	90 MVAr at 550 kV rms L-L, 283.4 Amps 107.1 MVAr at 600 kV rms L-L
8. Cooling System	ONAN
9. Sound Level	84 dBA at 600 kV L-L
10. Temperature Rise	65ºC at continuous 600 kV operation
11. 3-Phase Connection	Wye Impedance grounded through Purchaser-supplied 425 ohm neutral reactor
12. Number of Phases	1
13. Maximum Continuous Operating Voltage, Pre-Fault Operating Voltage and Energization Voltage	600 kV rms L-L
14. Normal Operating Voltage Range	475 to 550 kV L-L
15. Reactance	100% at 90 MVAr, 550 kV L-L, 283.4 Amps 1120 ohms at 60 Hz Refer to Remarks 3 & 4

SPEC ID# 1 — 90 MVAr 550 kV Shunt Reactor

16. Maximum Overvoltage

3 seconds	775 kV (1.55 pu)
20 seconds	750 kV/Hz (1.50 pu V/Hz)
1 minute	675 kV (1.35 pu)
continuous	600 kV (1.20 pu)

Refer to Remark 8

17. Insulation Class & Test Levels

	Line	Neutral
Impulse		
kV LIL	1550	650
kV Chops	1780	715
kV SIL	1300	540
Induced Potential		
7200 cycle		
kV rms L-G	**635**	133
Applied Potential		
One-Hour		
kV rms L-G	520	117

18. Bushings

Line: ABB, IEC standard
catalogue #
GOE 1800-1360-2500-0.6-G
Refer to Remark 10

Neutral: ABB Alamo, EEMAC standard
catalogue # 145G0600AA

19. Connectors — Refer to PCore Dole Test Terminals

SPEC ID# 1 90 MVAr 550 kV Shunt Reactor

20. PCore Doble Test Terminals	Line terminals: 500 kV 2500 Amp bushing PCore# B-63055-51-EE-70 3000 Amp 4-hole NEMA pad, streamlined corona-free Neutral Terminal: 145 kV 600 Amp bushings similar to PCore# B-63043-E-70 2000 Amp 4-hole NEMA pad, streamlined corona-free All connectors are subject to confirmation and may change at the time of drawing approval. Refer to Remark 11
21. Surge arresters	Not required
22. Surge arrester Support & Bus Assembly	Required on neutral only. See drawing of Purchaser-supplied arrester after the Remarks to determine arrester support height. The Line arrester will be on its own Purchaser-supplied support.
23. Discharge Counter	one for H2 only
24. GIC Detection	Required for only one reactor. Refer to Remarks 8 & 9.
25. WTI Gauge Type	Qualitrol 509 ITM
26. GE Hydran	Required.
27. Qualitrol 930 Pressure Sensors	Required

SPEC ID# 1 90 MVAr 550 kV Shunt Reactor

28. Current Transformers	Line Bushing:	
	2 x 600/300-5	10L400
	1 x 300/150-5	0.3B1.8 at 300-5 0.6B0.9 at 150-5
	MCIC approval is not required	
	Neutral Bushing:	
	2 x 600/300-5	10L400
	1 x 300/150-5	0.3B1.8 at 300-5 0.6B0.9 at 150-5
	MCIC approval is not required	
	1 x WTI CT	
	Metering CTs are for GIC detection.	
29. AC Auxiliary Voltage	Heaters & Lights:	120 V, 1-phase
30. DC Auxiliary Voltage	125 V dc for tripping & alarms The voltage may make steady excursions as high as 140 V periodically.	
31. Loss Evaluation	$8,112 / kW	
32. Paint Colour	ANSI 70 Grey	
33. Test Variations	Refer to Remark 13	
34. Limitations	None	
35. Quality Assurance Requirements	ISO 9001	

Remarks:

1) Design Review

A two-day design review meeting may be required with the Purchaser. If required, this meeting will be held at the Contractor's factory. At this meeting, design personnel will be available for discussion of the design. All drawings will be made available for inspection. Completion of the latest revision of Manitoba Hydro Design Review Document is required prior to the meeting. This shall be submitted to the Purchaser, as complete as possible, at least one (1) week prior to the scheduled design review meeting. The Contractor shall request the latest version of the Manitoba Hydro Design Review Document from the Purchaser prior to completing it.

2) Description

The 500 kV fixed shunt reactors specified herein are required on the 500 kV interconnection between Manitoba and USA to limit the switching surge over voltages to an acceptable level and to also limit the 60 Hz dynamic overvoltages when the line is open at one end. The shunt reactor specified herein will be solidly connected to the terminal end of the 500 kV line. The Purchaser's 500 kV circuit breakers will be used to switch and to provide fault protection for the shunt reactor. The use of an air-core dry-type 425 ohm neutral point reactor in conjunction with these shunt reactors will also allow single pole tripping and reclosing of the 500 kV circuit breaker. The specified duty shall be carefully considered when designing the units.

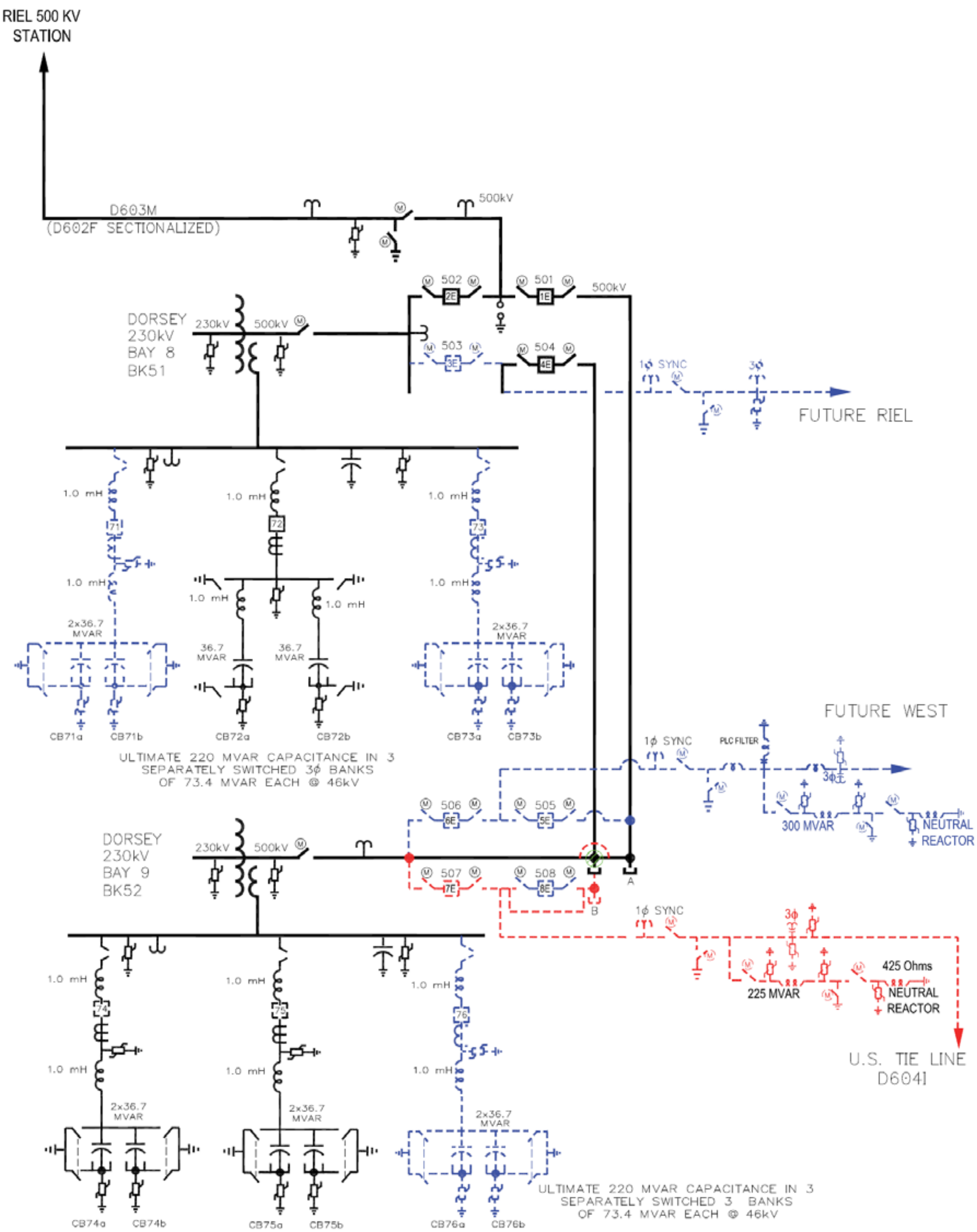


Figure 1: SLD

3) Linearity

The shunt reactor shall be designed and constructed so as not to introduce any harmonics into the Purchaser's system and it shall be linear with respect to voltage up to 1.2 x 550 kV = 660 kV rms L-L. If this slope is considered as the unsaturated 60 Hz impedance of the reactor, then above the level of 1.20 x 550 kV rms the reactor impedance shall not be less than one-third times the unsaturated value up to at least 1.4 x 550 kV = 770 kV rms L-L.

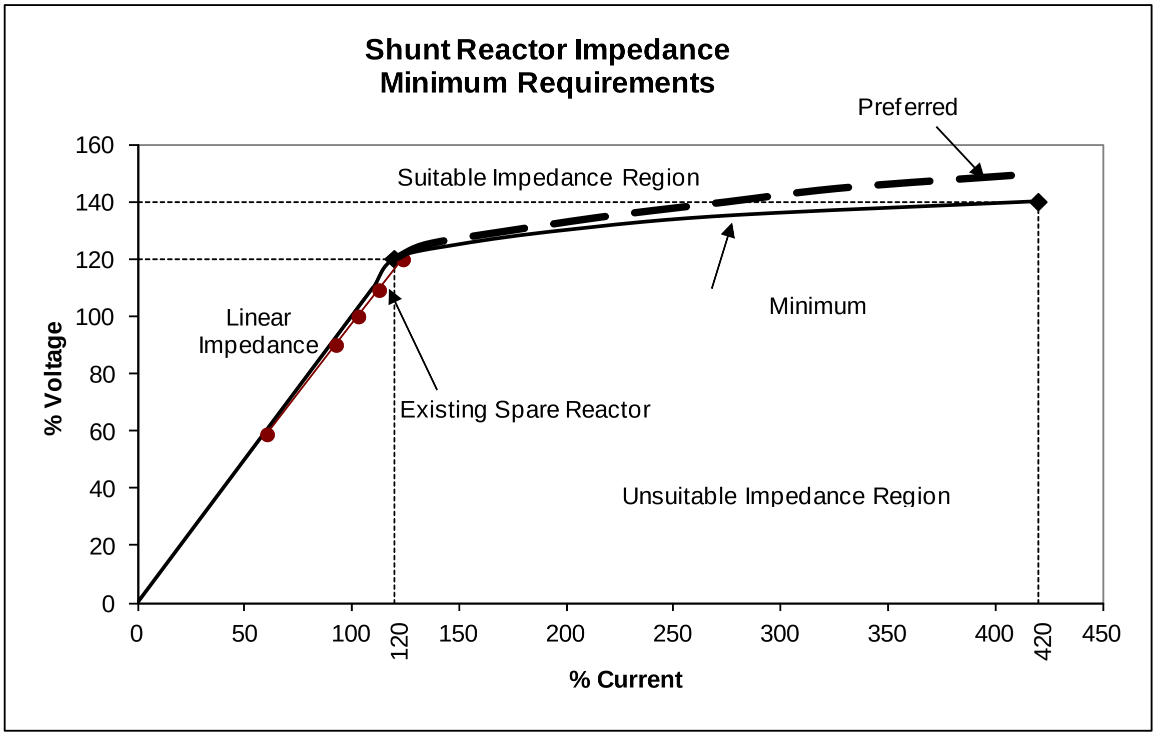


Figure 2: Impedance

4) Reactance Tolerance

The maximum deviation from unit rating shall be no greater than 2.5% and the maximum deviation between phases shall be no greater than 0.5%.

5) Short-Time and Continuous Over-voltages

The reactors will be operated on a system where long duration 60 Hz overvoltages can occur. The Contractor shall supply a curve of the 60 Hz over-excitation versus time capability (Volts per Hertz) for the reactors confirming their capability to operate at over-excited voltage conditions and the Contractor shall confirm that the units will perform this duty on an extended basis without any detrimental thermal, electrical e.g. (corona) or mechanical effects. The curve shall exceed or include the following 60 Hz points:

600 kV line-to-line rms continuous;
675 kV line-to-line rms one minute;
775 kV line-to-line rms three seconds.

6) Core Limbs

The construction of the single-phase shunt reactors shall be a single wound core limb design complete with a full magnetic shield, effectively creating a 3-limb core. The nameplate shall state the type of core and or shield construction.

7) Vibration

The design and construction of the shunt reactor shall be such to avoid detrimental effects of excessive stress of vibration.

8) GIC

It is anticipated that the shunt reactor will be subjected to a solar induced dc current as high as 3 A dc per phase.

The Purchaser plans to monitor the levels of dc current through the neutral reactor but cannot remove the shunt reactor from service if the current becomes too high. The Contractor shall provide time versus dc current withstand curves for the reactor.

9) GIC Detection

Refer also to Technical Specification Clause 40.
Since the bank is made up of three single-phase reactors, the neutral will be formed by the Purchaser. This means only one Advanced Power Technologies Eclipse and two Advanaced Power Technologies' HECT neutral CTs are required for the three single-phase reactors. It also means that the HECT CTs shall be installed by the Purchaser, but supplied loose by the Contractor. The Eclipse shall be installed in the first reactor. The metering CTs are required in all three reactors as are the terminal blocks and wiring for the Eclipse, in case the Eclipse is moved to a different phase. So all three control cabinets shall be designed the same, with only the Eclipse itself not being installed in two phases. The wiring from the terminal blocks to where the Eclipse would be installed may be omitted on those two phases.

10) Line Bushing

The line bushing shall be ABB, IEC standard, to be replaceable with the Purchaser's existing bushings.

Type:	GOE 1800-1360-2500-0.6-G
Drawing#:	2751369-105 attached
Bushing Catalogue#:	LF 121 076-AA (light grey)
Outer Terminal	LF170 073-B (Copper)
D2	50.8 mm (2")
H2	125 mm
Thread	12UN-2A

End Shield LF170 046-VP (Pressboard covered)
Draw Rod
Lower draw rod LF170 059 N1 = 6 holes
Upper draw rod LF170 057
Inner Terminal n/a
tan delta < 0.5%

All bushings shall be removable without draining the tank, to facilitate quick replacement of a bushing. For the 550 kV bushing, the corona shield and lower draw rod shall remain while a new bushing and re-used upper draw rod are installed. For the neutral bushing, the draw lead remains.

Bushings shall be suitable for -50ºC ambient temperature and 110°C oil temperature.

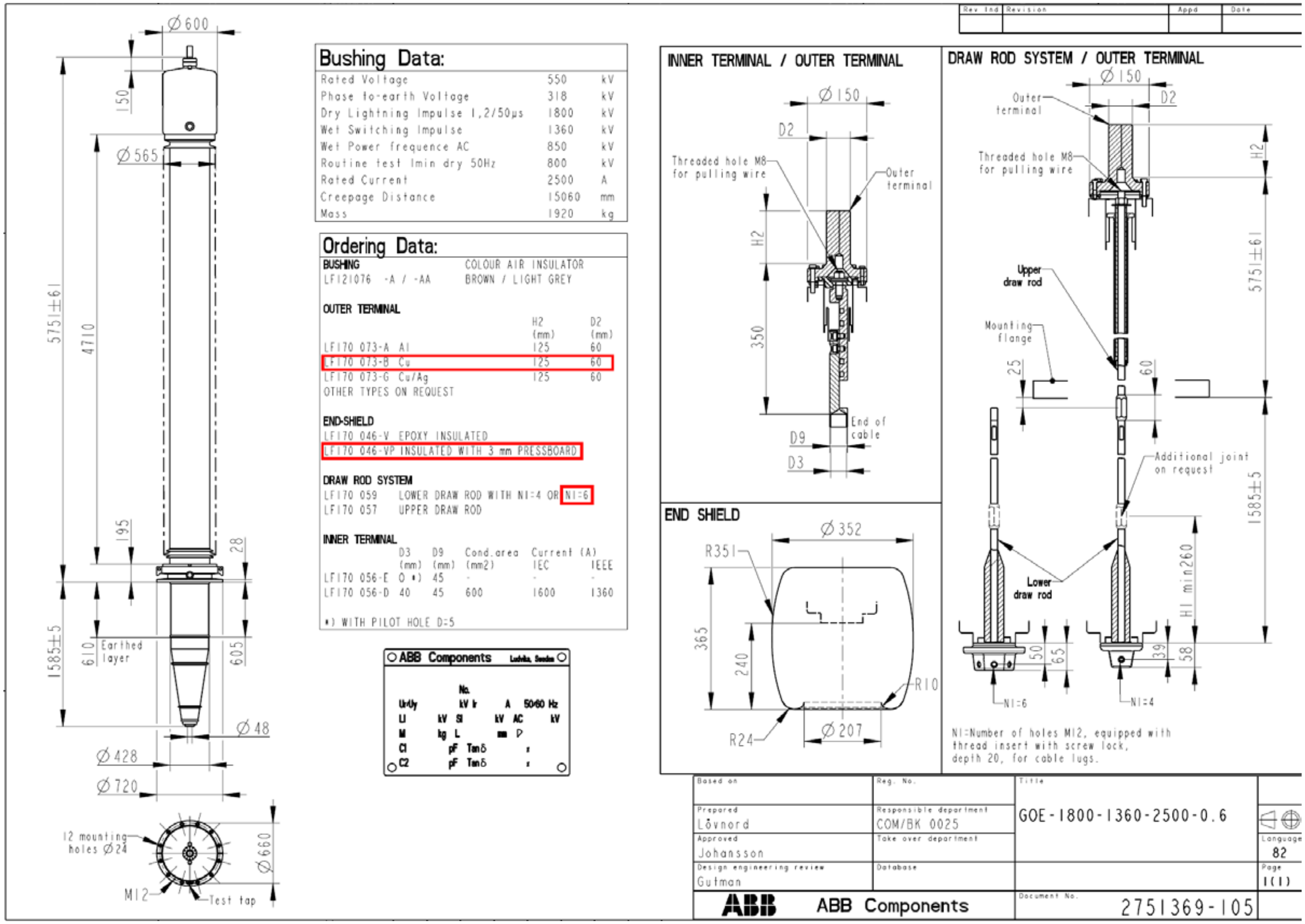
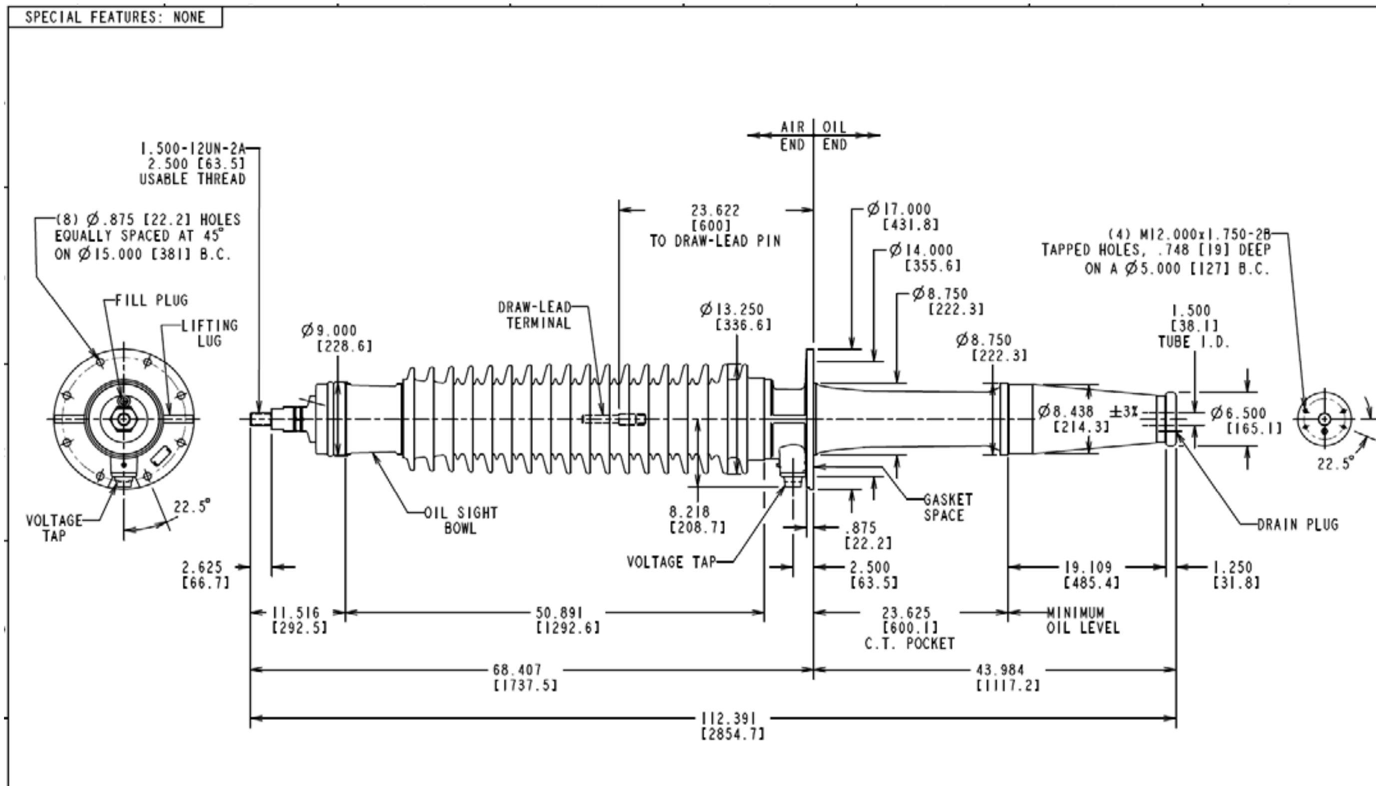


Figure 3: H1 Bushing



STYLE NO.	CATALOG NO.	OUTER INSULATING ENVELOPE COLOR	INSULATION CLASS kV	BASIC IMPULSE LEVEL kV	MAX. LINE TO GROUND VOLTAGE kV	CONNECTION METHOD AND CONTINUOUS CURRENT A @ 60Hz DRAW-LEAD	INBOARD END TRANS.	INBOARD END O.C.B.	MINIMUM CREEP DISTANCE in. / [mm]	MINIMUM ARCING DISTANCE in. / [mm]	MAXIMUM ALTITUDE ft / [m]	MOUNTING ANGLE FROM VERTICAL deg	APPROX. WEIGHT lb / [kg]
145G0600AA	N/A	GRAY	145	650	108	600	N/A	N/A	126.375 [3210]	50.891 [1293]	8300 [2530]	0 TO 30	450 [204.1]
145H0600AA	N/A	BROWN											

REVISIONS
D-4A0543 REDRAWN ON CADD WITH DIMENSIONAL CORRECTIONS. W.A.SHINER 2-02-00 H. McKIM 2/2/00

PRINTS TO: 1 7 13 2 8 1A 14 3 9 15 4 10 2P 16 1A 5 1A 11 17 6 12 18 REF:

ABB POWER T&D COMPANY INC.
COMPONENTS DIVISION, ALAMO, TN U.S.A.
TITLE: TYPE O Plus C™, CSA, CONDENSER BUSHING
RESP. DEPT.: BUSHINGS
DFTR: W.A.SHINER 02-Feb-00 UNITS = in./[mm] SCALE = 0.125 LANG. = ENGLISH
CHKD:
APPD:
P/E FILE KEY: LN23 GEN ASM
DRAWING NO: T145G0600AA
REV.: 4 SHEET 1 OF 1

Figure 4: H01 Bushing(s)

11) PCore test Terminals

All shields must cover the top of the bushing and therefore these PCore Doble test terminals may all require a custom design rather than the specific model specified above.

PCore Doble Test Terminals must be mounted, complete with shields, during factory dielectric testing of all equipment. They must also be installed and carrying current during the temperature rise and load run tests to ensure they are not overheating. They shall be included in the thermal scan.

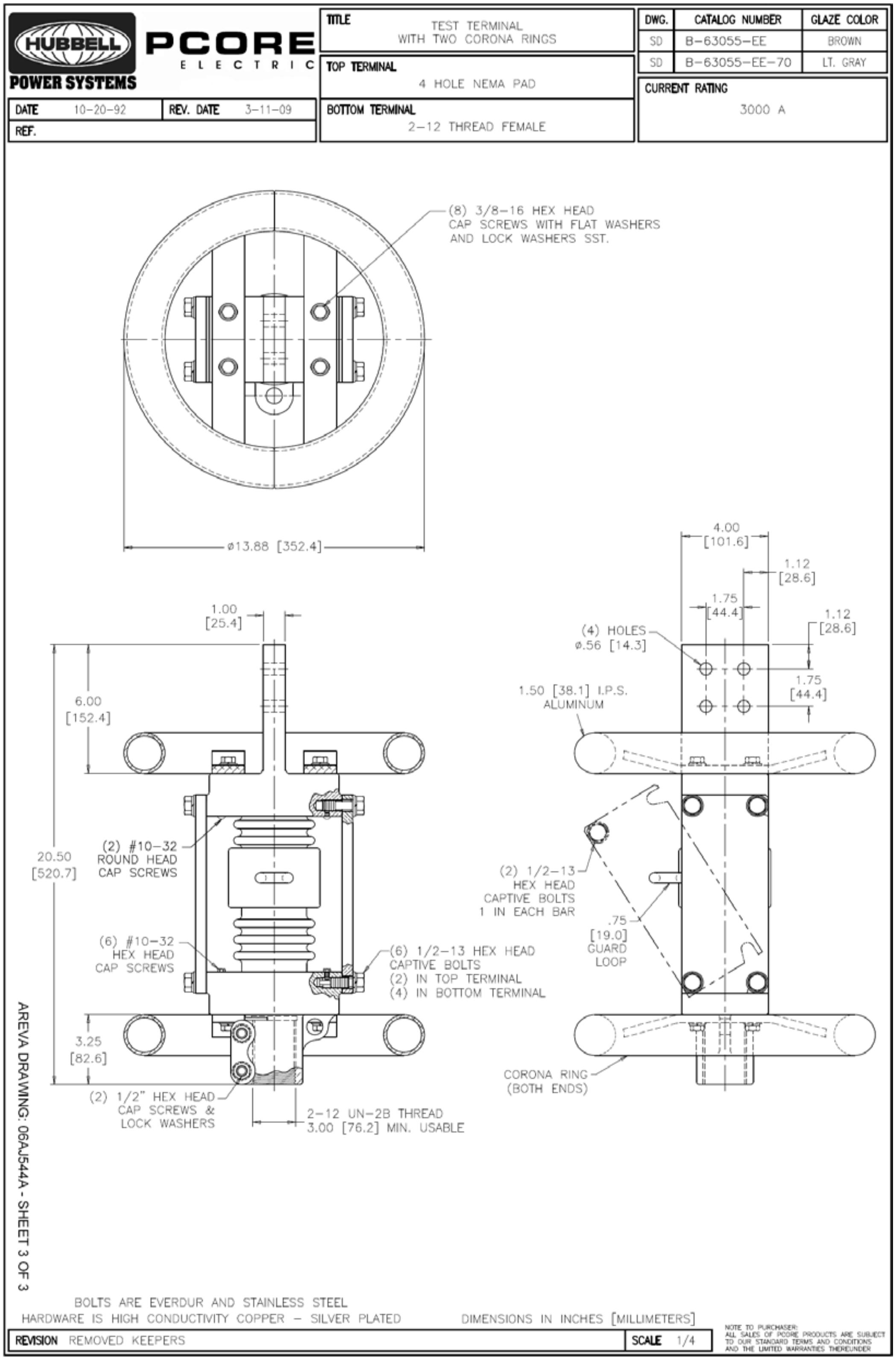


Figure 5: H1 Test Terminal

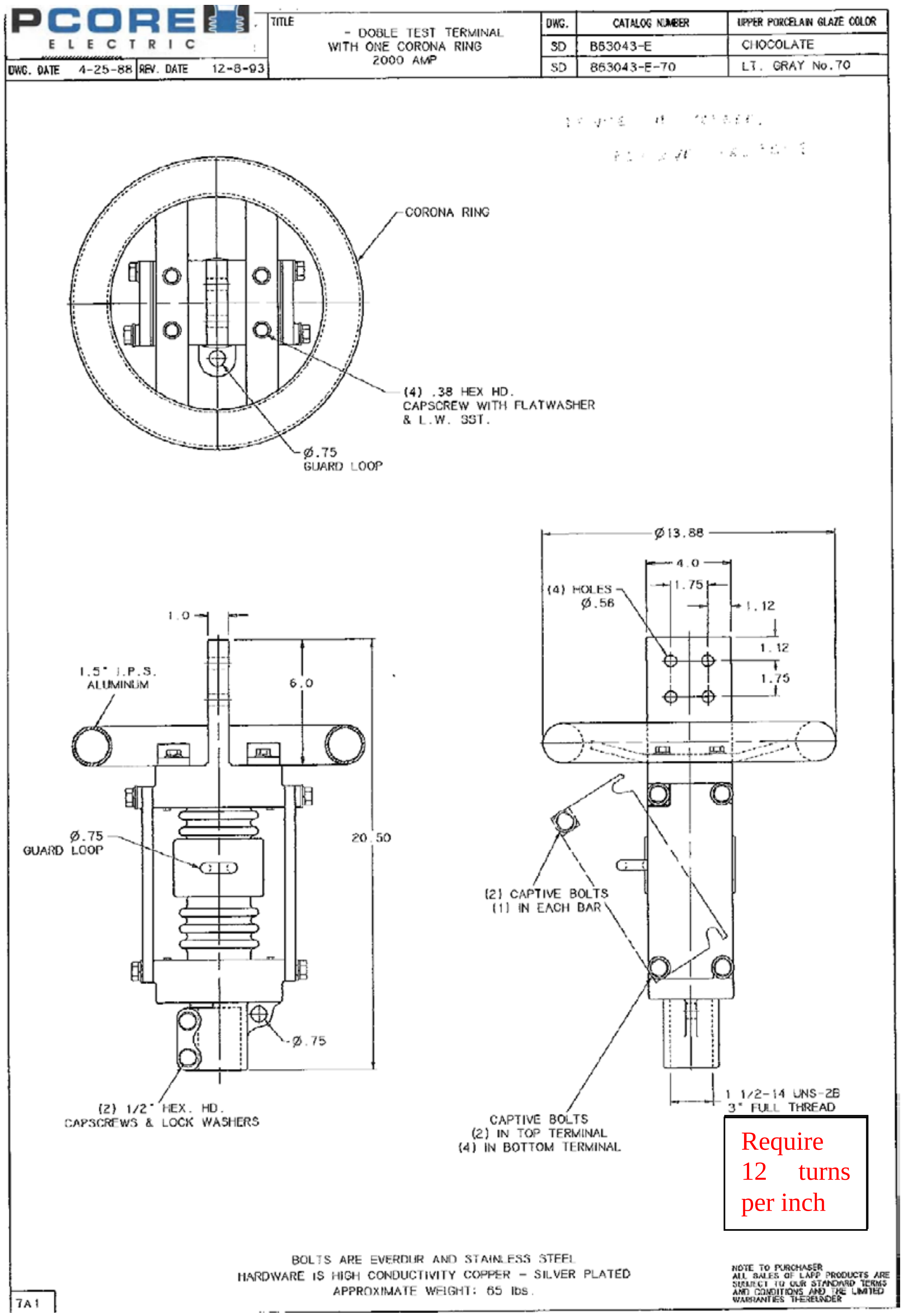


Figure 6: H01 Test Terminal

12) NERC Redundant Trips

Wherever possible, all trips shall include a redundant trip contact without the use of interposing relays. For example, the Qualitrol 509 ITM shall have an additional redundant trip contact for excessive winding temperature in addition to the primary contact. To make room for this redundant trip, the AC Fail Alarm output shall be replaced by HS Trip 2. A second WTI circuit is not required. The pressure relief device shall be ordered with DPDT contacts.

13) Apparatus Tests

The shunt reactor shall be completely assembled at the test facility or factory and tested in accordance with CAN/CSA C88 M90.

Further to the applicable production tests as specified in Clause 20.4.2 of CAN/CSA C88 M90, the design tests and other tests, as outlined in Section 2 of the Apparatus Tests and Quality Assurance Program Requirements, are required on all units.

Other tests as specified in CAN/CSA C88 M90, Clause 20.4.6 are required.

Impedance and loss shall be measured at 25%, 50%, 75% and from 85% to 125% voltage in 5% steps (based on 550 kV L-L). This data shall also be graphed. Current and loss curves shall be provided to 125% of rated voltage.
Reactor current and applied voltage wave shape oscillograms shall be taken.

Each reactor shall have a temperature rise test at 600 kV L-L. The test shall be extended out for 12 hours once a steady state temperature rise has been established. Oil samples for gas in oil analysis shall be taken at the start of the 12 hour run, 6 hours after the steady state has been reached and at the end of the run. A shutdown to determine average winding temperature shall be done at the end of the run.

Vibration tests shall be performed on each unit at 600 kV. The amplitude shall not exceed 0.1 mm peak to peak anywhere on the tank.

Sound level test shall be performed at 600 kV.

Applied or induced voltage tests shall be performed on both the line and neutral ends of the winding in accordance with the levels specified. The tests shall consist of a 7200 cycle voltage test and a one hour voltage withstand test. Partial discharge shall be recorded during all tests per Apparatus Test and Quality Assurance Program Requirements.

Calculated core losses shall be provided. The one (1) hour excitation measurement as specified in the Apparatus Test and Quality Assurance Program Requirements is not applicable.

14) Saturation Curve
The test report shall include a saturation curve showing loss and current to at least 140% voltage.

15) Capacitance
The test report shall include a sketch of the tested shunt capacitances combined with calculated values. This shall include the bushing capacitance separately.

16) Volts per Hertz
The test report shall include a voltage capability versus time curve (Volts per Hertz). The reactor will be operated on a system where long duration 60 Hz overvoltages can occur. The Contractor shall confirm that the reactor will perform this duty on an extended basis without any detrimental thermal, electrical or mechanical effects. It shall include 1.5 p.u. V/Hz at 20 seconds.

17) Test Facility Limitations
The Contractor shall advise the Purchaser of any limitations of its test facility which will not allow tests, as specified this Specification, to be performed.

18) Fire Protection
Water deluge mounting brackets shall be supplied per the Technical Requirements, clause 18.

A Heat Activated Detector (H.A.D.) control cabinet shall also be supplied.

19) Qualitrol 509 ITM Ordering Information

Figure 7: ITM

ITM 509 Ordering and Set-Up Information

Site	Riel - ITM Reactor	**with a building**
Base System	ITM 509-100 DW	
Enclosure	Panel Mount with 5 kV Surge Protection	
Heater	None	

For transformers:
ONAN

without fibre-optic sensors
Main Conservator oil level potentiometer

without Qualitrol 930 pressure sensors

Main Inputs

		Type	Mulipied Contact	Name	Code	Comment
7	Input 1	x Amp CT		WdgTemp	Cx	
7	Input 2	100 Ω Pt RTD		Top Oil	B	
7	Input 3	100 Ω Pt RTD		Ambient	B	
7	Input 4	Potentiometer		Oil Lvl	H	Oil level
5	Input 5	Dry Contact		Spare	R	
7	Input 6	Dry Contact		AC Fail	R	
7	Input 7	4 - 20 mA Loop		Hyd Gas	M	
7	Input 8	4 - 20 mA Loop		Hyd H2O	M	

Expansion Module Inputs Inputs

Input 9					
Input 10					
Input 11					
Input 12					
Input 13					
Input 14					
Input 15					
Input 16					

'x' Indicates current draw, to be chosen based on 2 p.u. current from the bushing CT, and limited to 120% of 'x'.
Therefore use C10 Amp for a 5 Amp secondary bushing CT. Use C5 Amp for a 2 Amp secondary bushing CT. (5, 10, 20 Amp)

'y' Indicates normal motor current draw for the sum of all fans in stage 1 or 2, or sum of stages 1 and 2, or sum of all pumps or LTC motor. (5,10, 20, 50, 100 Amp)

	Relay Designation for Front Panel		Base Logic from Output Relay set-up below	
10	Relay 1	Wdg Trip B	WdgTemp	
10	Relay 2	OLG Trip B	Oil Lvl	
9	Relay 3	Wdg Alarm	WdgTemp	
10	Relay 4	Wdg Trip A	WdgTemp	
12	Relay 5	Oil Temp Alm	Top Oil	
7	Relay 6	AC Fail	AC Fail	
8	Relay 7	OLG Alrm	Oil Lvl	Oil Lvl
10	Relay 8	OLG Trip A	Oil Lvl	

ITM Direct Winding		Length	Quantity
Neoptix T2 Fiber Optic Temperature Sensors	Neoptix CAB-699-Le	Length to suit	not required
Tank Wall Plate Assembly with COV-121-1 and CON-159-1	Weld On PLT-201	Steel	not required
Fibre Optic Extension Cables	Neoptix CAB-700-Le	Length to suit	not required
Hot Spot Module Channels Interface	Qualitrol MOD-638-8	8 channel	not required
Portable Fibre Optic Thermometer	Qualitrol KIT-057-1		not required

Figure 7: ITM

Remote Communiations

Additional Remote Communications Protocol	DNP 3
	MODBUS
	IEC 61850
Additional Remote Communications Ports	Ethernet FX,ST Fibre Optic
Additional Control Functions	
	Data Logging
	Event Recording
	Quantity
Hard Copy of Instruction Manual	9

Configuration file for easy set-up is available from Manitoba Hydro.
Include the actual Qualitrol order form, the Qualitrol Packing Set-up Sheet c/w serial/order number, this set-up information and the final configuration file printout in the Transformer Instruction Manual.

			Quantity
Accessories			
100 Ohm Pt RTD for Oil	Length to suit	Qualitrol 103-059-02 CS-41840	3
100 Ohm Pt RTD for Ambient	Length to suit	Qualitrol 103-054-01	0
Accessories Purchased Separately			
Thermal Well		Qualitrol 2WTL Thermal Plate	1
Brass Plug		Qualitrol 167-50-29F CS-31450	0
Main Tank Conservator Oil Level Gauge with 5 k Potentiomer		Qualitrol 042-305-01 CS 43801	1
LTC Conservator Oil Level Gauge with 5 k Potentiomer		Qualitrol 042-305-01 CS 43801	not required
MR RMV II Oil Level Gauge with two contacts (Lo, Critical Lo)		Qualitrol 032-038-01 CS-36552	not required
Pressure Sensors		Qualitrol 930-008-01 CS-36480	not required
Additional Communication Accessories (housed with in control cabinet)			
USB to DB9 Cable		Qualitrol CAB-049-1	1
USB-A to USB-B, 6 ft.		Qualitrol CAB-050-1	1

Figure 7: ITM

Aux are redundant relays for NERC requirements

Output Relay Properties	**Relay 1**	**Relay 2**	**Relay 3**	**Relay 4**
Relay	Wdg Trip B	OLG Trip B	Wdg Alarm	Wdg Trip A
Enabled	yes	yes	yes	yes
Failsafe	no	no	yes	no
Test Lockout	on	on	off	on
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

	Relay 5	**Relay 6**	**Relay 7**	**Relay 8**
Relay	Oil Temp Alm	AC Fail	OLG Alrm	OLG Trip A
Enabled	yes	yes	yes	yes
Failsafe	no	yes	yes	no
Test Lockout	on	off	off	on
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

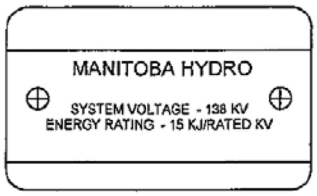
Aux are redundant relays for NERC requirements

Output Relay Control Logic	**Relay 1**	**Relay 2**	**Relay 3**	**Relay 4**
Relay	Wdg Trip B	OLG Trip B	Wdg Alarm	Wdg Trip A
	Input 1	Input 4	Input 1	Input 1
Setting	WdgTemp	Oil Lvl	WdgTemp	WdgTemp
Set Point	120	5%	105	120
Hysteresis	6	2%	6	6
Activation Direction	UP	DOWN	UP	UP
and/or/minus				
Setting				
Set Point				
Hysteresis				
Activation Direction				
and/or				
Setting				
Set Point				
Hysteresis				
Activation Direction				
and/or/minus				
Setting				
Set Point				
Hysteresis				
Activation Direction				

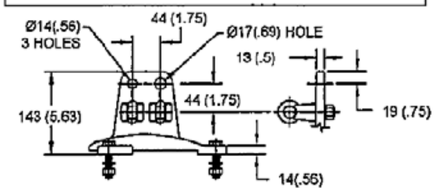
* Set Point and Hysteresis is dependent upon number of fans per stage.

	Relay 5	**Relay 6**	**Relay 7**	**Relay 8**
Relay	Oil Temp Alm	AC Fail	OLG Alrm	OLG Trip A
	Input 2	Input 6	Input 4	Input 4
Setting	Top Oil	AC Fail	Oil Lvl	Oil Lvl
Set Point	90	50%	90%	5%
Hysteresis	6	50%	6%	2%
Activation Direction	UP	DOWN	UP	DOWN
and/or/minus				
			Input 4	
Setting			Oil Lvl	
Set Point			10%	
Hysteresis			6%	
Activation Direction			DOWN	
and/or				
Setting				
Set Point				
Hysteresis				
Activation Direction				
and/or/minus				
Setting				
Set Point				
Hysteresis				
Activation Direction				

Figure 7: ITM

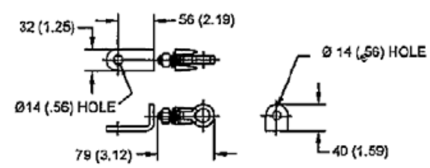


LINE TERMINAL DETAIL

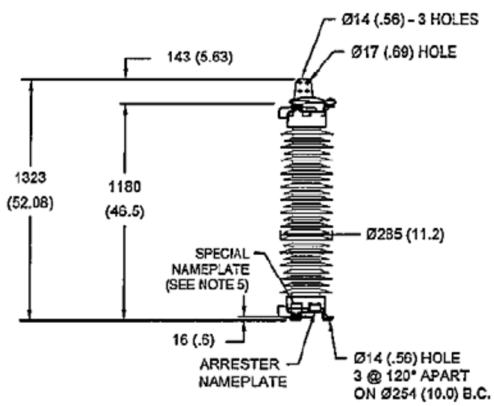


HDG 4-HOLE TERMINAL PAD, PART No. 901704001
TWO HDG TERMINALS, PART No. 2714143001
SUITABLE FOR Cu OR Al CONDUCTOR SIZE
Ø 7 (.25) - Ø 21 (.81) DIA
25 - 240 sq mm
AWG#4 - 500 MCM

GROUND TERMINAL DETAIL



HDG TERMINAL BRACKET, PART No. 896064001
ONE HDG TERMINAL, PART No. 2714143001
SUITABLE FOR Cu OR Al CONDUCTOR SIZE
Ø 7 (.25) - Ø 21 (.81) DIA
25 - 240 sq mm
AWG#4 - 500 MCM



CHARACTERISTICS	
RATED VOLTAGE, Ur	120 kVrms
MCOV, Uc	96 kVrms
MASS	75kg (166lb)
CREEPAGE DISTANCE	3620 (142.5)
LIGHTNING IMP W/S	585 kV
SWITCHING IMP W/S	424 kV
POWER FREQ W/S	301 kVrms
TOV 1s	132 kVrms
TOV 10s	124 kVrms
SLL BENDING FORCE	3023 N (680lbf)
SSL BENDING FORCE	6047 N (1359lbf)
COG ABOVE BASE	629 (24.8)
HOUSING	GREY SILICONE

NOTES:
1. DIMENSIONS IN millimeters(inches) SUBJECT TO ±3% TOLERANCE
2. CLEARANCE AND INSULATION W/S VOLTAGE APPLY AT SEA LEVEL
3. ARRESTER SUITABLE FOR OPERATION AT ALTITUDES UP TO 3650m (12000ft)
4. ARRESTER SUITABLE FOR LOW TEMPERATURE OPERATION TO -56C (-70F)
5. CUSTOMIZED NAMEPLATE

RECOMMENDED CLEARANCE (TO METAL PARTS)	
PHASE TO GROUND	540 (21.2)
PHASE TO PHASE	624 (24.6)

RESIDUAL VOLTAGE (kV) FOR INDICATED IMPULSE TYPES AND CURRENT MAGNITUDES						
STEEP CURRENT IMPULSE	SWITCHING IMPULSE		8/20 LIGHTNING IMPULSE			
20 kA	0.5 kA	2 kA	5 kA	10 kA	20 kA	40 kA
366	235	249	269	282	302	333

IEC CLASS 4
SURGE ARRESTER

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REV DATE 07/22/14

TITLE PH4 ARRESTER
120 KV RATED VOLTAGE

SIZE	DWG NO.	CAT / PART / ASSY NO.	REV
S	--	PH4145CM12001AA	0

DO NOT SCALE THIS DRAWING | DRN BY JVR | DATE 07/22/14 | SHEET 1 OF 1

Figure 8: Neutral Arrester

SPEC ID# 2 — 400 MVA 500 kV Auto Transformer

1. Delivery Location	Riel Converter Station 10 km East of Winnipeg on Provincial Hwy# 207 (6 km North of Hwy# 1) GPS: 49°51'39"N, 96°56'30"W
2. Delivery Date	2019 07 12 First issue of drawings required by 2017 09 05
3. Station Type	Terminal Station, HVDC Station
4. Type of Site	With a Building
5. Quantity	Three (3) single-phase
6. Transformer Type	Outdoor, load tap changing auto transformer suitable for step up and step-down operation. Primary operation is step-up.
7. MVA Rating	HV & LV: 400 TV: 76 Vectorial loading Refer to Remarks
8. Cooling System	ODAF
9. Sound Level	76 dBA at 550 kV L-L, LTC N
10. Temperature Rise	65ºC
11. 3-Phase Relationship	Ynad1
12. Number of Phases	1
13. Transformer Voltage	HV 500 kV GrdY / 288.7 LV 230 kV GrdY / 132.8 TV 46 kV
14. Normal Operating Voltage Range	475 kV to 550 kV

SPEC ID# 2 — 400 MVA 500 kV Auto Transformer

15. Maximum Continuous Operating Voltage and Pre-Fault Operating Voltage — 600 kV rms L-L

16. Maximum Overvoltage

	HV	TV
6 cycles		180 kV (3.91 pu)
1 second		78 kV (1.70 pu)
3 seconds	775 kV (1.55 pu)	
5 second		65 kV (1.4 pu)
20 seconds	750 kV/Hz (1.50 pu V/Hz)	
1 minute	675 kV (1.35 pu)	60 kV (1.3 pu)
continuous	600 kV (1.20 pu)	55 kV (1.2 pu)

Refer to Remark 7

	LV
20 seconds	1.40 puV / 0.91 pu Hz = 1.55 pu V/Hz

17. Reactance

HV	LV	TV	%H+L	%H+T	%L+T
537.5	230	46	13.5	39.7	24.2
500.0	230	46	14.0	40.0	24.2
462.5	230	46	14.8	40.7	24.2

18. Load Tap-changer

HV LTC in series circuit
for ±7.5% HV variation
in ±10 steps, FCBN

Tap changer shall be Reinhausen type
VRF II 1302
ED200L drive unit

HV neutral end tap changers are not acceptable.

Refer to Remarks 13 & 14

19. De-energised Tap-changer — n/a

20. Load Power Factor — 0.9 Lag to 0.9 Lead
Refer to Remarks 5 & 6

SPEC ID# 2 — 400 MVA 500 kV Auto Transformer

21. Maximum System Fault Level — Refer to Remark 4

22. Insulation Class & Test Levels

	kV LIL	Chops	SIL
HV:	1550	1780	1300
LV:	900	1035	750
H0X0:	110		
TV:	350	400	

Refer to Remark 26

	H1
Induced Potential 7200 cycle kV rms L-G	540

Applied Potential One-Hour kV rms L-G	475

23. Bushings

HV: ABB, IEC standard catalogue # GOE 1800-1360-2500-0.6-G
Refer to Remark 11

LV: ABB 300G4000EK

TV: ABB 072G2000GA

Neutral: ABB 028G3000KA

24. Connectors

For H1, X1, Y1 and Y2, refer to PCore Doble Test Terminals

H0X0: 4-hole NEMA pad

All connectors are subject to confirmation and may change at the time of drawing approval.

SPEC ID# 2 — 400 MVA 500 kV Auto Transformer

25. PCore Doble Test Terminals	HV terminal: 500 kV 2500 Amp bushing PCore# B-63055-51-EE-70 3000 Amp 4-hole NEMA pad, streamlined corona-free LV Terminal: 300 kV 4000 Amp bushings PCore# B-63080-52-EE-70 4000 Amp 6-hole NEMA pad, streamlined corona-free TV Terminal: 72.5 kV 2000 Amp bushings PCore# B-63055-51-E-70 3000 Amp 4-hole NEMA pad Neutral Terminal: not required All connectors are subject to confirmation and may change at the time of drawing approval. Refer to Remark 12
26. Surge arresters	Not required
27. Surge arrester Support & Bus Assembly	Required for LV and TV only Refer to the drawings of Purchaser-supplied arresters in Figures 14 & 15 to determine arrester support height. HV arrester will be on its own Purchaser-supplied support.
28. Discharge Counter	One (1) for LV only
29. GIC Detection	Required
30. WTI Gauge Type	Qualitrol 509 ITM Refer to Remark 26
31. GE Hydran	Required
32. Qualitrol 930 Pressure Sensors	Required

SPEC ID# 2 — 400 MVA 500 kV Auto Transformer

33. Current Transformers

H1 Bushing:
- 4 x 1500/1000/500-5
  - 10L200 at 1500-5
- Gapped-core low-remnance (Kr=0.1)

- 1 x 1500/1000-5 — 0.3B1.8 at 1000-5; 0.6B0.9 at 500-5
- Gapped-core low-remnance (Kr=0.1)
  - MCIC approval is not required

- 1 x WTI CT
- 1 x LDC CT

X1 Bushing
- 4 x 4000/3000/1000-5
  - 10L400 at 4000-5
- Gapped-core low-remnance (Kr=0.1)

- 1 x 3000/2000-5 — 0.3B1.8 at 2000-5; 0.6B0.9 at 1000-5
- Gapped-core low-remnance (Kr=0.1)
  - MCIC approval is not required

- 1 x LDC CT

Y1 Bushing:
- 1 x 5000-5 — 10L800 standard core

Y2 Bushing:
- 1 x 5000-5 — 10L800 standard core
- 1 x WTI CT

H2X2 Bushing:
- 1 x 2000/1200-5 — 0.3B1.8 at 1200-5; 0.6B0.9 at 800-5
- Gapped-core low-remnance (Kr=0.1)
  - MCIC approval is not required

- 1 x WTI CT

Metering CTs are for GIC detection.

SPEC ID# 2 — 400 MVA 500 kV Auto Transformer

34. AC Auxiliary Voltage — Fans & Pumps: 120/208 V, 3-phase, 4-W
Heaters & Lights: 120 V, 1-phase
Tap-changer: 120/208 V, 3-phase, 4-W

35. DC Auxiliary Voltage — 125 V dc for tripping & alarms
The voltage may make steady excursions as high as 140 V periodically.

36. Loss Evaluation — No Load: $8,112 / kW
Load: $2,020 / kW at 400 MVA

37. Paint Colour — ANSI 70 Grey

38. Test Variations — Refer to Remark 21

39. Limitations — Refer to Figure 16 for foundation limitations

40. Quality Assurance Requirements — ISO 9001

Load Tap-changer Control Options (Refer to the Technical Requirements)

41. Motor Voltage — 120/208 V, 3-phase, 4-W

42. Fully Automatic Voltage Control — Not required. Refer to Remarks 13 & 14

43. Supervisory Control — Required

44. Remote Indication — Required

45. Paralleling — Implemented by Purchaser.
Refer to Remarks 13 & 14

46. Voltage Sensing VT supplied by — Purchaser

47. Tap-change Direction for Step-up Operation

Pos.	Variation	Direction
+10	HV + 7.5%	↑ Raise
N		
-10	HV - 7.5%	↓ Lower

Remarks:

1) Design Review

A two-day design review meeting may be required with the Purchaser. If required, this meeting will be held at the Contractor's factory. At this meeting, design personnel will be available for discussion of the design. All drawings will be made available for inspection. Completion of the latest revision of Manitoba Hydro Design Review Document is required prior to the meeting. This shall be submitted to the Purchaser, as complete as possible, at least one (1) week prior to the scheduled design review meeting. The Contractor shall request the latest version of the Manitoba Hydro Design Review Document from the Purchaser prior to completing it.

2) Single Line

The transformer is required for service associated with the 500 kV interconnection between Manitoba and USA and these special duty requirements must be carefully considered when designing the overall bank and its associated equipment.

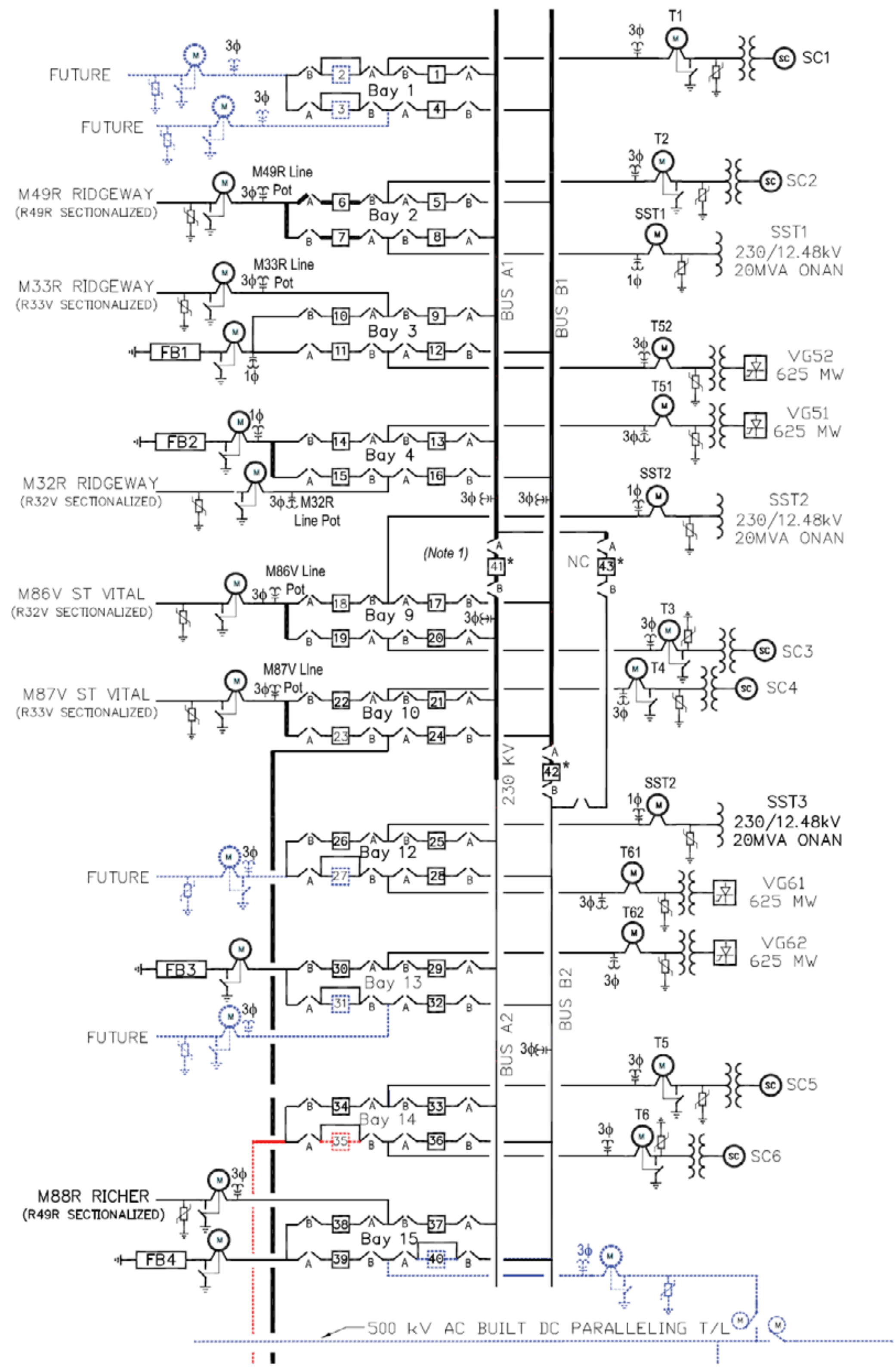


Figure 1a : Riel SLD : Existing

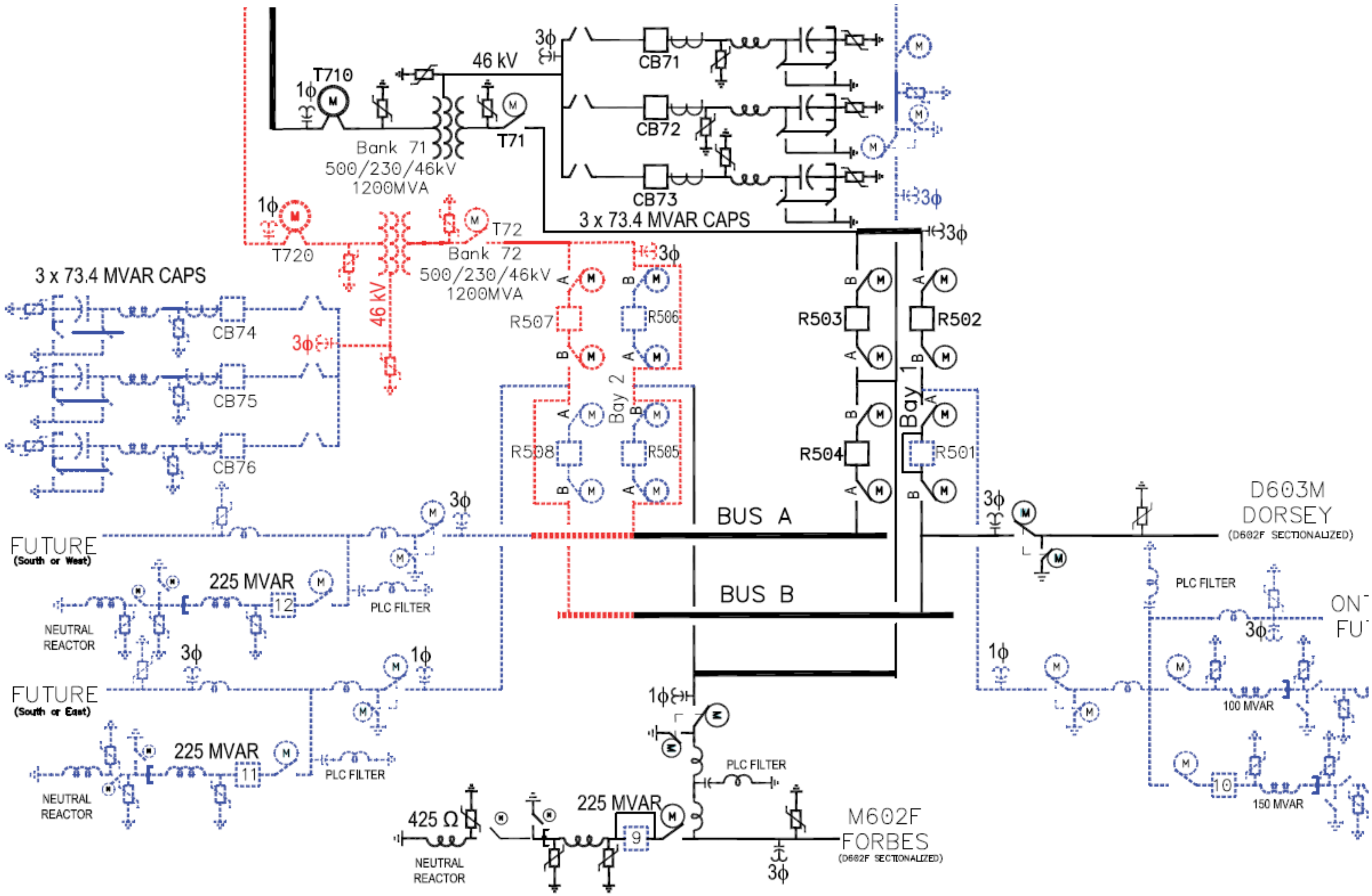


Figure 1b: Riel SLD : Existing continued and New T72

3) Cold Temperature Start-Up

Due to the special operating requirements, the transformer must be capable of being energised at -50ºC without unit damage of any nature. Special start-up instructions shall be supplied, if required, in the Instruction Manuals. Refer also to Technical Requirements, clause 41.2.2.

4) Tertiary

The tertiary is connected to capacitor banks rated up to 220 MVAr and 46 to 55 kV. The 3-phase capacitor banks are connected wye-wye ungrounded. Current limiting and outrush reactors are also attached in series with the capacitors as shown on the single-line diagram. However, these reactors shall not be considered in the determination of infeed for fault calculations. For short-circuit fault calculations, assume the tertiary system impedance is 4.39% at 400 MVA base. The HV and LV system impedances are zero.

The capacitors will be switched in and out daily, with the transformer energised and under load. The capacitor banks are rated 73.3 MVAr 3-phase (24.4 MVAr 1-phase) per double-wye bank. There are up to three of these banks connected to the tertiary for a total load of 220 MVAr 3-phase (73.3 MVAr 1-phase). So the capacitive load can be 0, 73.3, 146.7 or 220 MVAr 3-phase (0, 24.4, 48.9, 73.3 MVAr 1-phase). These MVAr ratings are based on a 46 kV rated voltage.

Initially, prior to the addition of the capacitor banks, the tertiary shall likely be connected to a VT protection scheme using an open-circuited delta secondary on the VTs. One end of this open delta secondary is grounded. In this case, the tertiary is not directly grounded.

The tertiary may alternatively be grounded with capacitive voltage transformers and lightning arresters.

The transformer must also be suitable for continuous operation with one corner of the delta tertiary grounded: that is, with a continuous single-line-to-ground fault. This applies with or without capacitors, VTs or CVTs.

5) 3-Circuit Loading

The auto-transformer shall be subject to the following operating conditions. This involves the determination of vectorial voltages and currents based on the transformer's T-diagram and the loads listed below.

For these calculations, the tap changer is allowed to move to a normal operating position, to satisfy the constraints. The worst cases that meet these constraints are the operating conditions.

Calculate this at the extreme tap positions and at rated tap. For cases that do not fall within the constraints, determine the proper tap position and recalculate at that position.

The tertiary is loaded with 0 to 220 MVAr of capacitance at 46 kV and will operate in the range of 46 to 55 kV. Note that the TV is connected to a fixed impedance load (constant ohms) and not a fixed MVA load. Hence, the TV load can be greater than 73.3 MVAr single-phase ($3 \times 46^2 / 73.3 = 86.6$ ohms fixed).

The tertiary may alternatively be grounded with capacitive voltage transformers and lightning arresters.

The transformer must also be suitable for continuous operation with one corner of the delta tertiary grounded: that is, with a continuous single-line-to-ground fault. This applies with or without capacitors, reactors, VTs or CVTs.

These voltages and currents shall then be used to determine the losses and the oil and winding temperatures. Typically the oil temperatures and each winding gradient are determined under different conditions.

Test data shall be used to determine the losses and shutdown currents for the temperature rise test.

An example calculation can be provided upon request.

<u>Heavy Export Loading</u> Step-up Operation

The following vectorial loading capability is required with the LV as the source. This means the LV supply is greater than 1200 MVA.

Circuit	MVA	Voltage	Power Factor
LV	source	230-243	
HV	1200	500-535	0.9 lag or lead
TV	220	46-55	0 lead

<u>Heavy Import Loading</u> Step-down Operation

The following vectorial loading capability is required with the HV as the source. This means the HV supply is greater than 1200 MVA.

Circuit	MVA	Voltage	Power Factor
HV	source	500-525	
LV	1200	230-243	0.9 lag or lead
TV	220	46-55	0 lead

Light Export Loading Step-up Operation

The following vectorial loading capability is required with the LV as the source. This means the LV supply is greater than 600 MVA.

Circuit	MVA	Voltage	Power Factor
LV	source	235-243	
HV	600	500-535	0.8 lag or lead
TV	73.3	43-50	0 lead
or	220	43-50	0 lead

Light Import Loading Step-down Operation

The following vectorial loading capability is required with the HV as the source. This means the HV supply is greater than 600 MVA.

Circuit	MVA	Voltage	Power Factor
HV	source	500-530	
LV	600	230-243	0.8 lag or lead
TV	73.3	43-50	0 lead
or	220	43-50	0 lead

6) Overload

An overloading capability study is required. During all of these loads,

0.9 lag $\leq$ HV power factor ≤ 0.9 lead

TV power factor = 0 lead

$46 \leq$ TV Voltage ≤ 55 kV rms

These are determined based on the same type of calculations as in Remark 5.

The auto-transformer shall be suitable for the following loads and overloads:

Required Overload

MVA Pre-Load HV	MVA Pre-Load TV	MVA Load HV	MVA Load TV	Voltage LV kV	Voltage HV kV	Duration hours	Ambient °C	Hotspot Limit °C
1200	220	1390	220	230-240	535	cont.	25	120
"	147	"	147	"	"	"	30	"
"	110	"	110	"	"	"	35	"
"	73	"	73	"	"	"	40	"
1200	220	1297	220	230-240	535	cont.	30	120
"	147	"	147	"	"	"	35	"
"	110	"	110	"	"	"	"	"
1200	220	1620	220	230-240	500-535	1	30	140
"	"	1572	"	"	"	2	"	"
"	"	1536	"	"	"	4	"	"
"	"	1500	"	"	"	cont.	"	"

Figure 2

The manufacturer shall also provide a loading study to determine the maximum allowable overloads based on the following conditions:

Overload to be determined by manufacturer

MVA Pre-Load HV	MVA Pre-Load TV	MVA Load HV	MVA Load TV	Voltage LV kV	Voltage HV kV	Duration hours	Ambient °C	Hotspot Limit °C
1200	220	?	220	230	537.5	1, 2, 4, 8	20, 25, 30, 35, 40	120,140
"	147	?	147	"	"	"	"	"
"	110	?	110	"	"	"	"	"
"	73	?	73	"	"	"	"	"
1200	220	?	220	230	500	1, 2, 4, 8	20, 25, 30, 35, 40	120,140
"	147	?	147	"	"	"	"	"
"	110	?	110	"	"	"	"	"
"	73	?	73	"	"	"	"	"
1200	220	?	220	230	462.5	1, 2, 4, 8	20, 25, 30, 35, 40	120,140
"	147	?	147	"	"	"	"	"
"	110	?	110	"	"	"	"	"
"	73	?	73	"	"	"	"	"

Figure 3

The overload limit for oil temperature is 110°C. If any of these overloads result in an overexcitation of the core, the core, clamping structure and tank shall be designed to suit. If a specific overexcitation condition cannot be met, the

Contractor shall notify the Purchaser immediately and specify the reason for the limitation.

7) Short-Time and Continuous Over-voltages

The transformers will be operated on a system where long duration 60 Hz overvoltages can occur. The Contractor shall supply a curve of the 60 Hz over-excitation versus time capability (Volts per Hertz) for the transformers confirming their capability to operate at over-excited voltage conditions and the Contractor shall confirm that the units will perform this duty on an extended basis without any detrimental thermal, electrical e.g. (corona) or mechanical effects. The curve shall exceed or include the following 60 Hz points:

600 kV line-to-line rms continuous;
675 kV line-to-line rms one minute;
775 kV line-to-line rms three seconds.

8) Core Flux Density

The 3 phase transformer banks will terminate a 340 mile, 500 kV line section. The line has a series capacitor at the end in Minnesota. There is a possibility of ferroresonance occurring following an inadvertent 230 kV side opening not preceded by a 500 kV side opening. This would be due to the attendant line-end voltage rise, further aggravated by the presence of up to 110 MVAr of tertiary capacitance, overexciting the transformer core. To guard against ferroresonance for a 230 kV load rejection, the core must be designed with a saturation characteristic of high air-core reactance and a higher than usual kneepoint. The average flux density in the core shall not exceed 1.56 Tesla at 230 kV.

9) Geomagnetically Induced Current (GIC)

It is anticipated that the auto-transformer series winding will be subjected to a solar induced dc current as high as 223 A dc per phase and the common winding up to 145 A dc per phase. The highest currents measured to date are 126 and 80 A dc respectively. Long duration base currents are estimated at 25 and 15 A dc respectively. A better estimate should be available after contract award.

A GIC capability study shall be performed as per clause 9 of IEEE C57.163-2015, IEEE Guide for Establishing Power Transformer Capability while under Geomagnetic Disturbances. The manufacturer shall use these base and peak GIC levels along with the generic GIC stepped waveform timing from IEEE C57.163-2015 clause 9.1 GIC Signature. The signature shall cycle for 8 hours minimum or until the cycle temperatures stabilize.

The manufacturer shall take special precautions (i.e. shielding, gapped core CTs, reduced core flux density) to minimize the effects of the solar induced dc currents.

The core temperature rise above ambient shall be limited to 100˚C rise with the core at saturation (2.0 Tesla).

The Purchaser plans to monitor the levels of dc current through the transformer and remove them from service if the values become excessive. The Contractor shall provide time versus dc current withstand curves for the transformer as well as the other requirements of clause 9.3 of IEEE C57.163.

10) GIC Detection

Refer also to Technical Specification Clause 40.

Since the bank is made up of three single-phase transformers, the neutral will be formed by the Purchaser. This means only one Advanced Power Technologies Eclipse and two Advanaced Power Technologies' HECT neutral CTs are required for the three single-phase transformers. It also means that the HECT CTs shall be installed by the Purchaser, but supplied loose by the Contractor. The Eclipse shall be installed in the first transformer. The metering CTs are required in all three transformers as are the terminal blocks and wiring for the Eclipse, in case the Eclipse is moved to a different phase. So all three control cabinets shall be designed the same, with only the Eclipse itself not being installed in two phases. The wiring from the terminal blocks to where the Eclipse would be installed may be omitted on those two phases.

11) HV Bushing

The HV bushing shall be ABB, IEC standard, to be replaceable with the Purchaser's existing bushings.

Type: GOE 1800-1360-2500-0.6-G
Drawing#: 2751369-105
Bushing Catalogue#: LF 121 076-AA (light grey)
Outer Terminal LF170 073-B (Copper)
D2 50.8 mm (2")
H2 125 mm
Thread 12UN-2A
End Shield LF170 046-VP (Pressboard covered)
Draw Rod
Lower draw rod LF170 059 N1 = 6 holes
Upper draw rod LF170 057
Inner Terminal n/a
tan delta < 0.5%

HV and LV bushings shall be removable without draining the tank, to facilitate quick replacement of a bushing. The corona shield and lower draw rod shall remain while a new bushing and re-used upper draw rod are installed. For the neutral bushing, the draw lead remains. Only a one piece corona shield that allows for the removal of the bushing with the corona shield attached is acceptable. Any paper covered part(s) and/or insulation that is not shipped inside of the main tank shall be shipped under oil or in the same method as the main tank insulation system.

Bushings shall be suitable for -50°C ambient temperature and 110°C oil temperature.

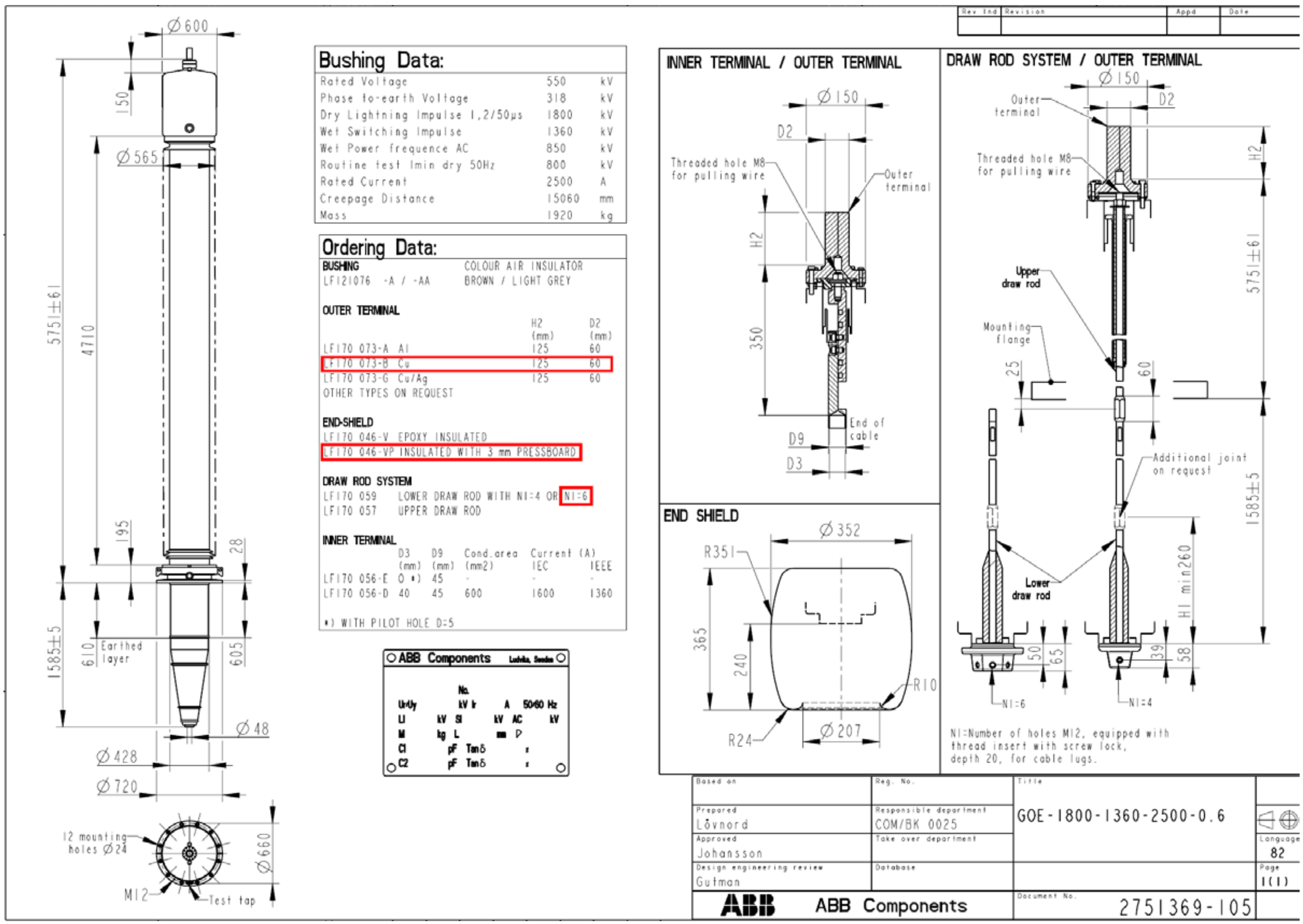
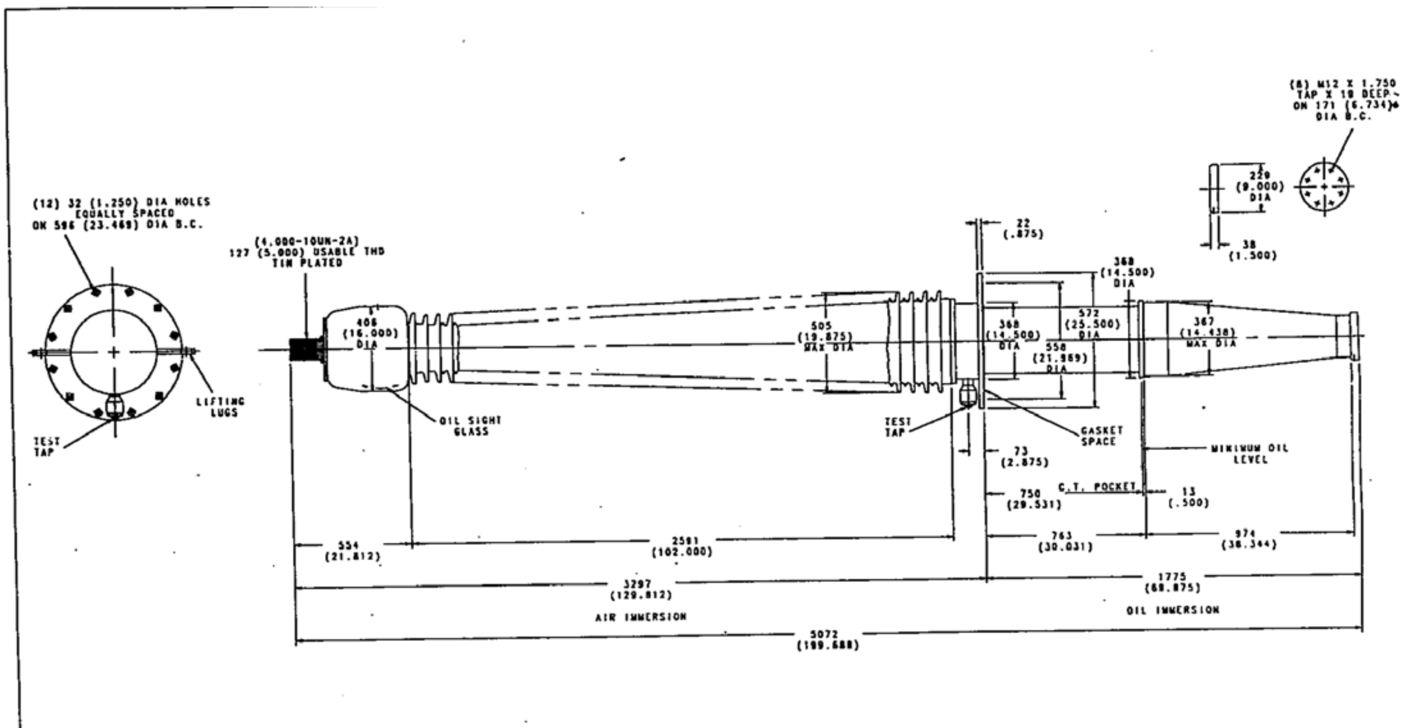


Figure 4: H1 Bushing



* DIMENSIONS ONLY CONFORM TO GL1-2.

STYLE	EEMAC STANDARD	KV CLASS	L.I.L. KV	RATED MAX LINE TO GROUND VOLTAGE KV	INSULATING ENVELOPE COLOR	MINIMUM CREEP DISTANCE MILLIMETERS (INCHES)	MINIMUM ARCING DISTANCE MILLIMETERS (INCHES)	APPROXIMATE WEIGHT KILOGRAMS (LBS)	RATED CONTINUOUS CURRENT AMPS	RATED CONTINUOUS CURRENT CONNECTION	MOUNTING	ANGLE OF INCLINATION FROM THE VERTICAL DEGREES	MAX ALTITUDE METERS (FEET)
300G4000EK	GL1-3*	300	1050	191	GRAY	6543 (257.6)	2591 (102.0)	1148 (2530)	4000 TRANS.	INBOARD END CONNECTED	VERTICAL	0 TO 30	3300 (10000)
300H4000EK	GL1-3*	300	1050	191	BROWN	6543 (257.6)	2591 (102.0)	1148 (2530)	4000 TRANS.	INBOARD END CONNECTED	VERTICAL	0 TO 30	3300 (10000)

ABB POWER T&D COMPANY INC.

APPARATUS TYPE O PLUS C™ EEMAC BUSHING OUTLINE

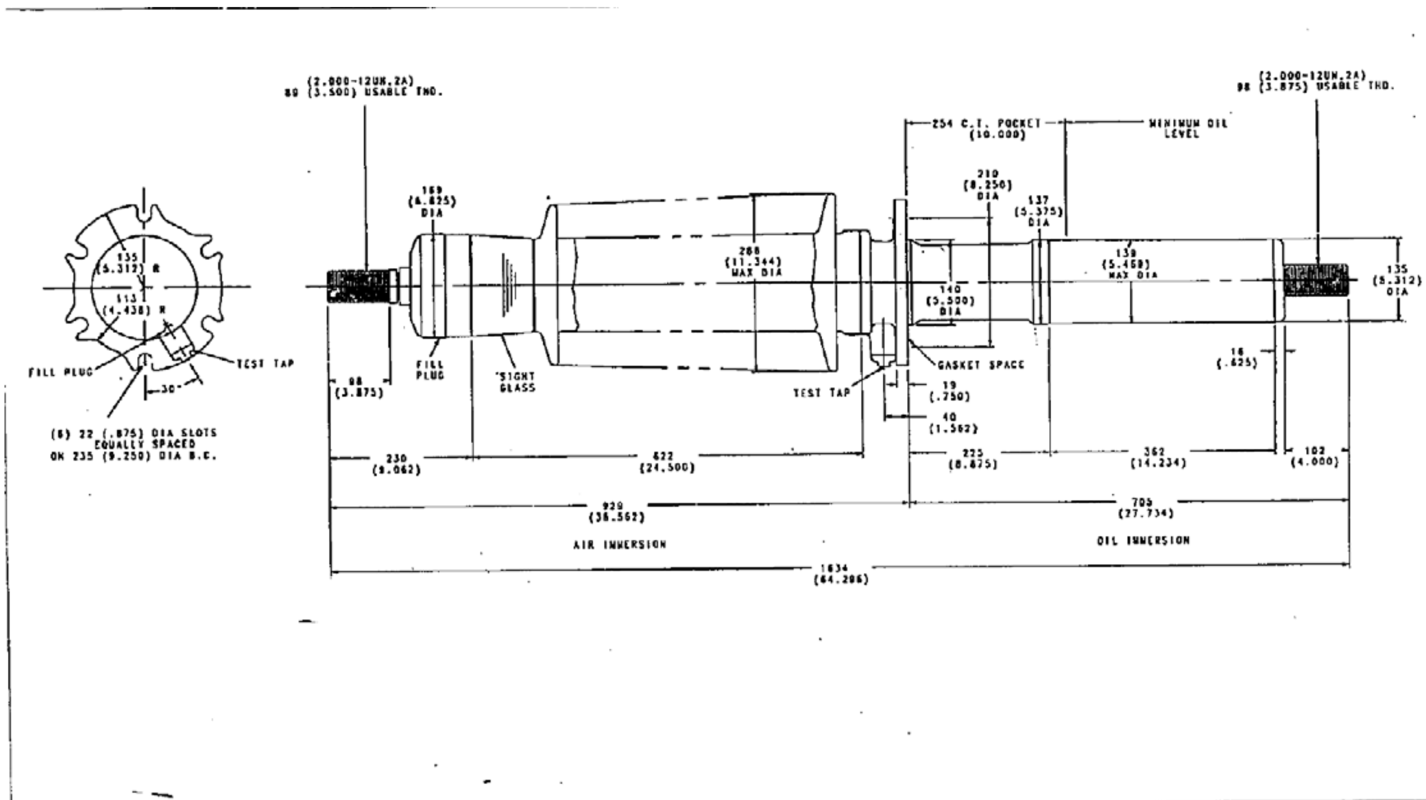
DIMENSIONS IN MILLIMETERS(INCHES)-SCALE NTS REV. 3

T300G4000EK

COMPONENTS DIVISION ALAMO, TN., U.S.A.

THIS DWG. TO BE CHANGED ON GRAPHICS SYSTEM ONLY

Figure 5: X1 Bushing

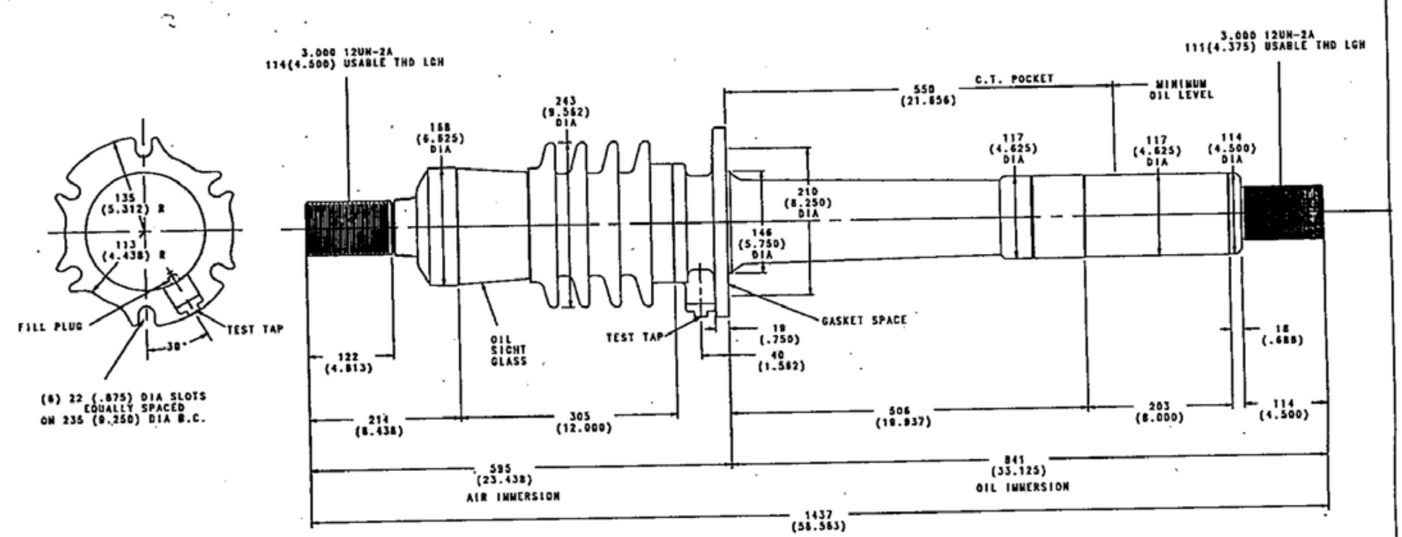


STYLE	EEMAC STANDARD	KV CLASS	L.I.L. KV	RATED MAX LINE TO GROUND VOLTAGE KV	INSULATING ENVELOPE COLOR	MINIMUM CREEP DISTANCE MILLIMETERS (INCHES)	MINIMUM ARCING DISTANCE MILLIMETERS (INCHES)	APPROXIMATE WEIGHT KILOGRAMS (LBS)	RATED CONTINUOUS CURRENT AMPS	RATED CONTINUOUS CURRENT CONNECTION	MOUNTING	ANGLE OF INCLINATION FROM THE VERTICAL DEGREES	MAX ALTITUDE METERS (FEET)
072G2000GA	CL1-3	72.5	350	47	GRAY	1445 (56.90)	622 (24.500)	55 (122)	2000 TRANS.	INBOARD END CONNECTION	VERTICAL	0 TO 30	1000 (3300)
072H2000GA	CL1-3	72.5	350	47	BROWN	1445 (56.90)	622 (24.500)	55 (122)	2000 TRANS.	INBOARD END CONNECTION	VERTICAL	0 TO 30	1000 (3300)

ABB POWER T&D COMPANY INC.
APPARATUS TYPE O PLUS C™ EEMAC BUSHING OUTLINE
T072G2000GA
COMPONENTS DIVISION
ALAMO, TN., U.S.A.
THIS DWG TO BE CHANGED ON GRAPHICS SYSTEM ONLY

Figure 6: TV Bushing

STYLE	SPECIAL FEATURES
028G3000KC	FRENCH NAMEPLATES
028H3000KC	FRENCH NAMEPLATES



STYLE	EEMAC STANDARD	KV CLASS	L.I.L. KV	RATED MAX LINE TO GROUND VOLTAGE KV	INSULATING ENVELOPE COLOR	MINIMUM CREEP DISTANCE MILLIMETERS (INCHES)	MINIMUM ARCING DISTANCE MILLIMETERS (INCHES)	APPROXIMATE WEIGHT KILOGRAMS (LBS)	RATED CONTINUOUS CURRENT AMPS	RATED CONTINUOUS CURRENT CONNECTION	MOUNTING	ANGLE OF INCLINATION FROM THE VERTICAL DEGREES	MAX ALTITUDE METERS (FEET)
028G3000KA 028G3000KC	GL1-3	27.5	150	17	GRAY	544 (21.400)	305 (12.000)	68 (150)	3000 TRANS.	INBOARD END CONNECTED	VERTICAL	0 TO 30	1000 (3300)
028H3000KA 028H3000KC	GL1-3	27.5	150	17	BROWN	544 (21.400)	305 (12.000)	68 (150)	3000 TRANS.	INBOARD END CONNECTED	VERTICAL	0 TO 30	1000 (3300)

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PRINTS TO

1		10	P
2		11	
3		12	A
4		13	
5	3A	14	
6		15	
7		16	A
8	A	17	
9	6A	18	

ABB POWER T&D COMPANY INC.

APPARATUS TYPE O PLUS C™ EEMAC BUSHING OUTLINE

DIMENSIONS IN MILLIMETERS(INCHES)-SCALE NTS REV. 1

DFTR Doris Hicks 12/28/92 APPD L Elder 1-12-93

APPD

CHKD APPD

T028G3000KA

COMPONENTS DIVISION ALAMO, TN., U.S.A.

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Figure 7 : H2X2 Bushing

12) PCore test Terminals

All shields must cover the top of the bushing and therefore these PCore Doble test terminals may all require a custom design rather than the specific model specified above.

PCore Doble Test Terminals must be mounted, complete with shields, during factory dielectric testing of all equipment. They must also be installed and carrying current during the temperature rise and load run tests to ensure they are not overheating. They shall be included in the thermal scan.

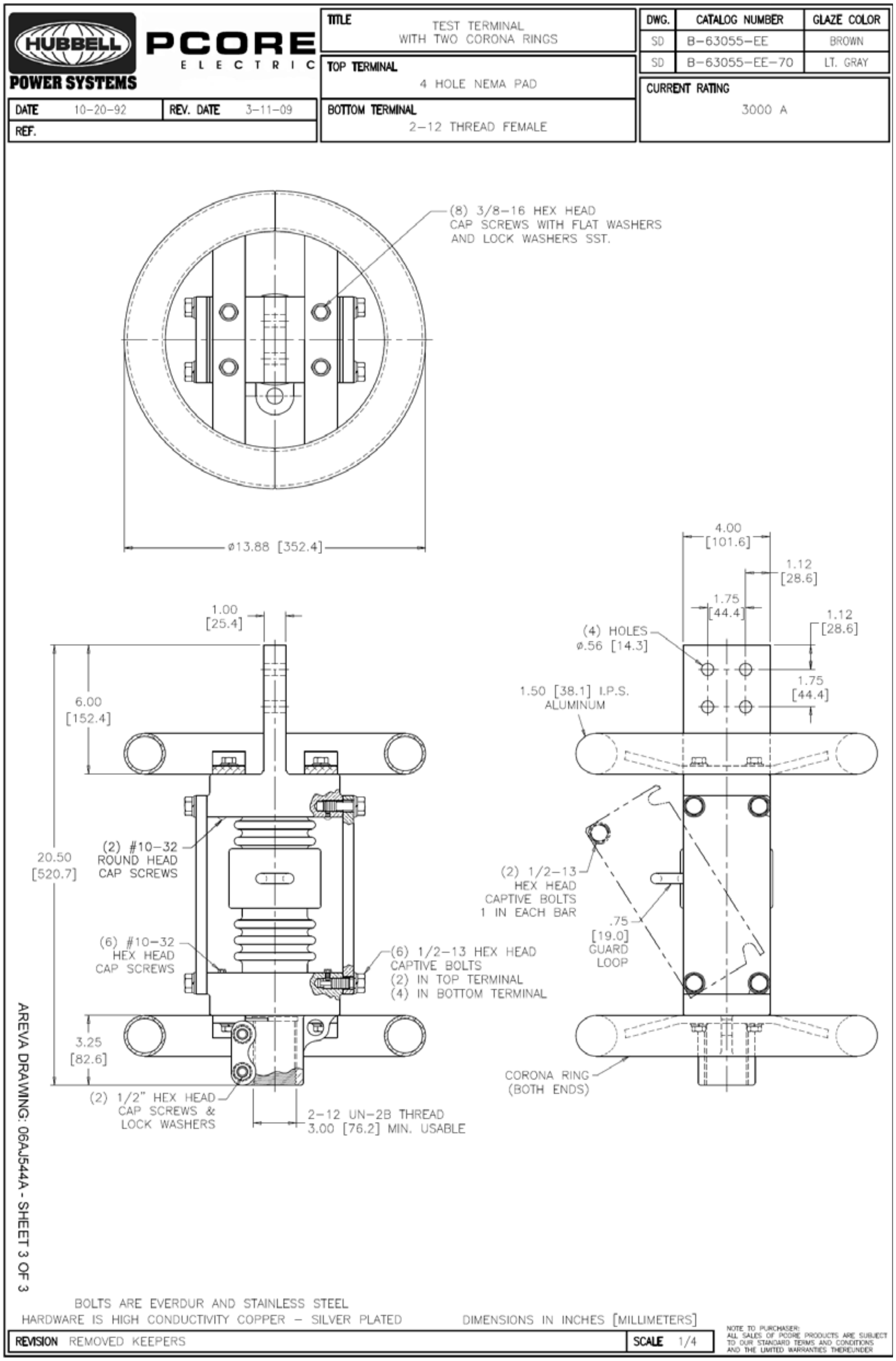


Figure 8: H1 & Y Test Terminals

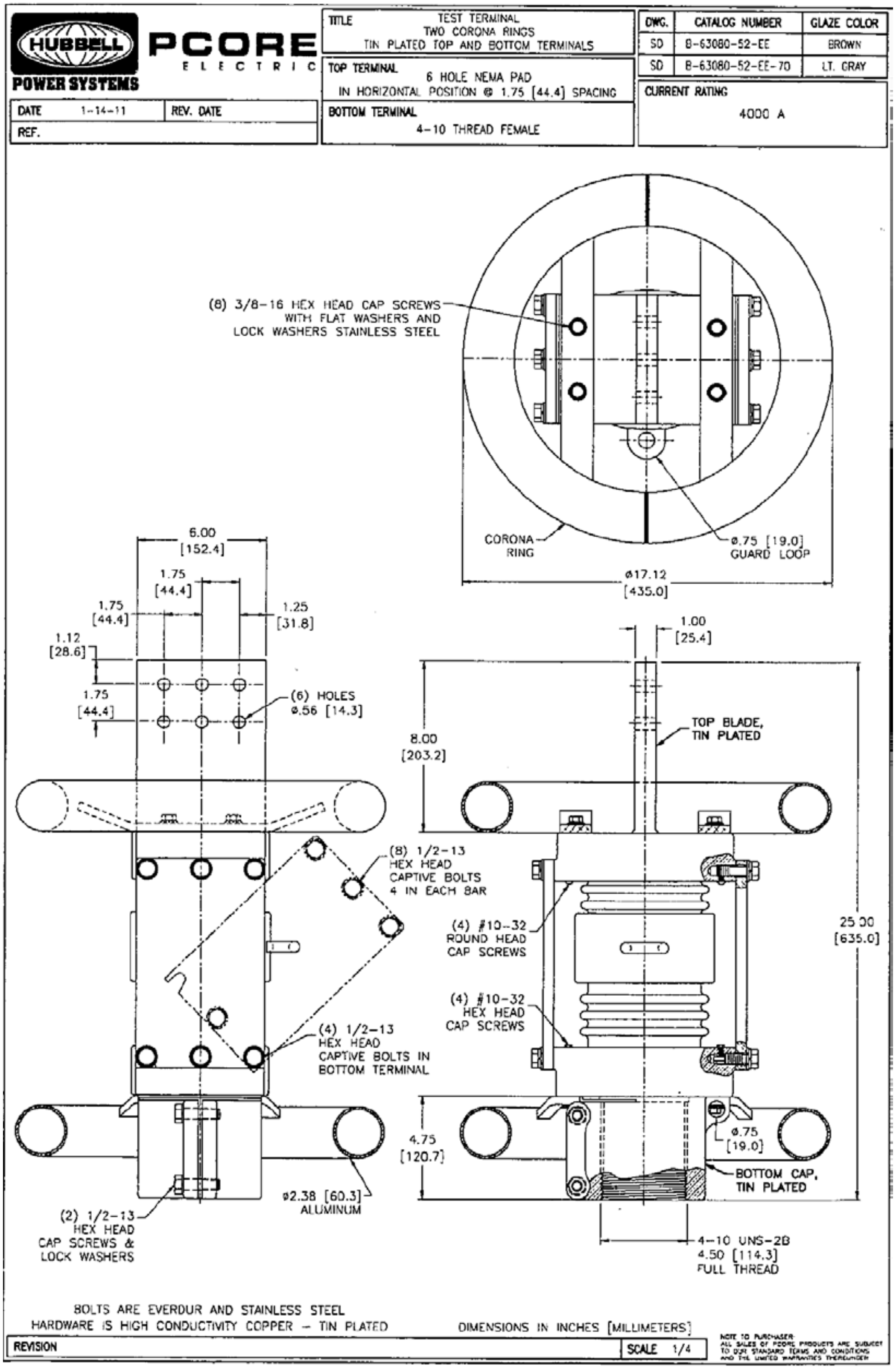


Figure 9: X1 Test Terminal

13) Supervisory Control

The transformer shall be equipped with remote-manual control so that taps may be controlled manually from a common supervisory point.

14) Existing Reinhausen TAPCON

The Contractor does not need to supply voltage regulation equipment (other than the LDC CTs), paralleling equipment or a Beckwith or TAPCON voltage regulating relay.

The existing bank, T71, uses a single Reinhausen TAPCON relay to control the three single-phase tap changers. Likewise, the new T72 bank will use a single TAPCON to control its three single-phase tap changers. This TAPCON will be supplied by the Purchaser and installed in the building.

Bank T71 tap changers and the TAPCON were purchased under

Reinhausen project #	2417745_3
Motor Drive serial numbers	1163234, 1163237, 1163236
LTC serial numbers	1351093, 1163237, 1163236
Master TAPCON serial number	1357560 (spare is 1411717)

NOTE: T71 was originally purchased with a TAPCON in each LTC motor drive, but these were later removed and scrapped in favour of a single master TAPCON. Quote these serial numbers when ordering the tap changer from Reinhausen. Reinhausen is familiar with this project.

The T71 TAPCON and T72 TAPCON will communicate through a CANBUS connection, allowing one of these to become the master and the other the slave, to allow for paralleling. This will be implemented by the Purchaser.

The Purchaser-supplied TAPCON will control the three T72 transformer tap changers through the Supervisory analogue interposing relays (Raise / Lower / Remote / Manual). The BCD module in the LTC cabinet shall feed back tap position to the TAPCON. No communication through fibre will be used. So the standard controls as specified in the Technical Requirements, clauses 14 and 33, shall be supplied by the Contractor, less the paralleling (clause 33.9) and voltage regulation controls (clause 33.7).

NOTE: The BCD module provides all open contacts in LTC position neutral. This confuses the TAPCON, so the normal at-rest position of the tap changer shall be "N+".

Refer to Figure 10.

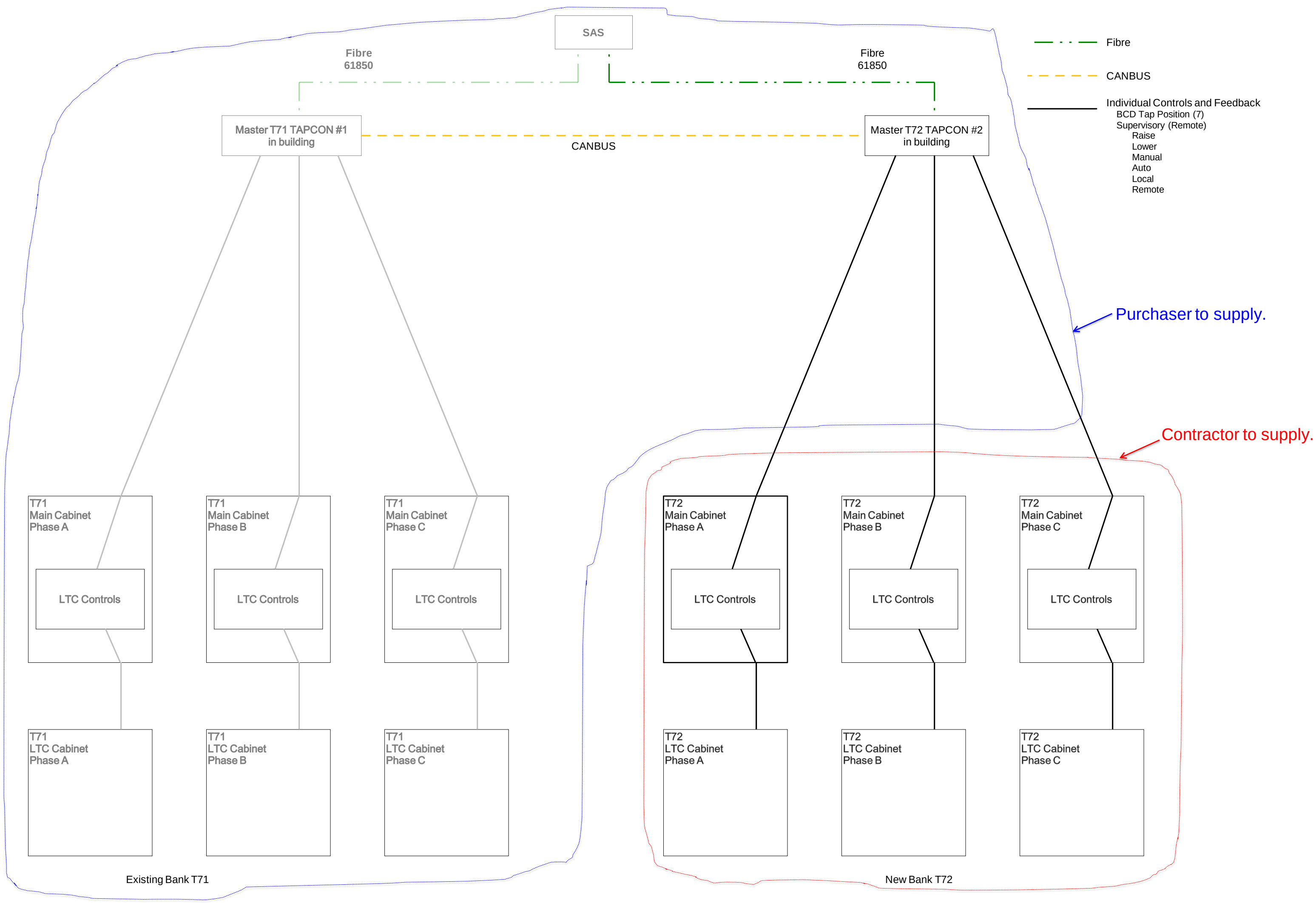


Figure 10 : LTC Control Connections

15) Fire Protection

Water deluge mounting brackets shall be supplied per the Technical Requirements, clause 18.

A Heat Activated Detector (H.A.D.) control cabinet shall also be supplied.

16) Cabinet Locations

Refer to Figure 2 for mounting location of the Main, LTC, Qualitrol 509 ITM and H.A.D. cabinets.

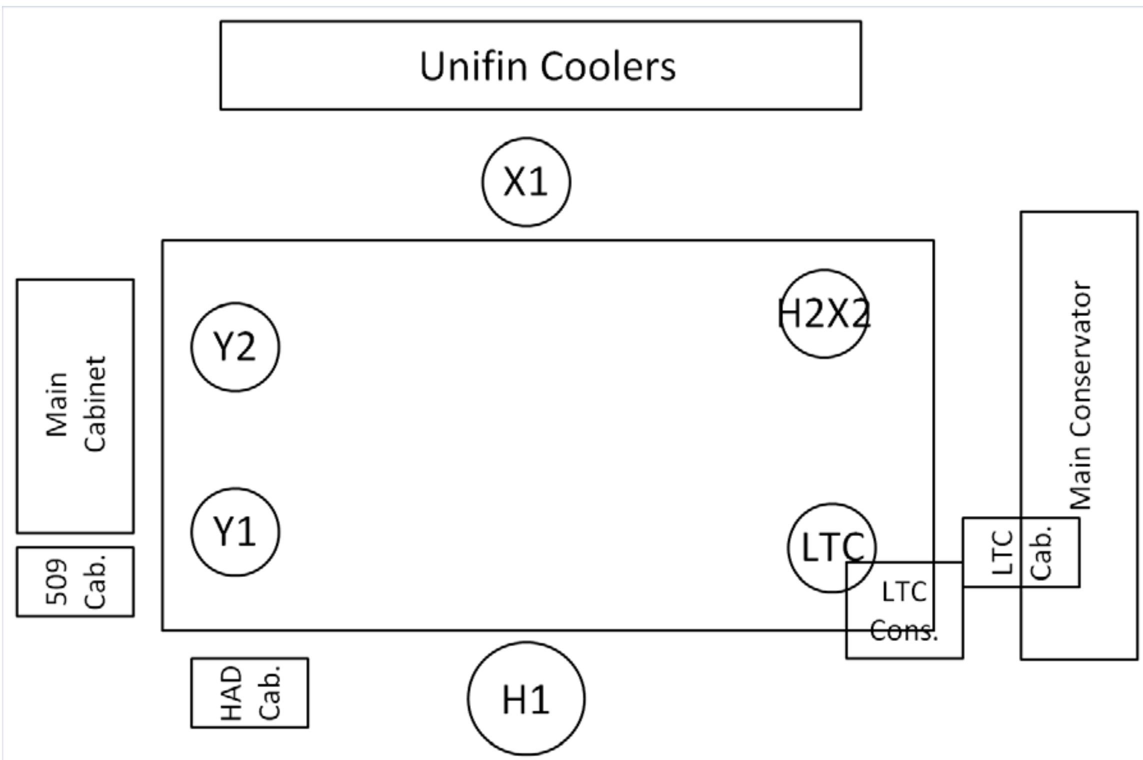


Figure 11: General Arrangement

17) Cooling Failure

Fan and pump circuits shall be monitored in such a manner that they give a positive alarm indication for either fan/pump failure or voltage supply failure.

18) Bird Guards

Bird guards are required for the TV bushings. This may be in the form of netting or rubber terminal covers and is subject to Purchaser's approval.

19) NERC Redundant Trips

Wherever possible, all trips shall include a redundant trip contact without the use of interposing relays. For example, the Qualitrol 509 ITM shall have an additional redundant trip contact for excessive winding temperature in addition to the primary contact. The pressure relief device shall be ordered with DPDT contacts.

20) Transient Recovery Voltage Data

The Contractor shall provide the following to facilitate transient recovery voltage studies for associated circuit breaker requirements:

a) A saturation curve showing the core loss and exciting current characteristics up to and beyond the point at which the air-core reactance line becomes tangent to the magnetization curve. The air-core reactance in ohms shall be provided for all three circuits.

b) All inter-winding, winding-to-ground and terminal-to-ground capacitance values and data pertaining to the natural frequency of oscillations occurring in the auto-transformer due to high current surges.

c) A curve of the overexcitation versus time (Volts per Hertz) capability of the auto-transformer which confirms the capability to operate at the specified overexcited voltage conditions. The Contractor shall confirm that the auto-transformer will perform this duty on an extended basis without any detrimental thermal, electrical (e.g. corona) or mechanical effects.

d) The calculated switching surge capability limit of the LV winding for neutral tap and the tap extremes, and a statement about what is limiting the capability.

21) Additional Testing

Further to the production tests as outlined in the Apparatus Tests and Quality Assurance Program Requirements, the following tests shall apply:

a) No load loss and excitation current from 80% to 120%. Another measurement point shall be done as near to 125% voltage as the test equipment allows.

b) ODAF temperature rise test with 3-circuit total losses based on the Heavy Loading criteria at the worst case tap positions, with “N” coolers. Each winding temperature shall be determined based on its own worst case condition and the worst case oil temperature.

c) The additional temperature rise tests to determine the 'm' and 'n' exponents is required on one single-phase transformer.

d) Additional temperature rise run (with single shutdown) to determine temperature rises for:
   “N+1” coolers in operation;
   “N” coolers, less one fan;
   “N” coolers, two of which have one failed fan.
   The duration of these runs is until 4 consecutive 15 minute readings of top oil rise are within one degree.

e) The H1 induced voltage test levels shall be 540 kVrms for 1 minute and 475 kVrms for 1-hour. The test shall be done twice, once with each tertiary bushing grounded. H1, X1 and the ungrounded tertiary bushing shall be monitored for partial discharge.

f) Sound level at 110% voltage.

g) Special Excitation Tests
   The Contractor shall obtain a highly accurate power quality meter to measure the 3-phase vectorial voltages and currents during core excitation testing after dielectrics. This would not use the normal meters such as the Haefely measuring system nor oscilloscopes which aren’t accurate enough. This requires a power quality analyzer or a Phaser Measuring Unit such as the Dranetz-BMI Power Xplorer series, ERLPHase Tesla PMU recorders or other such devices which samples voltage and current at a rate of at least 256 samples per cycle, with storage and download capability.

   The purpose is to use these 3-phase voltage and current phasors (magnitude and phase angle) for the creation of accurate B-H curves by the Purchaser. This would be used for both transient studies and GIC studies.

   The meter would need to measure several voltage levels, both in the forward and reverse regions of the B-H curve. For example, measure at 10%, 30%, 50%, 70%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, and as high as practical for the supply, and then begin stepping down again through the same levels. The measurement recording shall provide data for at least 3 cycles at each level.

   The test shall be done for at least two tap positions: the neutral and one extreme tap position.

   The core should be demagnetized prior to this test.

h) A sketch of the tested shunt capacitances combined with calculated values shall be included in the test report. This shall include the bushing capacitance separately.

22) Factory Test Limitations

The Contractor shall advise the Purchaser of any limitations of its test facility which will not allow tests, as specified in this Specification, to be performed.

23) Test Data Calculations

After testing, the Contractor shall supply the following information in the test report, based on the factory test results.
Temperature rises at full-load based on three-circuit loading with N+1, N and N-1 coolers in service.
Temperature rises at full-load based on three-circuit loading with N coolers in service but 1 fan in total from those N coolers removed from service.
Temperature rises at full-load based on three-circuit loading with N coolers in service but 2 fans in total from those N coolers removed from service.

20) Saturation Curve

The test report shall include a saturation curve showing loss and current.

21) Capacitance

The test report shall include a sketch of the tested shunt capacitances combined with calculated values. This shall include the bushing capacitance separately.

22) Volts per Hertz

The test report shall include a voltage capability versus time curve (Volts per Hertz). The reactor will be operated on a system where long duration 60 Hz overvoltages can occur. The Contractor shall confirm that the reactor will perform this duty on an extended basis without any detrimental thermal, electrical or mechanical effects. It shall include 1.5 p.u. V/Hz at 20 seconds.

24) Qualitrol 930 Pressure Sensors

Three Qualitrol 930 Pressure sensors are required, Qualitrol part number 930-008-01 CS-36480.

25) Fibre-Optic Sensors

16 Fibre-optic sensors shall be supplied and installed, connected to the Qualitrol 509 ITM. Some of these will be used for GIC detection.

The sensors shall be monitored during the temperature rise tests. This will be done during both the oil rise tests and during all winding temperature shutdowns for comparison with the shutdown resistances. The entire log of data from the monitoring device shall be provided as a file and a summary of the relevant results shall be printed with the test report.

26) Qualitrol 509 ITM

Two ITMs are required as per the ordering information shown below. They are referred to as ITM-A and ITM-B.

Figure 12: ITM-A

ITM 509 Ordering and Set-Up Information

Site	Riel - ITM A		with a building
Base System	ITM 509-100	DW	**For transformers:**
Enclosure	Panel Mount with 5 kV Surge Protection		ODAF in-tank LTC with fibre-optic sensors Main Conservator oil level potentiometer
Heater	None		without Qualitrol 930 pressure sensors

Main Inputs

	Input	Type	Muliplied Contact	Name	Code	Comment
7	Input 1	100 Ω Pt RTD		Top Oil	B	
7	Input 2	x Amp CT		SV Temp	Cx	
7	Input 3	x Amp CT		CV Temp	Cx	
7	Input 4	x Amp CT		TV Temp	Cx	
7	Input 5	Potentiometer		MainOLG	H	
7	Input 6	100 Ω Pt RTD		Ambient	B	
7	Input 7	4 - 20 mA Loop		Hyd Gas	M	
7	Input 8	4 - 20 mA Loop		Hyd H2O	M	
	Expansion Module Inputs Inputs					
	Input 9					
	Input 10					
	Input 11					
	Input 12					
	Input 13					
	Input 14					
	Input 15					
	Input 16					

'x' Indicates current draw, to be chosen based on 2 p.u. current from the bushing CT, and limited to 120% of 'x'.
Therefore use C10 Amp for a 5 Amp secondary bushing CT. Use C5 Amp for a 2 Amp secondary bushing CT. (5, 10, 20 Amp)

'y' Indicates normal motor current draw for the sum of all fans in stage 1 or 2, or sum of stages 1 and 2, or sum of all pumps or LTC motor. (5,10, 20, 50, 100 Amp)

	Relay Designation for Front Panel		Base Logic from Output Relay set-up below				
6	Relay 1	Fans 1	SV Temp	or	CV Temp	or	TV Temp
6	Relay 2	Fans 2	SV Temp	or	CV Temp	or	TV Temp
6	Relay 3	Fans 3	SV Temp	or	CV Temp	or	TV Temp
9	Relay 4	Wdg Alarm	SV Temp	or	CV Temp	or	TV Temp
8	Relay 5	Wdg Trip	SV Temp	or	CV Temp	or	TV Temp
12	Relay 6	Oil Temp Alm	Top Oil				
12	Relay 7	MainOLG Alrm	MainOLG		MainOLG		
12	Relay 8	MainOLG Trip	MainOLG				

Figure 12: ITM-A

ITM Direct Winding

		Length	Quantity
Neoptix T2 Fiber Optic Temperature Sensors	Neoptix CAB-699-Le	Length to suit	8
Tank Wall Plate Assembly with COV-121-1 and CON-159-1	Weld On PLT-201	Steel	1 Plate for 16 sensors
Fibre Optic Extension Cables	Neoptix CAB-700-Le	Length to suit	8
Hot Spot Module Channels Interface	Qualitrol MOD-638-8	8 channel	1
Portable Fibre Optic Thermometer	Qualitrol KIT-057-1		not required

Remote Communiations

Additional Remote Communications Protocol	DNP 3
	MODBUS
	IEC 61850
Additional Remote Communications Ports	Ethernet FX,ST Fibre Optic
Additional Control Functions	
	Data Logging
	Event Recording
	Quantity
Hard Copy of Instruction Manual	9

Configuration file for easy set-up is available from Manitoba Hydro. Include the actual Qualitrol order form, the Qualitrol Packing Set-up Sheet c/w serial/order number, this set-up information and the final configuration file printout in the Transformer Instruction Manual.

Accessories

			Quantity
100 Ohm Pt RTD for Oil	Length to suit	Qualitrol 103-059-02 CS-41840	2
100 Ohm Pt RTD for Ambient	Length to suit	Qualitrol 103-054-01	1

Accessories Purchased Separately

Thermal Well	Qualitrol 2WTL Thermal Plate	1
Brass Plug	Qualitrol 167-50-29F CS-31450	1
Main Tank Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	1
LTC Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	not required
MR RMV II Oil Level Gauge with two contacts (Lo, Critical Lo)	Qualitrol 032-038-01 CS-36552	not required
Pressure Sensors	Qualitrol 930-008-01 CS-36480	not required

Additional Communication Accessories (housed with in control cabinet)

USB to DB9 Cable	Qualitrol CAB-049-1	1
USB-A to USB-B, 6 ft.	Qualitrol CAB-050-1	1

Figure 12: ITM-A

Aux are redundant relays for NERC requirements

Output Relay Properties	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Fans 1	Fans 2	Fans 3	Wdg Alarm
Enabled	yes	yes	yes	yes
Failsafe	no	no	no	yes
Test Lockout	off	off	off	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	Wdg Trip	Oil Temp Alm	MainOLG Alrm	MainOLG Trip
Enabled	yes	yes	yes	yes
Failsafe	no	yes	yes	no
Test Lockout	on	off	off	on
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

Aux are redundant relays for NERC requirements

Output Relay Control Logic	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Fans 1	Fans 2	Fans 3	Wdg Alarm
	Input 2	Input 2	Input 2	Input 2
Setting	SV Temp	SV Temp	SV Temp	SV Temp
Set Point	30	40	50	110
Hysteresis	6	6	6	6
Activation Direction	UP	UP	UP	UP
and/or/minus	**or**	**or**	**or**	**or**
	Input 3	Input 3	Input 3	Input 3
Setting	CV Temp	CV Temp	CV Temp	CV Temp
Set Point	30	40	50	110
Hysteresis	6	6	6	6
Activation Direction	UP	UP	UP	UP
and/or	**or**	**or**	**or**	**or**
	Input 4	Input 4	Input 4	Input 4
Setting	TV Temp	TV Temp	TV Temp	TV Temp
Set Point	30	40	50	110
Hysteresis	6	6	6	6
Activation Direction	UP	UP	UP	UP
and/or/minus				
Setting				
Set Point				
Hysteresis				
Activation Direction				

* Set Point and Hysteresis is dependent upon number of fans per stage.

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	Wdg Trip	Oil Temp Alm	MainOLG Alrm	MainOLG Trip
	Input 2	Input 1	Input 5	Input 5
Setting	SV Temp	Top Oil	MainOLG	MainOLG
Set Point	120	90	90%	5%
Hysteresis	6	6	6%	2%
Activation Direction	UP	UP	UP	DOWN
and/or/minus	**or**			
	Input 3		Input 5	
Setting	CV Temp		MainOLG	
Set Point	120		10%	
Hysteresis	6		6%	
Activation Direction	UP		DOWN	
and/or	**or**			
	Input 4			
Setting	TV Temp			
Set Point	120			
Hysteresis	6			
Activation Direction	UP			
and/or/minus				
Setting				
Set Point				
Hysteresis				
Activation Direction				

Figure 12: ITM-A

Figure 13: ITM-B

ITM 509 Ordering and Set-Up Information

Site	Riel - ITM B	with a building
Base System	ITM 509-300 DW	
Enclosure	Panel Mount with 5 kV Surge Protection	
Heater	None	

For transformers:
ODAF
in-tank LTC
with fibre-optic sensors

LTC oil level gauge potentiometer
without Qualitrol 930 pressure sensors

Muliplied Contact

Main Inputs

		Type		Name	Code	Comment
7	Input 1	100 Ω Pt RTD		Top Oil	B	
7	Input 2	x Amp CT		SV Temp	Cx	
7	Input 3	x Amp CT		CV Temp	Cx	
7	Input 4	x Amp CT		TV Temp	Cx	
7	Input 5	Potentiometer		LTC OLG	H	
7	Input 6	x Amp Sensor		LTCMotr	Iy	
7	Input 7	Tap Position Resistor Bridge		LTC Pos	V3	
7	Input 8	Dry Contact		LTC L/R	R	

Expansion Module Inputs Inputs

Input 9					
Input 10					
Input 11					
Input 12					
Input 13					
Input 14					
Input 15					
Input 16					

'x' Indicates current draw, to be chosen based on 2 p.u. current from the bushing CT, and limited to 120% of 'x'.
Therefore use C10 Amp for a 5 Amp secondary bushing CT. Use C5 Amp for a 2 Amp secondary bushing CT. (5, 10, 20 Amp)

'y' Indicates normal motor current draw for the sum of all fans in stage 1 or 2, or sum of stages 1 and 2, or sum of all pumps or LTC motor. (5,10, 20, 50, 100 Amp)

	Relay Designation for Front Panel		Base Logic from Output Relay set-up below				
6	Relay 1	Fans 1	SV Temp	or	CV Temp	or	TV Temp
6	Relay 2	Fans 2	SV Temp	or	CV Temp	or	TV Temp
6	Relay 3	Fans 3	SV Temp	or	CV Temp	or	TV Temp
9	Relay 4	Wdg Alarm	SV Temp	or	CV Temp	or	TV Temp
8	Relay 5	Wdg Trip	SV Temp	or	CV Temp	or	TV Temp
12	Relay 6	Oil Temp Alm	Top Oil				
12	Relay 7	LTC OLG Alrm	LTC OLG		LTC OLG		
12	Relay 8	LTC OLG Trip	LTC OLG				

Figure 13: ITM-B

ITM Direct Winding

		Length	Quantity
Neoptix T2 Fiber Optic Temperature Sensors	Neoptix CAB-699-Le	Length to suit	8
Tank Wall Plate Assembly with COV-121-1 and CON-159-1	Weld On PLT-201	Steel	Use plate from ITM A
Fibre Optic Extension Cables	Neoptix CAB-700-Le	Length to suit	8
Hot Spot Module Channels Interface	Qualitrol MOD-638-8	8 channel	1
Portable Fibre Optic Thermometer	Qualitrol KIT-057-1		not required

Remote Communiations

Additional Remote Communications Protocol	DNP 3
	MODBUS
	IEC 61850
Additional Remote Communications Ports	Ethernet FX,ST Fibre Optic
Additional Control Functions	
	Data Logging
	Event Recording
	Quantity
Hard Copy of Instruction Manual	9

Configuration file for easy set-up is available from Manitoba Hydro. Include the actual Qualitrol order form, the Qualitrol Packing Set-up Sheet c/w serial/order number, this set-up information and the final configuration file printout in the Transformer Instruction Manual.

Accessories

			Quantity
100 Ohm Pt RTD for Oil	Length to suit	Qualitrol 103-059-02 CS-41840	1
100 Ohm Pt RTD for Ambient	Length to suit	Qualitrol 103-054-01	1

Accessories Purchased Separately

Thermal Well	Qualitrol 2WTL Thermal Plate	Use well from ITM A
Brass Plug	Qualitrol 167-50-29F CS-31450	0
Main Tank Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	0
LTC Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	1
MR RMV II Oil Level Gauge with two contacts (Lo, Critical Lo)	Qualitrol 032-038-01 CS-36552	not required
Pressure Sensors	Qualitrol 930-008-01 CS-36480	not required

Additional Communication Accessories (housed with in control cabinet)

USB to DB9 Cable	Qualitrol CAB-049-1	1
USB-A to USB-B, 6 ft.	Qualitrol CAB-050-1	1

Figure 13: ITM-B

Aux are redundant relays for NERC requirements

Output Relay Properties	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Fans 1	Fans 2	Fans 3	Wdg Alarm
Enabled	yes	yes	yes	yes
Failsafe	no	no	no	yes
Test Lockout	off	off	off	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	Wdg Trip	Oil Temp Alm	LTC OLG Alrm	LTC OLG Trip
Enabled	yes	yes	yes	yes
Failsafe	no	yes	yes	no
Test Lockout	on	off	off	on
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

Aux are redundant relays for NERC requirements

Output Relay Control Logic	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Fans 1	Fans 2	Fans 3	Wdg Alarm
	Input 2	Input 2	Input 2	Input 2
Setting	SV Temp	SV Temp	SV Temp	SV Temp
Set Point	30	40	50	110
Hysteresis	6	6	6	6
Activation Direction	UP	UP	UP	UP
and/or/minus	**or**	**or**	**or**	**or**
	Input 3	Input 3	Input 3	Input 3
Setting	CV Temp	CV Temp	CV Temp	CV Temp
Set Point	30	40	50	110
Hysteresis	6	6	6	6
Activation Direction	UP	UP	UP	UP
and/or	**or**	**or**	**or**	**or**
	Input 4	Input 4	Input 4	Input 4
Setting	TV Temp	TV Temp	TV Temp	TV Temp
Set Point	30	40	50	110
Hysteresis	6	6	6	6
Activation Direction	UP	UP	UP	UP
and/or/minus				
Setting				
Set Point				
Hysteresis				
Activation Direction				

* Set Point and Hysteresis is dependent upon number of fans per stage.

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	Wdg Trip	Oil Temp Alm	LTC OLG Alrm	LTC OLG Trip
	Input 2	Input 1	Input 5	Input 5
Setting	SV Temp	Top Oil	LTC OLG	LTC OLG
Set Point	120	90	90%	5%
Hysteresis	6	6	6%	2%
Activation Direction	UP	UP	UP	DOWN
and/or/minus	**or**			
	Input 3		Input 5	
Setting	CV Temp		LTC OLG	
Set Point	120		10%	
Hysteresis	6		6%	
Activation Direction	UP		DOWN	
and/or	**or**			
	Input 4			
Setting	TV Temp			
Set Point	120			
Hysteresis	6			
Activation Direction	UP			
and/or/minus				
Setting				
Set Point				
Hysteresis				
Activation Direction				

Figure 13: ITM-B

Figure 14: LV Arrester

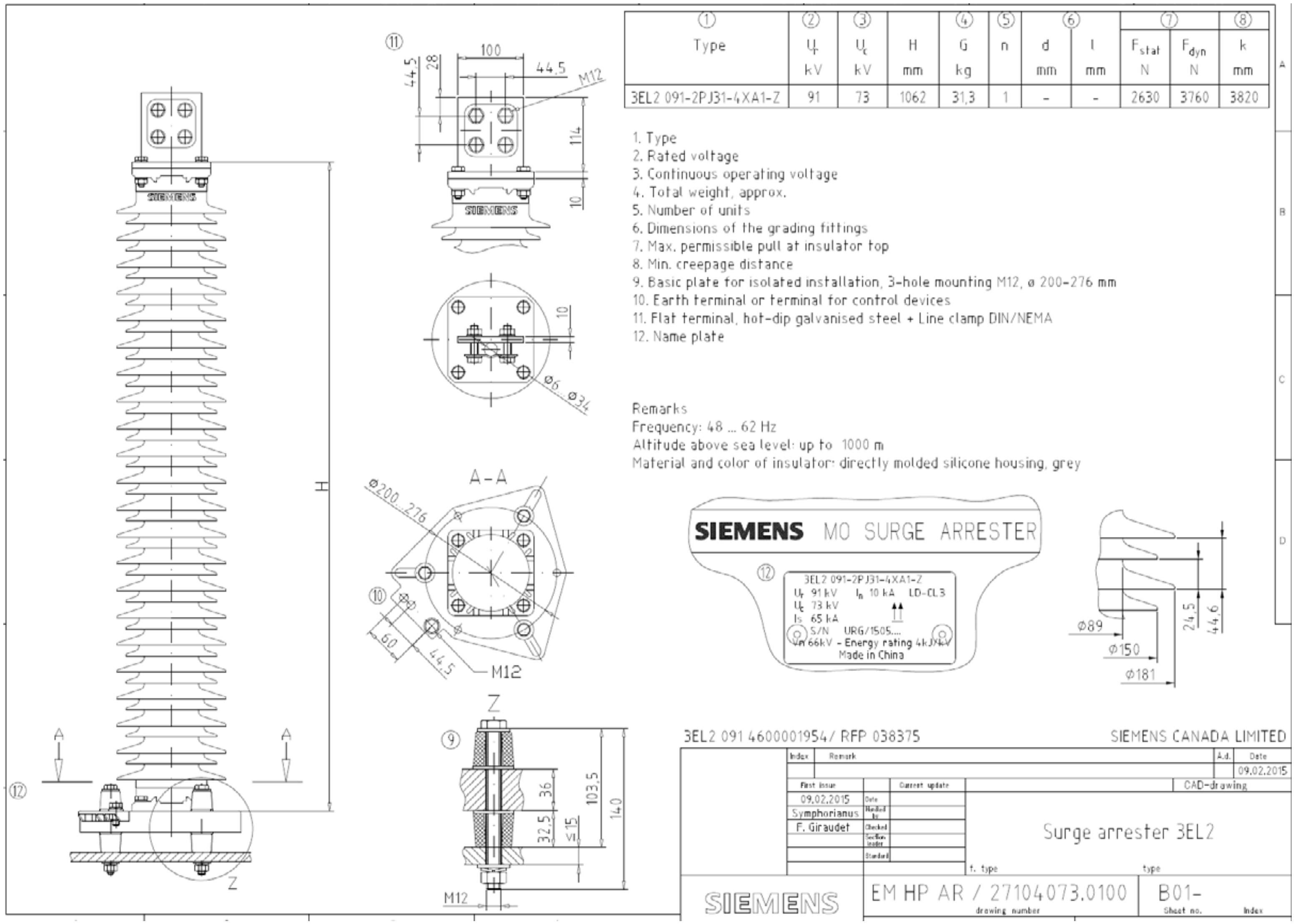


Figure 15: TV Arrester

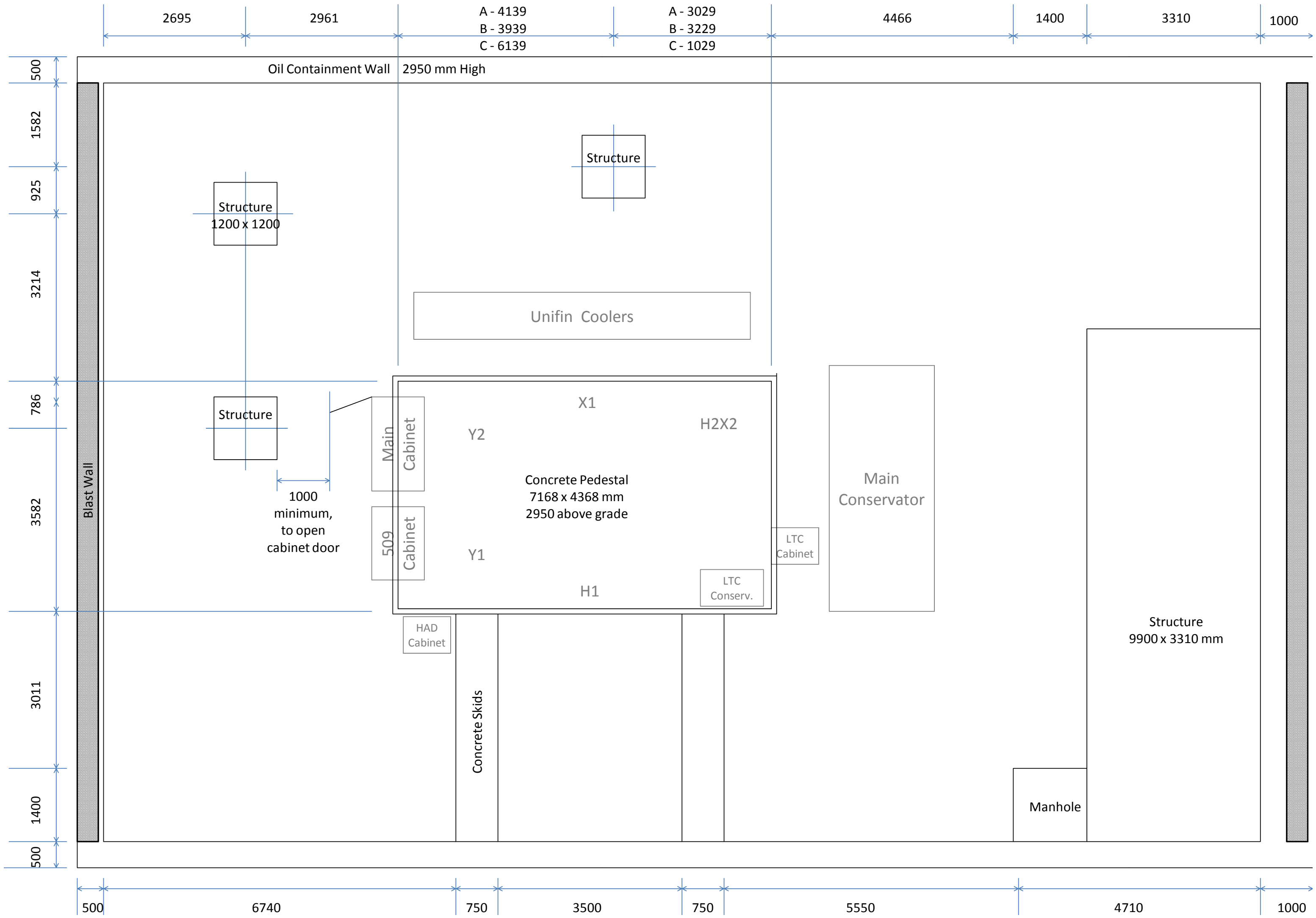


Figure 16: Foundation and Layout Plan View

SPEC ID# 3 — 300 MVA 230 kV Phase-Shifter

1. Delivery Location	Glenboro South station nearest Canadian Pacific Railways siding near Glenboro, Manitoba (approximately 100 km west of Winnipeg)
2. Delivery Date	2019 09 12 First issue of Drawings required by 2017 11 01
3. Station Type	Terminal Station GPS: 49°32'18"N, 99°17'02"W
4. Type of Site	With a Building
5. Quantity	two (2) connected in series
6. Transformer Type	Outdoor, extended-delta style, symmetrical, single-core phase-shifting transformer (single tank)
7. MVA Rating	180 / 240 / 300 (753 Amps at 230 kV) Refer to Remarks 3 & 4
8. Cooling System	ONAN / ONAF / ONAF
9. Sound Level	84 / 86 / 87 dBA
10. Temperature Rise	65ºC
11. Phase Relationship	Extended Delta style phase-shifter
12. Number of Phases	3
13. System Voltage	230 kV GrdY / 132.8 rated +/-10% at no-load +6.5% to -10% at 300 MVA +5% to -10% at 356 MVA Refer to Remark 5

SPEC ID# 3 — 300 MVA 230 kV Phase-Shifter

14. Reactance — Approximately 8 to 12% at 300 MVA at the tap extremes

Zero at neutral tap

15. Load Tap-changer for phase-shift — +40˚ at full-load
-30˚ at full-load
Full capacity at all taps.
Approximately 2.5 to 3 degrees no-load per step, across the full tap range (35 positions preferred).
Refer to Remarks 3, 4 & 5

16. De-energised Tap-changer — n/a

17. Load Power Factor — 0.9 to 1.0 PF lagging at heavy load, 230 - 245 kV

0.9 to 1.0 PF leading at heavy load, 230 - 245 kV

0.0 to 1.0 PF lagging at light load, 230-253 kV

0.0 to 1.0 PF leading at light load, 230-253 kV

Typical PF of 0.94 to 0.98 leading for heavy loading

18. Maximum System Fault Level — 10.3 kA rms sym 3-phase

10.1 kA rms sym SLG

2 second duration

solidly grounded system

19. Insulation Class & Test Levels

kV LIL	Chops	SIL
900	990	750

20. Bushings — 245 kV, 1200 Amp — ABB 245 G 1200 MK

SPEC ID# 3 300 MVA 230 kV Phase-Shifter

21. Line Connectors	4-hole NEMA pad streamlined corona-free All connectors are subject to confirmation and may change at the time of drawing approval.
22. PCore Doble Test Terminals	Required
23. Surge arresters	Not required
24. Surge arrester Support & Bus Assembly	Required. Refer to the drawing of Purchaser-supplied arrester after the Remarks to determine arrester support height.
25. Discharge Counter	One (1) for S1-S2-S3 combined One (1) for L1-L2-L3 combined
26. GIC Detection	Required
27. WTI Gauge Type	Qualitrol 509 Quantity: 2
28. GE Hydran	Required
29. Qualitrol 930 Pressure Sensors	Required
30. Current Transformers	Bushings: 24 x 1200-5 10L800 6 x 1000/700/350-5 0.3B1.8 at 700-5 0.6B0.9 at 350-5 MCIC approval required Refer also to SPEC ID# 8 through 11 for additional options.
31. AC Auxiliary Voltage	Fans: 120/208 V, 3-phase, 4-W Heaters & Lights: 120 V, 1-phase Tap-changer: 120/208 V, 3-phase, 4-W
32. DC Auxiliary Voltage	125 V dc for tripping & alarms
33. Loss Evaluation	Refer to Remarks 13 & 14

SPEC ID# 3 300 MVA 230 kV Phase-Shifter

34. Paint Colour	ANSI 70 Grey
35. Test Variations	Refer to Remark 29
36. Limitations	None
37. Quality Assurance Requirements	ISO 9001
38. Additional Standards	IEEE C57.135-2012 60076-57-1202 draft, IEC/IEEE:2014

Load Tap-changer Control Options (Refer to the Technical Requirements)

39. Motor Voltage	120/208 V, 3-phase, 4-W
40. Fully Automatic Voltage Control	Refer to Remarks 19, 21 & 24
41. Supervisory Control	Refer to Remark 19, 21 & 24
42. Remote Indication	Refer to Remarks 17 & 18
43. Paralleling	Not Required
44. Voltage Sensing VT supplied by	Purchaser

45. Tap-change Direction

Pos.	Phase Shift	Source-to-Load Power Flow	Direction
35	Lag	decreased	↑ Retard
N	0°		
1	Lead	increased	↓ Advance

Refer to Remarks 17 & 18

<u>Remarks</u>:

1) Design Review

A two-day design review meeting may be required with the Purchaser. If required, this meeting will be held at the Contractor’s factory. At this meeting, design personnel will be available for discussion of the design. All drawings will be made available for inspection. Completion of the latest revision of Manitoba Hydro Design Review Document is required prior to the meeting. This shall be submitted to the Purchaser, as complete as possible, at least one (1) week prior to the scheduled design review meeting. The Contractor shall request the latest version of the Manitoba Hydro Design Review Document from the Purchaser prior to completing it.

2) General Description of System

General System Operation

The power systems in Saskatchewan, Manitoba, Ontario, Minnesota and North Dakota have several power loops, some of which are controlled by phase-shifting transformers. This region is comprised of four primary loops with three phase-shifting transformers at

Boundary Dam, SK
Whiteshell, MB
International Falls, MN

Recent wind farm additions have changed the loop flows necessitating an additional phase-shifting transformer (PST) site at Glenboro South station in Manitoba. Refer to the loop flow diagram below.

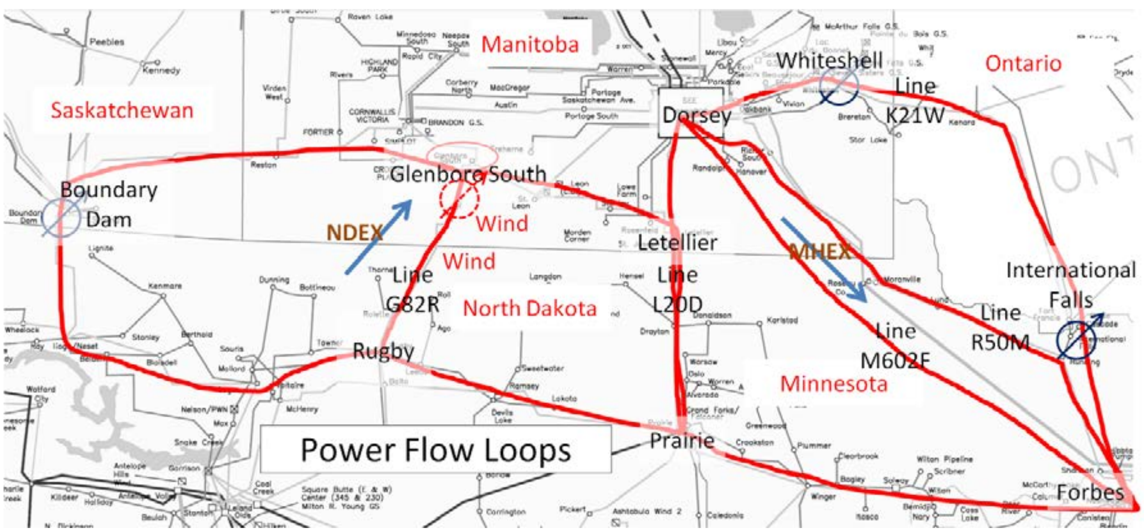


Figure 1

The Glenboro PSTs will provide the operators with a congestion management tool. There is significant inadvertent loop flow through Manitoba that currently can cause congestion on M602F (primary Manitoba export path) and L20D during system intact conditions. During a prior outage of M602F, congestion can occur on R50M and G82R in addition to L20D. There are no tools available to the operator to manage congestion other than market redispatch or NERC Transmission Loading Relief.

Figure 2 shows high Manitoba (MHEX) to US exports, and high North Dakota Export (NDEX) transfer levels require maximum positive phase angles (S-to-L) at Glenboro.

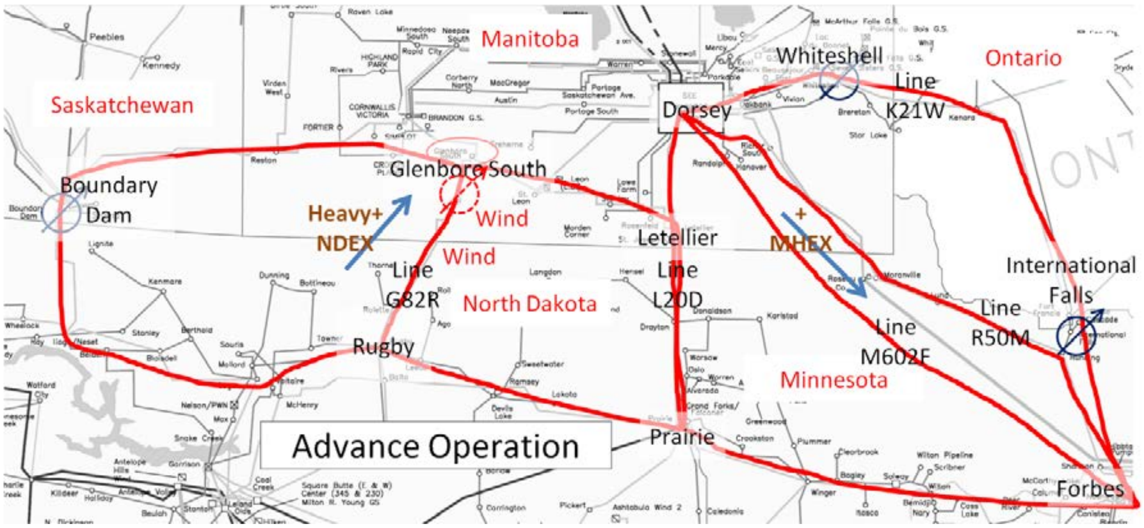


Figure 2

Figure 3 shows high Manitoba to US import and low NDEX transfers require maximum negative phase angles (S-to-L).

Figure 3

Manitoba planning studies currently indicate that the best mode of operation is to control the MW flow through the Glenboro phase shifter to 0 MW normally. This forces the maximum flow onto M602F. When congestion is noticed or predicted, the PST can then be adjusted up to 250 MW north when Manitoba Hydro is importing and 250 MW south when Manitoba Hydro is exporting to the US.

3) Normal Loading Capability

Figure 3 shows the range of required PST phase angles needed to be able to control this flow on Line G82R. This applies for the range of power factors and voltages specified earlier.

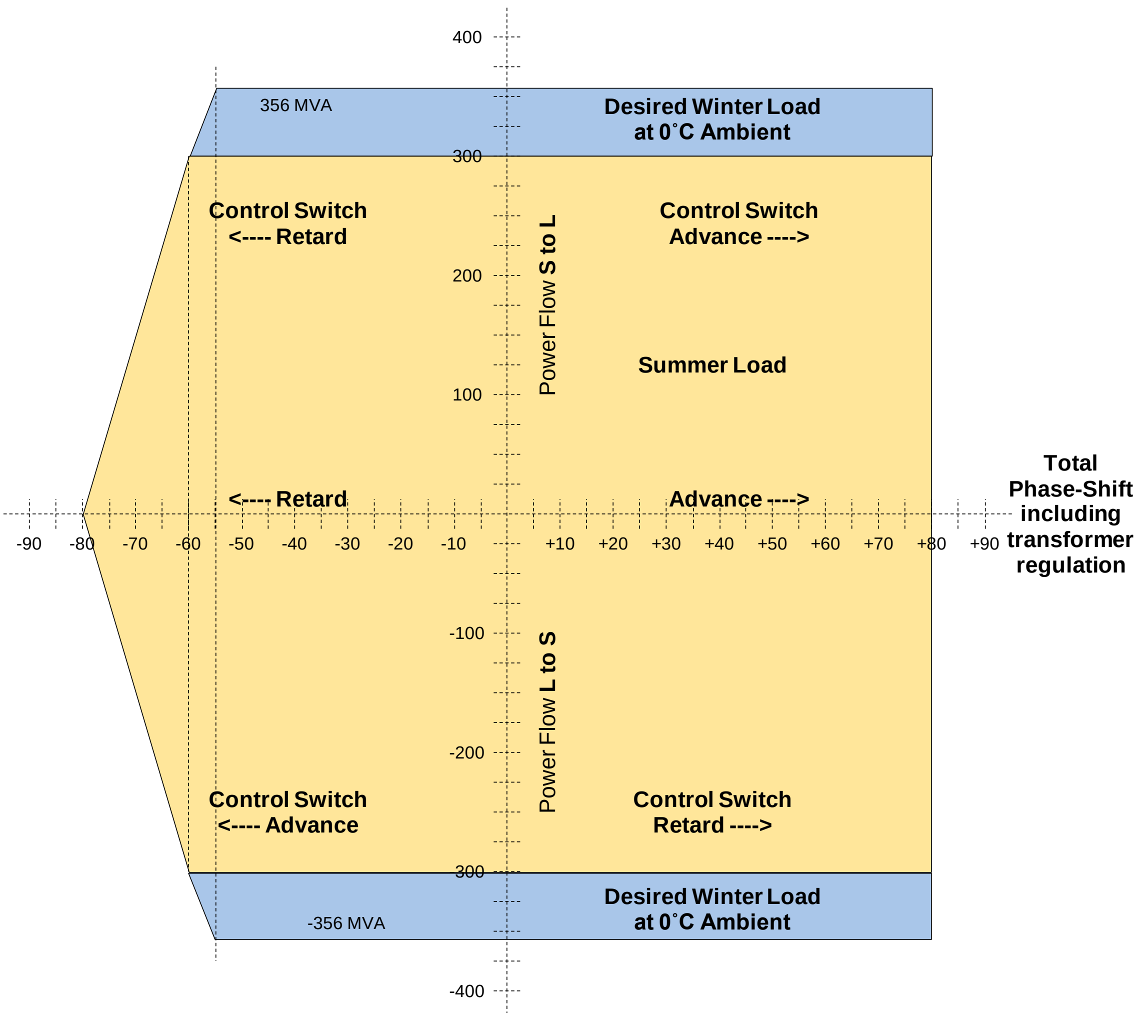


Figure 4 : Normal Loading Capability of PST

The winter loading level is the CSA Standard winter loading of 118.75% at 0˚C ambient temperature.

4) Extra Load Capability and Overload Capability

Clause 6 of the Technical Requirements provides the Purchaser’s normal loading requirements for all new power transformers. It is understood that not all of these requirements can be met for this PST. However, the limiting factor on loading shall always be the tap changer’s switching capacity and step voltage. The core, coils, leads, bushings, tank etc. shall not be the limiting factor.

It is expected that the Contractor can meet the summer loading requirements for all three conditions specified in Clause 6.2.3: Normal Continuous loading (105%); Long-Time Emergency 6-week loading (110%); and Short-Time Emergency 30-Minute loading (120%).

The winter loading may or may not be practical to meet. The Contractor shall inform the Purchaser of the capability of the PST under each of the three winter loading criteria: Normal Continuous loading; Long-Time Emergency 6-week loading; and Short-Time Emergency 30-Minute loading. These shall only be limited by the tap changer's switching capacity and step voltage.

5) No-Load vs Load Phase-Shift Range

This specification has been written assuming a transformer phase angle of about 6.5˚ to 7˚ at the tap extremes with 300 MVA. To obtain a +40˚ shift under full winter load of 356 MVA, it is assumed the tap range must be extended to about +/-47˚ at no-load and +/-17 or +/-16 steps. These assumptions are not requirements and this information is only given to clarify the Purchaser's preliminary assumptions. The Purchaser is requesting the Contractor to provide a design that will satisfy the requirements of this SPEC ID presented outside of this Remark. If these assumptions have produced a restriction, doubt or question, the Contractor shall discuss this with Purchaser in hopes of finding a better solution. The Purchaser does not want to limit the Contractor's ability to provide a better solution, when a minor change can alleviate it.

6) Single-Line and 3-Line Schematics

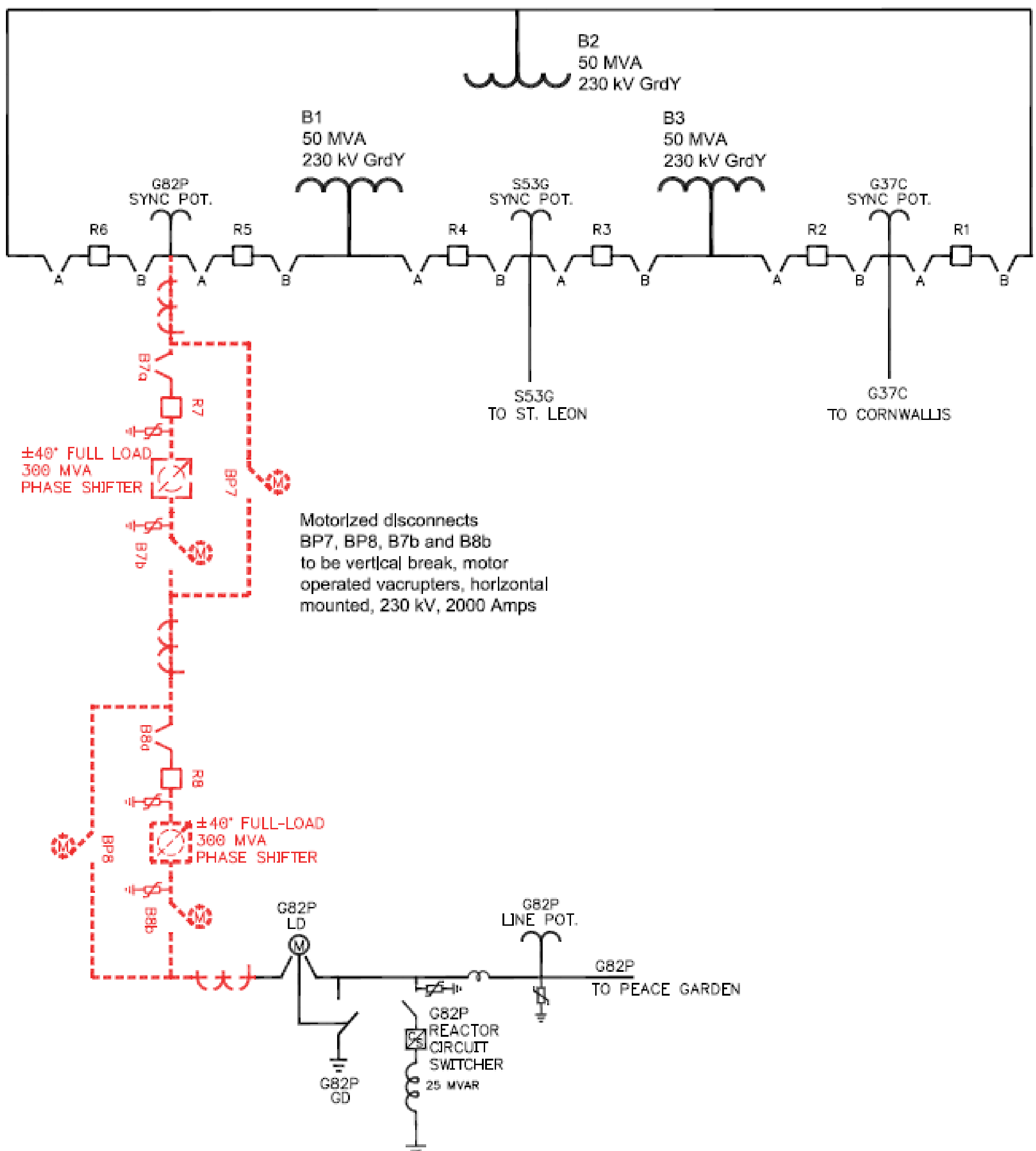


Figure 5: SLD

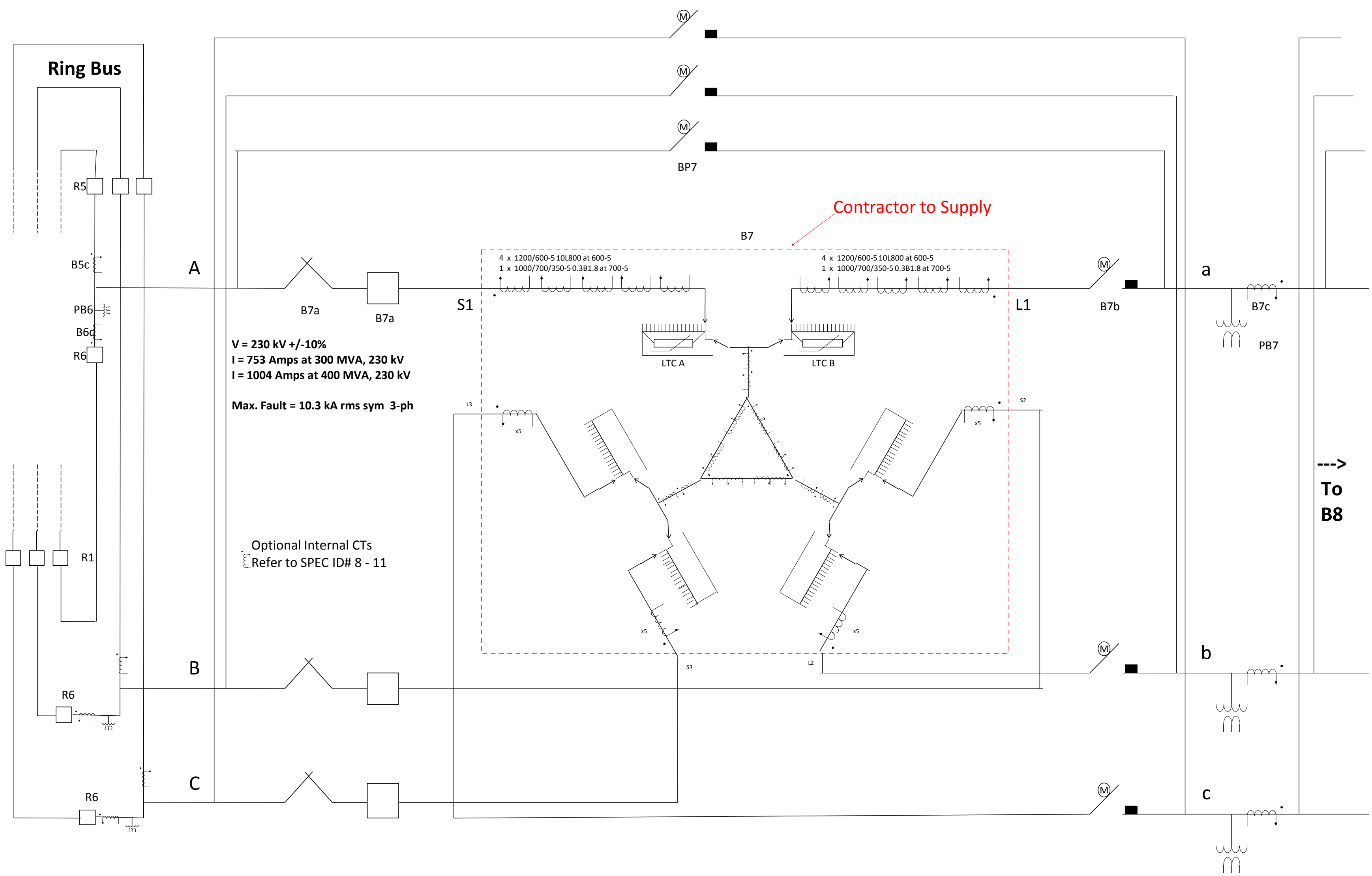


Figure 6 : Partial 3-Line Schematic

7) Connection

At this stage, it is not known to which lines the source or load terminals will be connected. It depends on the relative positioning of the PSTs in the station. This does not change the definition of advance and retard from the PST's perspective. It will impact the power flow controller.

8) Primary Terminal

The PST shall be suitable for energization from either the S or L terminals.

The PST shall be capable of transferring rated MVA with the electrical source of power connected to the S or L terminals.

9) Operation

The PST is not expected to remain energized and under load in the bypassed state for long periods. Once the bypass is closed, disconnect B7b or B8b will be opened to remove the load on the PST. However, this is not an instantaneous event and so the PST is expected to be able to operate in the bypassed and loaded state. The Source and Load terminals shall only be shorted by the bypass when the tap changer is in the neutral position.

10) GIC

The transformer is initially estimated to experience dc currents in the range of 10 to 50 A dc on the 230 kV lines. Long duration base current is 5 A dc. A better estimate should be available after contract award.

A GIC capability study shall be performed as per clause 9 of IEEE C57.163-2015, IEEE Guide for Establishing Power Transformer Capability while under Geomagnetic Disturbances. The manufacturer shall use these base and peak GIC levels along with the generic GIC stepped waveform timing from IEEE C57.163-2015 clause 9.1 GIC Signature. The signature shall cycle for 8 hours minimum or until the cycle temperatures stabilize.

The Purchaser plans to monitor the levels of dc current through the transformer and remove it from service if the values become excessive. The Contractor shall provide time versus dc current withstand curves for the transformer as well as the other requirements of clause 9.3 of IEEE C57.163.

11) Regular Frequent Energization

The PST is not initially expected to have frequent energize/de-energize cycles per day but this could change over time as wind power grows in the region.

12) Rating Plate

The rating plate shall show the total phase-shift at no-load, 75 MVA, 150 MVA, 225 MVA, 300 MVA and 356 MVA based on 1 power factor and 230 kV on the Load side. This shall be provided for each tap position.

The rating plate itself shall show final tested T-diagram impedance (r+jx), both positive and zero-sequence, for each tap position. The rating plate drawing shall show calculated T-diagram impedances for each tap.

13) Loss Evaluation

The Contractor shall evaluate the total no-load and load losses in the two series connected phase shifting transformers at the operating points identified in the table below, based upon factory measurements under the following assumptions:

a) Ambient temperature is +20°C.
b) The base voltage is 230 kV on the secondary.
c) The base MVA is 300 MVA on the secondary.
d) Power factor is 1.0 p.u on the secondary.
e) Losses in switchgear, bus bars, cables, clamps and connectors are excluded. Losses associated with harmonic currents are omitted from loss calculations.
f) Auxiliary equipment losses, such as pumps and fans, needed by the phase shifting transformer are included.
g) The frequency is 60 Hz.

Operating Point	#1	#2	#3	Total
MVA base	300	300	300	
Estimated Phase-Shift, S to L				
no-load	+94°	+12°	-57°	
under-load	+80°	+11.3°	-60°	
Estimated tap position	+17	+4	-10	
Use nearest tap position				
A: No-load losses (kW)	___	___	___	
B: Value of No-Load losses ($/kW)	$8,112 /kW			
C: Load losses (kW)	___	___	___	
D: Value of Load losses ($/kW)	$5,611 /kW			
E: Fan and Pump losses (kW)	___	___	___	
F: Value of Load losses ($/kW)	$5,611 /kW			
G: Weighting Factor	0.2	0.7	0.1	

Weighted Operating Points Cost (A*B+C*D+E*F)*G	___	___	___	
Sum of Weighted Operating Points Costs				___
Base Price			+	___
Loss-Evaluated Price				___

14) Loss Penalty

These losses shall be guaranteed. A deduction will be applied against the base price if the sum of the weighted operating point costs exceed the guaranteed sum.

15) Test Winding

If a wye-connected test winding is used for test purposes, it shall be designed for one higher insulation class than necessary.

16) Fibre-Optic Sensor Package

The transformer shall have sixteen (16) fibre-optic sensors and all associated equipment as specified in the Technical Requirements, Clause 39 FIBRE-OPTIC TEMPERATURE PROBES, Option 3. This shall also include allowance for monitoring the sensors during the temperature rise tests. This will be done during both the ONAN and ONAF oil rise tests and during all winding temperature shutdowns for comparison with the shutdown resistances. The entire log of data from the monitoring device shall be provided as a file and a summary of the relevant results shall be printed with the test report.

Some of these sixteen sensors will also be used for GIC monitoring.

17) Tap Position Indication

In addition to the remote tap position indication described in the Technical Requirements, Clause 14.10.10, each LTC shall add three additional BCD tap position transmitters, for a total of four BCD transmitters. These additional transmitters will be used by the protection relays as primary and secondary sources, and by the Power Flow Controller.

Total number of transmitters:

One 4-20 mA	for main transformer cabinet
One BCD	for HMI in building
Two BCD	for protection relays
One BCD	for PFC

BCD transmitters shall count from 1 to 35 (or 33), rather than -17 to +17. This is to avoid neutral tap indicating 00000. A BCD code of 00000 cannot be verified to be operating correctly.

The additional resistor bridge is also required for connection into the Qualitrol 509 ITM.

18) Tap Position Numbering

To avoid a BCD code of 00000 for neutral tap, all tap position numbering (LTC, nameplate, gauges etc.) shall be numbered 1 to 35 (or 33), in lieu of Technical Requirements, clause 14.5. Tap position# 1 shall be the advance (raise) extreme position.

19) Remote Control

Full remote control is required, both for the power flow controller (PFC) and for manual control from a remote location.

Remote control shall be defined as remote from the current location.

The tap changer cabinets shall have Advance, Retard, and Local/Remote controls. Remote shall refer to the main PST control cabinet. Optionally, if not in the PST's main control cabinet, Return to Neutral can be supplied by the tap changer control cabinet. The controls for the two tap changers shall operate independently, allowing for them to be in different operating positions. It is understood that Local/Remote switches must both be set the same for the PST to be placed into operation.

The main PST control cabinet shall have Advance, Retard, Return to Neutral and Local/Remote controls. This one set of controls shall drive both tap changer control cabinets. Remote shall refer to the HMI in the control building within the Glenboro station.

The control building at Glenboro station shall have Advance, Retard, Return to Neutral and Local/Remote/Automatic(PFC). Remote shall refer to System Control in Winnipeg. The Power Flow Controller is described in SPEC ID# 12.

20) Time to "Return-to-Neutral"

The tap changers are expected to be able to switch from either tap extreme to neutral tap in one continuous operation and within 2 minutes.

21) Switching Operation

There are many combinations and possibilities of switching for these two lines and PSTs. Some of the more common switching sequences are listed below. Time delays are arbitrary and may change.

To Remove PST B7 (or B8):

1. If PST B7 LTCs are not in Neutral tap position, move PST B7's LTCs one step closer to neutral.
2. If PST B8 is in operation, increase the tap position of PST B8, to compensate.
3. Repeat the above two steps until either PST B7 reaches neutral tap or PST B8 reaches its tap extreme.
4. If PST B7 is still not at neutral tap, continue taping towards neutral tap.
5. Once PST B7 reaches neutral tap, stop taping.
6. Wait 2 seconds.
7. Close the bypass switch BP7.
8. Wait 2 seconds.
9. Open breaker B7.
10. Wait 2 seconds.
11. Open disconnect B7b.
12. Open disconnect B7a.

To Insert PST B7 (or B8):

1. If PST B7 LTCs are not at neutral tap, move to neutral tap.
2. If bypass switch BP7 is not closed, close BP7.
3. Wait 2 seconds.
4. Close disconnect B7a.
5. Close breaker B7.
6. Wait 2 seconds.
7. Close disconnect B7b.
8. Wait 2 seconds.
9. Open bypass switch BP7.
10. If PST B8 is in service, and if PST B8 is not in LTC positions -1, N or +1, then
11. Tap PST B7 one step towards the position PST B8 is in.
12. Tap PST B8 one step in the opposite direction, to compensate.
13. If PST B7 is NOT within one tap position of PST B8, then repeat above step.
    Continue with normal control of the two PSTs in series.

To Insert first PST B7 (or B8) when G82R is loaded (both bypass switches closed):

1. If PST B7 LTCs are not at neutral tap, move to neutral tap.
2. If bypass switch BP7 is open, close it.
3. Close disconnect B7a.
4. Close breaker B7.
5. Wait 2 seconds.
6. Close disconnect B7b.
7. Wait 2 seconds.
8. Open bypass switch BP7.

To Insert first PST B7 (or B8) when G82R is open (both bypass switches open):

1. If PST B7 LTCs are not at neutral tap, move to neutral tap.
2. Close bypass switch BP8.
3. Close bypass switch BP7.
4. Wait 2 seconds.
5. Close disconnect B7a.
6. Close breaker B7.
7. Wait 2 seconds.
8. Close disconnect B7b.
9. Wait 2 seconds.
10. Open bypass switch BP7.

To Remove both PSTs, B7 & B8:

1. If PST B7 LTCs are not in Neutral tap position, move PST B7's LTCs one step closer to neutral.
   If PST B8 LTCs are not in Neutral tap position, move PST B8's LTCs one step closer to neutral.
   These can be done simultaneously.
2. Repeat the above steps until both PSTs reach neutral tap.
3. Wait 2 seconds
4. Close the bypass switch BP7.
5. Wait 2 seconds
6. Close the bypass switch BP8.
7. Wait 2 seconds.
8. Open breaker B7.
9. Wait 2 seconds.
10. Open breaker B8.
11. Wait 2 seconds.
12. Open disconnect B7a.
13. Open disconnect B8a.
14. Open disconnect B7b.
15. Wait 2 seconds.

16. Open disconnect B8b.

The normal PST state when not loaded, is energized from the breaker side, with the bypass closed.

22) Protection System

The Purchaser is looking for recommendations and assistance in designing the protection system.

23) Insulation Coordination System

The Contractor shall supply a complete insulation coordination study for the PST.

24) Recovery Voltage

If necessary, a control scheme shall be provided to ensure the reversing switches of the two tap changers A & B are not switching at the same time, resulting in an excessive recovery voltage across the tap changer reversing contacts. In no case shall this scheme slow down the 'return-to-neutral' control scheme, so the scheme must only activate when stepping from LTC N to +1, or from LTC N to -1. It shall not activate when stepping from LTC +1 to N, nor from LTC -1 to N.

However, it is preferred that other methods be considered to reduce the recovery voltage, such as advance/retard switches, tie-in resistors or altering the relevant transformer capacitances. Tie-in resistors or advance/retard switching shall be supplied by the tap changer manufacturer.
Details of test winding grounding and the insulation of the floating terminals shall be provided.

25) Breakers

The Purchaser-supplied energization and protection breakers (R7 & R8) use closing resistors to limit the inrush current of each PST.

Single-phase re-closing is not done on the Purchaser's 230 kV system.

26) External Instrument Transformers

The bus voltage transformers (PB6, PB7, PB8) and the ring bus current transformers (CTR5a, CTR6b) are supplied by the Purchaser.

VTs are capacitive voltage transformers, Trench TEMF 230, rated 138,000 - 115/69 - 115/69, accuracy 1P and 0.3WXYZ.

CTs are Electromagnetic ATS230, rated 2000/1200/1000/400-5, 10L800

27) Shunt Reactor

There is a 25 MVAr 230 kV shunt reactor connected to transmission towards the USA. This is normally switched-in at times of light loading on that line. It may remain connected during heavy loading but only to improve the power factor.

28) Bushing Monitoring Cable Raceway

The Purchaser intends to install bushing monitoring devices in the future. To facilitate this, a NEMA 4 cable raceway shall be provided between the capacitance tap of each bushing, and the main control cabinet. The raceway shall be designed to allow placement of the cables into the raceway, when the cables already have one large capacitance cap connector on one end. There shall be no interference with the opening of the raceway panels from any other accessories.

29) Additional Tests on PSTs

(a) Positive-Sequence Two-Circuit Load Loss and Impedances

After placing the active assembly in the tank with its cover, but prior to oil-filling, the impedances and load losses shall be measure for the three individual circuits

Delta to Source LTC and Load LTC,
Delta to Source LTC,
Delta to Load LTC,
Source LTC to Load LTC.

The test current shall be as high as possible but at least 5%, preferably 10%, of rated current and scaled up to the rated MVA.
The test shall be done at both extreme tap positions.

The Delta to Source LTC and Load LTC tests shall be done the same way as per the final testing.

The Delta to Source LTC and Delta to Load LTC tests shall be done by supplying the respective bushings and shorting the delta winding at the tap changer connections.

The Source LTC to Load LTC test shall be done with a severed connection between the tap changers and the delta. The two tap changers may remain inter-connected.

(b) Ratio

Ratio tests shall be done between all windings prior to tanking.

(c) Resistance

DC Resistance tests shall be done on all windings prior to tanking.

(d) No-Load Phase Angle

Measurement of the phasor group and no-load phase angle shall be done as per C57.135, clause 10.2.2 (or an equivalent and accurate method) in addition to the standard ratio tests.

(e) Special Lightning an Switching Impulse Tests

Single-terminal lightning and switching impulse tests shall be performed.
Two-terminal lightning and switching impulse testing shall be performed as per C57.135. This is in addition to the standard lightning and switching surge tests. All tests shall be done at full levels. It may be necessary to perform some or all of these tests in up to three tap positions (neutral and tap extremes), on all phases, depending upon the internal stresses.

(f) Three-Phase Induced Test

It may be necessary to perform this test in up to three tap positions (neutral and tap extremes), depending upon the internal stresses.

(g) Excitation

No-load loss and excitation current shall be measured on at least five tap positions, including neutral and the tap extremes as per the Apparatus Test Specification.

(h) Tap Changer Cycle Recordings

The cycle recording tests shall each be done separately for the Source and Load tap changers.

The no-load tests shall be done by supplying the test winding and measuring the voltage waveform on the Source and Load terminals.

The load cycle recording test shall be done three times. The first two tests shall be done switching from +17 to +1, -1 to -17, -17 to -1 and +1 to +17.

Supply the Source terminals with the Load terminals shorted.

Supply the Load terminals with the Source terminals shorted.

The third and fourth tests are done at a much reduced load level, supplying the test terminals, and switching from -2 to +2 and +2 to -2. The third test has the Source terminals shorted while the fourth test has the Load terminals shorted.

NOTE: The test winding should not be sized for this load cycle test, but it is expected that the test winding be capable of handling at least 50 Amps for this short-term test.

(i) Load Loss and Impedance

Load loss and impedance shall be measured on each tap position at the base MVA.
Impedance and losses shall also be measured between the test winding and the Source and Load terminals separately, for the tap extremes.

(j) Zero-Sequence Impedance
Zero-sequence impedance shall be measured between the
Source and Load terminals
Source and test winding terminals
Load and test winding terminals

(k) Special Excitation Tests
The Contractor shall obtain a highly accurate power quality meter to measure the 3-phase vectorial voltages and currents during core excitation testing after dielectrics. This would not use the normal meters such as the Haefely measuring system nor oscilloscopes which aren't accurate enough. This requires a power quality analyzer or a Phaser Measuring Unit such as the Dranetz-BMI Power Xplorer series, ERLPHase Tesla PMU recorders or other such devices which samples voltage and current at a rate of at least 256 samples per cycle, with storage and download capability.

The purpose is to use these 3-phase voltage and current phasors (magnitude and phase angle) for the creation of accurate B-H curves by the Purchaser. This would be used for both transient studies and GIC studies.

The meter would need to measure several voltage levels, both in the forward and reverse regions of the B-H curve. For example, measure at 10%, 30%, 50%, 70%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, and as high as practical for the supply, and then begin stepping down again through the same levels. The measurement recording shall provide data for at least 3 cycles at each level.

The test shall be done for at least two tap positions: the neutral and one extreme tap position.

The core should be demagnetized prior to this test.

30) Test Report

The test report shall include tested/derived positive and zero-sequence impedances, in r+jx form, for each component of the three-circuit T-diagram (Source impedance Z_S, Load impedance Z_L and ground impedance Z_G). This shall be provided for each tap position. Where test data for only some tap positions is available, the other positions will be derived from the tested and calculated data.

The test report shall also contain total phase angle vs. tap position, for each load of
0 MVA,

+/-75 MVA,
+/-150 MVA,
+/-225 MVA,
+/-300 MVA,
+/-356 MVA,
+/- summer and winter continuous and emergency loads.

This shall be based on 230 kV and 1.0 power factor on the Load terminals.

This shall also be provided for 235, 240 and 245 kV, taking into account any locked-out tap positions where the switching capacity of the tap changers is exceeded.

The test report shall also include a table of MVA capability vs. steady-state ambient temperature, from -50 to +50˚C, in 5˚C increments, at neutral tap position, for 230 kV and 1.0 power factor on the Load.

31) Qualitrol 509 ITM Ordering Information

There shall be two (2) ITM each with an expansion module and fibre-optics. They shall be labeled ITM Source and ITM Load.

A separate cabinet for the ITM shall be required, as described in Technical Requirements, clause 38.6.2 for HVDC Stations.

ITM 509 Ordering and Set-Up Information

Site	Glenboro PST ITM - Source	**with a building**
Base System	ITM 509-300	DW
Enclosure	Panel Mount with 5 kV Surge Protection	
Heater	None	

For transformers:
ONAN/ONAF/ONAF
in-tank LTC
with fibre-optic sensors
Main Conservator oil level potentiometer

with Qualitrol 930 pressure sensors

Main Inputs

		Type	Muliplied Contact	Name	Code	Comment
7	Input 1	100 Ω Pt RTD		OilTemp	B	1st RTD in WTL termal well
3	Input 2	x Amp CT		Wdg	Cx	WTI CT
7	Input 3	x Amp Sensor		Fan Pwr	Iy	loop through fan power cables additively
7	Input 4	4 - 20 mA Loop		930PCov	M	Qualitrol 930 Pressure Sensor on Cover: Slow Pressure Rise K1, Static low or high pressure
5	Input 5	Dry Contact	✓	Trips	R	Parallel GDR fast gas, LTC Rapid Pressure Rise, Main PRD, Source and Load LTC PRD
7	Input 6	Dry Contact	✓	SlowGas	R	Gas detector Relay alarm
6	Input 7	Dry Contact	✓	SrcLck	R	Source LTC Oil Temp. Lockout Alarm
6	Input 8	Dry Contact		SrcR/L	R	Source LTC Raise & Lower Actuation (Reinhausen cam 127)
	Expansion Module Inputs Inputs					
7	Input 9	Tap Position Resistor Bridge		LTCPosS	V3	2nd resistor bridge from Source LTC
6	Input 10	Potentiometer		SrcOLG	H	Source LTC conservator oil level
7	Input 11	Potentiometer		MainOLG	H	Main conservator oil level
7	Input 12	Dry Contact		PwrFail	R	Main breaker, Source LTC and Load LTC Power Fail Alarm, Three paralleled Qualitrol 930 K2 Power Status contacts
7	Input 13	Dry Contact		BreCycl	R	Main Breather cycling (heating system status)
7	Input 14	Dry Contact		BreFail	R	Parallel Source LTC, Load LTC and Main Consvervator Breather malfunction
7	Input 15	x Amp Sensor		LoadMtr	Iy	Load LTC motor current
7	Input 16	4 - 20 mA Loop		Gas Lvl	M	Hydran gas level

'x' Indicates current draw, to be chosen based on 2 p.u. current from the bushing CT, and limited to 120% of 'x'.
Therefore use C10 Amp for a 5 Amp secondary bushing CT. Use C5 Amp for a 2 Amp secondary bushing CT. (5, 10, 20 Amp)

'y' Indicates normal motor current draw for the sum of all fans in stage 1 or 2, or sum of stages 1 and 2, or sum of all pumps or LTC motor. (5,10, 20, 50, 100 Amp)

	Relay Designation for Front Panel		Base Logic from Output Relay set-up below						
12	Relay 1	Stage 1 Fans	Wdg	or	Fiber 1	or	Fiber 2	or	Fiber 3
12	Relay 2	Stage 2 Fans	Wdg	or	Fiber 1	or	Fiber 2	or	Fiber 3
11	Relay 3	Fan Alarm 1	Fan Pwr	and	Stage 1 Fans				
9	Relay 4	2nd Alarm	SrcLck	or	SrcOLG	or	BreFail	or	PwrFail
9	Relay 5	1st Alarm	MainOLG	or	SlowGas	or	OilTemp	or	Wdg
8	Relay 6	1st Trip	Trips	or	OilTemp	or	Wdg		
8	Relay 7	2nd Trip	SlowGas	or	SrcOLG	or	MainOLG		
9	Relay 8	LTC Alarm							

Figure 7: ITM Source

ITM Direct Winding

		Length	Quantity
Neoptix T2 Fiber Optic Temperature Sensors	Neoptix CAB-699-Le	Length to suit	8
Tank Wall Plate Assembly with COV-121-1 and CON-159-1	Weld On PLT-201	Steel	1 Plate for 16 sensors
Fibre Optic Extension Cables	Neoptix CAB-700-Le	Length to suit	8
Hot Spot Module Channels Interface	Qualitrol MOD-638-8	8 channel	1
Portable Fibre Optic Thermometer	Qualitrol KIT-057-1		not required

Remote Communiations

Additional Remote Communications Protocol	DNP 3
	MODBUS
	IEC 61850
Additional Remote Communications Ports	Ethernet FX,ST Fibre Optic
Additional Control Functions	
	Data Logging
	Event Recording
	Quantity
Hard Copy of Instruction Manual	9

Configuration file for easy set-up is available from Manitoba Hydro.
Include the actual Qualitrol order form, the Qualitrol Packing Set-up Sheet c/w serial/order number, this set-up information and the final configuration file printout in the Transformer Instruction Manual.

Accessories

			Quantity
100 Ohm Pt RTD for Oil	Length to suit	Qualitrol 103-059-02 CS-41840	2
100 Ohm Pt RTD for Ambient	Length to suit	Qualitrol 103-054-01	1

Accessories Purchased Separately

Thermal Well	Qualitrol 2WTL Thermal Plate	1
Brass Plug	Qualitrol 167-50-29F CS-31450	1
Main Tank Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	1
LTC Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	0
MR RMV II Oil Level Gauge with two contacts (Lo, Critical Lo)	Qualitrol 032-038-01 CS-36552	n/a
Pressure Sensors	Qualitrol 930-008-01 CS-36480	3

Additional Communication Accessories (housed with in control cabinet)

USB to DB9 Cable	Qualitrol CAB-049-1	1
USB-A to USB-B, 6 ft.	Qualitrol CAB-050-1	1

Aux are redundant relays for NERC requirements

Output Relay Properties

	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Stage 1 Fans	Stage 2 Fans	Fan Alarm 1	2nd Alarm
Enabled	yes	yes	yes	yes
Failsafe	yes	yes	no	no
Test Lockout	off	off	off	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	1st Alarm	1st Trip	2nd Trip	LTC Alarm
Enabled	yes	yes	yes	yes
Failsafe	no	no	no	no
Test Lockout	off	off	off	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

Figure 7: ITM Source

Aux are redundant relays for NERC requirements

Output Relay Control Logic	**Relay 1**	**Relay 2**	**Relay 3**	**Relay 4**
Relay	Stage 1 Fans	Stage 2 Fans	Fan Alarm 1	2nd Alarm
	Input 2	Input 2	Input 3	Input 7
Setting	Wdg	Wdg	Fan Pwr	SrcLck
Set Point	75	85	*TBD	50%
Hysteresis	10	10		50%
Activation Direction	UP	UP	DOWN	UP
and/or/minus	**or**	**or**	**and**	**or**
	Fiber 1	Fiber 1	Relay 1	Input 10
Setting	Fiber 1	Fiber 1	Stage 1 Fans	SrcOLG
Set Point	75	85	50%	20%
Hysteresis	10	10	50%	10%
Activation Direction	UP	UP	UP	DOWN
and/or	**or**	**or**		**or**
	Fiber 2	Fiber 2		Input 14
Setting	Fiber 2	Fiber 2		BreFail
Set Point	75	85		50%
Hysteresis	10	10		50%
Activation Direction	UP	UP		UP
and/or/minus	**or**	**or**		**or**
	Fiber 3	Fiber 3		Input 12
Setting	Fiber 3	Fiber 3		PwrFail
Set Point	75	85		50%
Hysteresis	10	10		50%
Activation Direction	UP	UP		UP

* Set Point and Hysteresis is dependent upon number of fans per stage.

	Relay 5	**Relay 6**	**Relay 7**	**Relay 8**
Relay	1st Alarm	1st Trip	2nd Trip	LTC Alarm
	Input 11	Input 5	Input 6	
Setting	MainOLG	Trips	SlowGas	
Set Point	20%	50%	5%	
Hysteresis	10%	50%	5%	
Activation Direction	DOWN	UP	UP	
and/or/minus	**or**	**or**	**or**	
	Input 6	Input 1	Input 10	
Setting	SlowGas	OilTemp	SrcOLG	
Set Point	50%	110	10%	
Hysteresis	50%	10	5%	
Activation Direction	UP	UP	DOWN	
and/or	**or**	**or**	**or**	
	Input 1	Input 2	Input 11	
Setting	OilTemp	Wdg	MainOLG	
Set Point	90	120	10%	
Hysteresis	10	10	5%	
Activation Direction	UP	UP	DOWN	
and/or/minus	**or**			
	Input 2			
Setting	Wdg			
Set Point	105			
Hysteresis	10			
Activation Direction	UP			

LTC Monitor Setup

Tap Position		Tap Motor Sensing	
Load tap changer monitor	Enabled	Motor current input module	Input 15 : LoadMtr
Tap position module	Input 9 : LTCPosS	Switch contact module 1	Input 8 : SrcR/L
Total number of taps	35	Switch contact module 2	
Tap Count		**Load Current**	
Tap Count Period (hrs)	24	Load Current	Input 2 : Wdg

LTC Alarm Setup - High Priority

Alarm Relay Setup		Running Motor Current	
Alarm Relay	Relay 8 : LTC Alarm	Upper Setpoint (Amps)	~rated + 20%
Relay Function	Enabled	Lower Setpoint (Amps)	0
Relay Operation	Non-Failsafe	Actuate Alarm	Yes
Test Lock Out	no	**Starting Motor Current**	
Latching Relay	yes	Upper Setpoint (Amp-sec)	~rated + 30%
Actuation Delay hh:mm	0:00	Lower Setpoint (Amp-sec)	0
Total Tap Counts (per tap)		Actuate Alarm	yes
Tap Count Setpoint	n/a	**Motor Actuations (per period)**	
Actuate Alarm	no	Motor Actuations Setpoint	n/a
Multiple Tap Movements		Actuate Alarm	no
Actuate Alarm	no	**Motor Actuation Time**	
Tap Run Time (per tap)		Setpoint (sec)	n/a
Tap Run Time Setpoint	n/a	Actuate Alarm	no
Actuate Alarm	no	**Differential Temperature**	
Tap Counts per Period		Temperature Setpoint	n/a
Tap Counts/Period Setpoint	100	Hysteresis	
Actuate Alarm	yes	Actuate Alarm	no

Figure 7: ITM Source

ITM 509 Ordering and Set-Up Information

Site	Glenboro PST ITM - Load	**with a building**	
Base System	ITM 509-300	DW	**For transformers:**
			ONAN/ONAF/ONAF
Enclosure	Panel Mount		in-tank LTC
	with 5 kV Surge Protection		with fibre-optic sensors
Heater	None		LTC oil level gauge potentiometer

Main Inputs

		Type	Muliplied Contact	Name	Code	Comment
7	Input 1	100 Ω Pt RTD		OilTemp	B	2nd RTD in WTL thermal well
3	Input 2	x Amp CT		Wdg	Cx	WTI CT
5	Input 3	4 - 20 mA Loop		930P1	M	Qualitrol 930 Pressure Sensor on Side-1 Slow Pressure Rise K1 Static low or high pressure
5	Input 4	4 - 20 mA Loop		930P2	M	Qualitrol 930 Pressure Sensor on Side-2 Slow Pressure Rise K1, Static low or high pressure
5	Input 5	Dry Contact	✓	Trips	R	2nd Parallel GDR fast gas, LTC Rapid Pressure Rise, Main PRD, Source and Load LTC PRD
	Input 6	Dry Contact			R	Spare
7	Input 7	Dry Contact	✓	LoadLck	R	Load LTC Oil Temp. Lockout Alarm
7	Input 8	Dry Contact		LoadR/L	R	Load LTC Raise & Lower Actuation (Reinhausen cam 127)
	Expansion Module Inputs Inputs					
7	Input 9	Tap Position Resistor Bridge		LTCPosL	V3	2nd resistor bridge from Load LTC
7	Input 10	Potentiometer		LoadOLG	H	Load LTC conservator oil level
	Input 11	Dry Contact			R	Spare
7	Input 12	Dry Contact		PwrFail	R	Source LTC and Load LTC Power Fail Alarm
	Input 13	Dry Contact			R	Spare
7	Input 14	x Amp Sensor		Fan Pwr	Iy	loop through fan power cables additively
6	Input 15	x Amp Sensor		SrcMtr	Iy	Source LTC motor current
7	Input 16	4 - 20 mA Loop		H2O Lvl	M	Hydran moisture level

'x' Indicates current draw, to be chosen based on 2 p.u. current from the bushing CT, and limited to 120% of 'x'.
Therefore use C10 Amp for a 5 Amp secondary bushing CT. Use C5 Amp for a 2 Amp secondary bushing CT. (5, 10, 20 Amp)

'y' Indicates normal motor current draw for the sum of all fans in stage 1 or 2, or sum of stages 1 and 2, or sum of all pumps or LTC motor. (5,10, 20, 50, 100 Amp)

	Relay Designation for Front Panel		Base Logic from Output Relay set-up below						
12	Relay 1	Stage 1 Fans	Wdg	or	Fiber 1	or	Fiber 2	or	Fiber 3
12	Relay 2	Stage 2 Fans	Wdg	or	Fiber 1	or	Fiber 2	or	Fiber 3
11	Relay 3	Fan Alarm 2	Fan Pwr	and	Stage 2 Fans				
9	Relay 4	2nd Alarm	LoadLck	or	LoadOLG	or	PwrFail		
9	Relay 5	1st Alarm	LoadOLG	or	OilTemp	or	Wdg		
8	Relay 6	1st Trip	Trips	or	OilTemp	or	Wdg		
8	Relay 7	2nd Trip	LoadOLG		Fan Pwr				
9	Relay 8	LTC Alarm							

Figure 8: ITM Load

ITM Direct Winding

		Length	Quantity
Neoptix T2 Fiber Optic Temperature Sensors	Neoptix CAB-699-Le	Length to suit	8
Tank Wall Plate Assembly with COV-121-1 and CON-159-1	Weld On PLT-201	Steel	use plate from ITM-A
Fibre Optic Extension Cables	Neoptix CAB-700-Le	Length to suit	8
Hot Spot Module Channels Interface	Qualitrol MOD-638-8	8 channel	1
Portable Fibre Optic Thermometer	Qualitrol KIT-057-1		not required

Remote Communiations

Additional Remote Communications Protocol	DNP 3
	MODBUS
	IEC 61850
Additional Remote Communications Ports	Ethernet FX,ST Fibre Optic
Additional Control Functions	
	Data Logging
	Event Recording
	Quantity
Hard Copy of Instruction Manual	9

Configuration file for easy set-up is available from Manitoba Hydro.
Include the actual Qualitrol order form, the Qualitrol Packing Set-up Sheet c/w serial/order number, this set-up information and the final configuration file printout in the Transformer Instruction Manual.

Accessories

			Quantity
100 Ohm Pt RTD for Oil	Length to suit	Qualitrol 103-059-02 CS-41840	1
100 Ohm Pt RTD for Ambient	Length to suit	Qualitrol 103-054-01	0

Accessories Purchased Separately

Thermal Well	Qualitrol 2WTL Thermal Plate	0
Brass Plug	Qualitrol 167-50-29F CS-31450	0
Main Tank Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	0
LTC Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	2
MR RMV II Oil Level Gauge with two contacts (Lo, Critical Lo)	Qualitrol 032-038-01 CS-36552	n/a
Pressure Sensors	Qualitrol 930-008-01 CS-36480	0

Additional Communication Accessories (housed with in control cabinet)

USB to DB9 Cable	Qualitrol CAB-049-1	1
USB-A to USB-B, 6 ft.	Qualitrol CAB-050-1	1

Aux are redundant relays for NERC requirements

Output Relay Properties

	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Stage 1 Fans	Stage 2 Fans	Fan Alarm 2	2nd Alarm
Enabled	yes	yes	yes	yes
Failsafe	yes	yes	no	no
Test Lockout	off	off	off	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	1st Alarm	1st Trip	2nd Trip	LTC Alarm
Enabled	yes	yes	yes	yes
Failsafe	no	no	no	no
Test Lockout	off	off	off	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

Figure 8: ITM Load

Aux are redundant relays for NERC requirements

Output Relay Control Logic	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Stage 1 Fans	Stage 2 Fans	Fan Alarm 2	2nd Alarm
	Input 2	Input 2	Input 14	Input 7
Setting	Wdg	Wdg	Fan Pwr	LoadLck
Set Point	75	85	*TBD	50%
Hysteresis	10	10		50%
Activation Direction	UP	UP	DOWN	UP
and/or/minus	or	or	and	or
	Fiber 1	Fiber 1	Relay 2	Input 10
Setting	Fiber 1	Fiber 1	Stage 2 Fans	LoadOLG
Set Point	75	85	50%	20%
Hysteresis	10	10	50%	10%
Activation Direction	UP	UP	UP	DOWN
and/or	or	or		or
	Fiber 2	Fiber 2		Input 12
Setting	Fiber 2	Fiber 2		PwrFail
Set Point	75	85		50%
Hysteresis	10	10		50%
Activation Direction	UP	UP		UP
and/or/minus	or	or		
	Fiber 3	Fiber 3		
Setting	Fiber 3	Fiber 3		
Set Point	75	85		
Hysteresis	10	10		
Activation Direction	UP	UP		

* Set Point and Hysteresis is dependent upon number of fans per stage.

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	1st Alarm	1st Trip	2nd Trip	LTC Alarm
	Input 10	Input 5	Input 10	
Setting	LoadOLG	Trips	LoadOLG	
Set Point	20%	50%	10%	
Hysteresis	10%	50%	5%	
Activation Direction	DOWN	UP	DOWN	
and/or/minus	or	or		
	Input 1	Input 1	Input 14	
Setting	OilTemp	OilTemp	Fan Pwr	
Set Point	90	110	*TBD	
Hysteresis	10	10		
Activation Direction	UP	UP	DOWN	
and/or	or	or		
	Input 2	Input 2		
Setting	Wdg	Wdg		
Set Point	105	120		
Hysteresis	10	10		
Activation Direction	UP	UP		
and/or/minus				
Setting				
Set Point				
Hysteresis				
Activation Direction				

LTC Monitor Setup

Tap Position	
Load tap changer monitor	Enabled
Tap position module	Input 9 : LTCPosL
Total number of taps	35
Tap Count	
Tap Count Period (hrs)	24

Tap Motor Sensing	
Motor current input module	Input 15 : SrcMtr
Switch contact module 1	Input 8 : LoadR/L
Switch contact module 2	
Load Current	
Load Current	Input 2 : Wdg

LTC Alarm Setup - High Priority

Alarm Relay Setup	
Alarm Relay	Relay 8 : LTC Alarm
Relay Function	Enabled
Relay Operation	Non-Failsafe
Test Lock Out	no
Latching Relay	yes
Actuation Delay hh:mm	0:00
Total Tap Counts (per tap)	
Tap Count Setpoint	n/a
Actuate Alarm	no
Multiple Tap Movements	
Actuate Alarm	no
Tap Run Time (per tap)	
Tap Run Time Setpoint	n/a
Actuate Alarm	no
Tap Counts per Period	
Tap Counts/Period Setpoint	100
Actuate Alarm	yes

Running Motor Current	
Upper Setpoint (Amps)	~rated + 20%
Lower Setpoint (Amps)	0
Actuate Alarm	Yes
Starting Motor Current	
Upper Setpoint (Amp-sec)	~rated + 30%
Lower Setpoint (Amp-sec)	0
Actuate Alarm	yes
Motor Actuations (per period)	
Motor Actuations Setpoint	n/a
Actuate Alarm	no
Motor Actuation Time	
Setpoint (sec)	n/a
Actuate Alarm	no
Differential Temperature	
Temperature Setpoint	n/a
Hysteresis	
Actuate Alarm	no

Figure 8: ITM Load

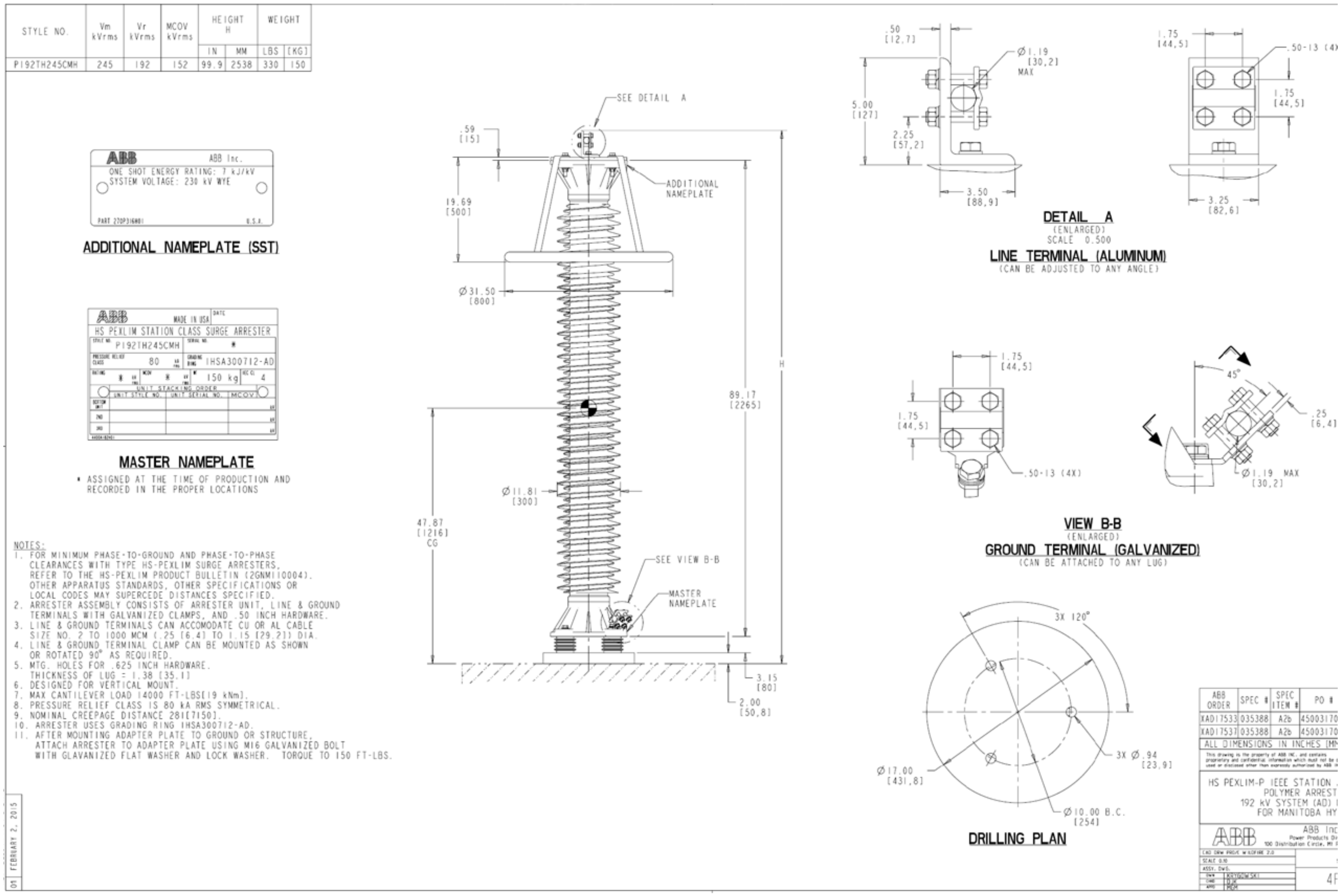


Figure 9: Arrester

SPEC ID# 4 333 MVA 230-138 kV Auto Transformer

1.	Delivery Location	Radisson Converter Station or Kelsey Generation Station or System Spare Radisson Station: 5 km NE of Gillam, Manitoba Rail service provided by Canadian National Railways to The Pas, Manitoba. OmniTrax from The Pas to Gillam, Manitoba. Tractor trailer from Gillam, Manitoba to Radisson Converter Station on PR# 280. GPS: 56°21'43"N, 94°36'38"W Kelsey Generating Station: Kelsey Rail Spur, TP32, Mile 255.5 Rail service provided by Canadian National Railways to The Pas, Manitoba. OmniTrax from The Pas to Kelsey Spur. GPS: 56°02'9"N, 96°30'55"W
2.	Delivery Date	No current date
3.	Station Type	Terminal Station, HVDC Station GPS: 56°21'43"N, 94°36'38"W
4.	Type of Site	With a Building
5.	Quantity	One (1)
6.	Transformer Type	Outdoor, load tap changing auto transformer suitable for step up and step down operation.
7.	MVA Rating	HV & LV: 200 / 267 / 333 TV: 30 / 40 / 50 MVA at 0 power factor lag or lead Vectorial loading Refer to Remarks 10 through 13
8.	Cooling System	ONAN / ONAF / ONAF
9.	Sound Level	84 / 86 / 88 dBA at 230 kV L-L, LTC N
10.	Temperature Rise	65°C

SPEC ID# 4 — 333 MVA 230-138 kV Auto Transformer

11. 3-Phase Relationship — YNad1

12. Number of Phases — 3

13. Transformer Voltage
    - HV 230 kV GrdY / 132.8
    - LV 138 kV GrdY / 79.67
    - TV 13.8 kV

14. Normal Operating Voltage Range — 135 to 150 kV

15. Maximum System Voltage and Pre-Fault Operating Voltage — 130% continuous

16. Maximum Overvoltage

    At Kelsey
    - 1 second — 1.4 p.u. Refer to Remarks 4, 7
    - continuous — 1.3 p.u. Refer to Remark 5, 7

    At Radisson
    - 2 seconds — 1.50 p.u. Refer to Remark 5, 7
    - 3 seconds — 1.27 p.u.
    - continuous — 1.1 p.u. at full overloads
      Refer to Remarks 10 through 13

17. Reactance — Positive-Sequence at 200 MVA base

HV	LV	TV	%H+L	%H+T	%L+T
253	138	13.8	8.1	28.1	16.0
230	138	13.8	7.6	27.1	16.0
207	138	13.8	7.3	26.2	16.0

Refer to Remark 3

18. Load Tap-changer — HV LTC in series circuit
    for ±10% HV variation
    in ±10 steps, FCBN

    HV neutral end tap changers are not acceptable.

    Refer to Remark 20

SPEC ID# 4 333 MVA 230-138 kV Auto Transformer

19. De-energised Tap-changer — n/a

20. Load Power Factor — 0.9 Lag to 0.9 Lead
Refer to Remark 10

21. Maximum System Fault Level — Infinite bus

22. Insulation Class & Test Levels

	kV LIL	Chops	SIL
HV:	900	990	745
LV:	650	715	540
H0X0:	110		
TV:	110	121	

23. Bushings

HV:	245 kV
LV:	145 kV
TV:	27.5 kV
Neutral:	15 kV

24. Connectors

HV:	4-hole NEMA pad streamlined corona-free
LV:	4-hole NEMA pad streamlined corona-free
TV:	6-hole NEMA pad
H0X0:	4-hole NEMA pad

All connectors are subject to confirmation and may change at the time of drawing approval.

25. PCore Doble Test Terminals — Required on HV and LV
TV and Neutral Terminal: not required

26. Surge arresters — Not required

SPEC ID# 4 333 MVA 230-138 kV Auto Transformer

27. Surge arrester Support & Bus Assembly	Required for HV, LV and TV Refer to the drawings of Purchaser-supplied arresters after the Remarks to determine arrester support height.
28. Discharge Counter	one for H1-H2-H3 combined one for X1-X2-X3 combined
29. GIC Detection	Required
30. WTI Gauge Type	Qualitrol 509 ITM Refer to Remark 25
31. GE Hydran	Required
32. Qualitrol 930 Pressure Sensors	Not required

SPEC ID# 4 333 MVA 230-138 kV Auto Transformer

33. Current Transformers	HV Bushings: 6 x 2000/1200/600/200-5 10L800 1 x 1000/500-5 0.3B1.8 at 500-5 MCIC approval is not required 1 x WTI CT 1 x LDC CT LV Bushings 3 x 1500/750-5 10L800 1 x 1500/750-5 0.3B1.8 at 750-5 MCIC approval is not required TV Bushings: 6 x 4000/2000-5 10L800 1 x WTI CT 1 x LDC CT TV inside delta 1 x 2000-5 10L800 Common Winding 1 x WTI CT H0X0 Bushing: 1 x 200-5 10L400 1 x 600/300-5 0.3B1.8 at 600-5 0.6B0.9 at 300-5 MCIC approval is not required 1 x WTI CT H1 and X1 Metering CTs are for GIC detection.
34. AC Auxiliary Voltage	Stepped-down from in-coming 600 Volt supply. Refer to Remark 21. Fans: 120/208 V, 3-phase, 4-W Heaters & Lights: 120 V, 1-phase Tap-changer: 120/208 V, 3-phase, 4-W
35. DC Auxiliary Voltage	Refer to Remark 22

SPEC ID# 4 — 333 MVA 230-138 kV Auto Transformer

36. Loss Evaluation	No Load:	$8,112 / kW
	Load:	$5,611 / kW at 200 MVA
37. Paint Colour	ANSI 70 Grey	
38. Test Variations	Refer to Remark 23	
39. Limitations	Refer to Figure 17	
40. Quality Assurance Requirements	ISO 9001	

Load Tap-changer Control Options (Refer to the Technical Requirements)

41. Motor Voltage	120/208 V, 3-phase, 4-W
42. Fully Automatic Voltage Control	Required
43. Supervisory Control	Required
44. Remote Indication	Required
45. Paralleling	Required This transformers shall be paralleled with the transformers described in Remark 3.
46. Voltage Sensing VT supplied by	Purchaser

47. Tap-change Direction for Step-up Operation

Pos.	Variation	Direction
+10	HV - 10%	↑ Raise
N		
-10	HV + 10%	↓ Lower

Remarks:

1) **Design Review**
A two-day design review meeting may be required with the Purchaser. If required, this meeting will be held at the Contractor’s factory. At this meeting, design personnel will be available for discussion of the design. All drawings will be made available for inspection. Completion of the latest revision of Manitoba Hydro Design Review Document is required prior to the meeting. This shall be

submitted to the Purchaser, as complete as possible, at least one (1) week prior to the scheduled design review meeting. The Contractor shall request the latest version of the Manitoba Hydro Design Review Document from the Purchaser prior to completing it.

2) Single Line Diagram

This universal transformer could be used at three different locations in the Purchaser's Northern Collector System as shown in Figures 1a and 1b. This system, the Northern Collector System, corrals power for the two HVDC BiPole systems, at Radisson and Henday Converter Stations. The transformer could also be added as a fourth transformer, B44, in parallel with Radisson B41, B42 and B43.

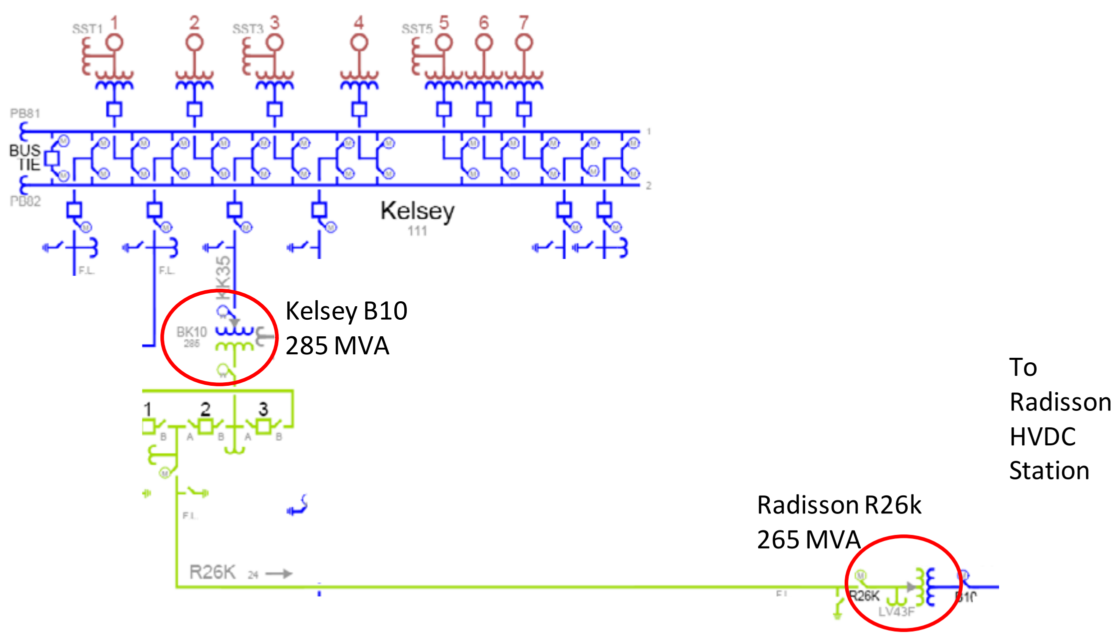


Figure 1a : Kelsey to Radisson

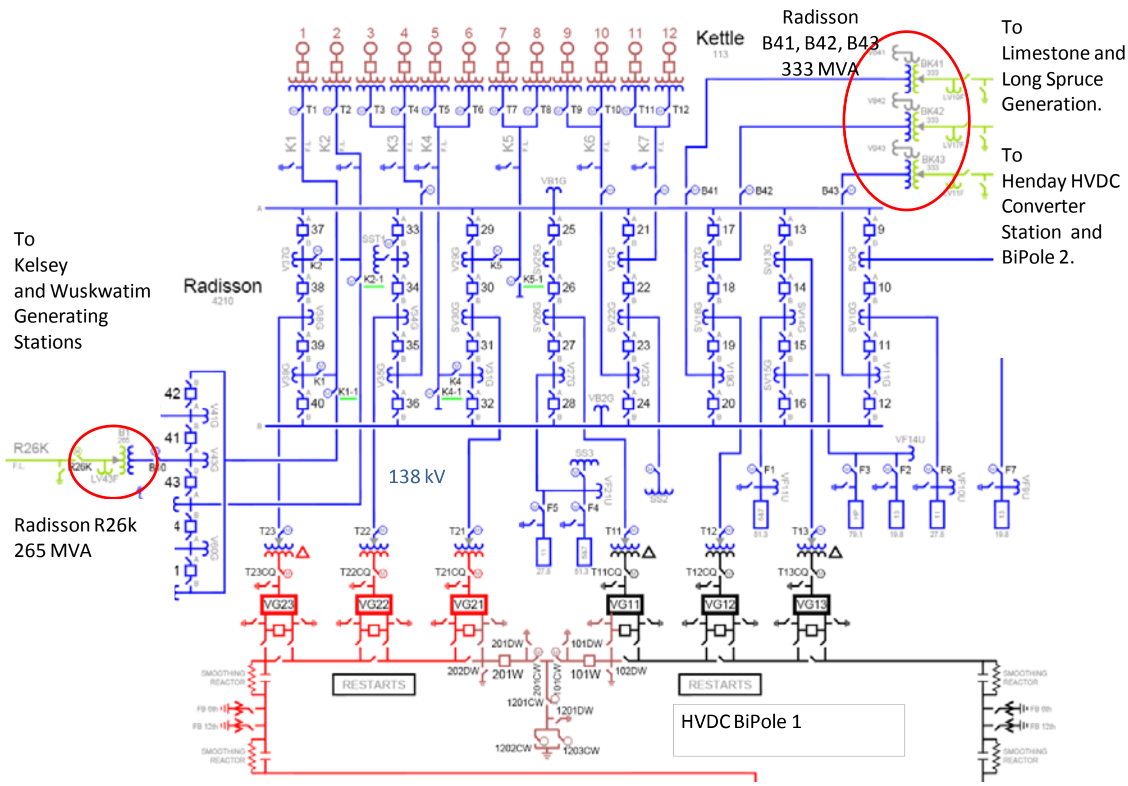


Figure 1b : Radisson - Henday

3) Existing Transformers

This transformer may be paralleled with three equally rated auto transformers:

200 / 267 / 333 MVA
230 kVY +/-10% in +/-10 steps FCBN
138 kVY
13.8 kV 50 MVA

Alternatively, it may be a replacement for Radisson R26K or Kelsey B10.
Design for paralleling with Radisson B41, B42 and B43, as the fourth parallel transformer.

	Radisson Autos B41, B42, B43	Radisson R26k	Kelsey B10
MVA Rating	200/267/333	159/212/265	171/228/285
HV	230 kVY +/-10% in +/-10 steps	230 kVY +/-10% in +/-10 steps	230 kVY +/-10% in +/-10 steps
LV	138 kVY	138 kVY	138 kVY
TV	13.8 kV	13.8 kV	13.8 kV

Positive-Sequence

kV	H+X	288820	288819	288821	Average	A3S7784		12088-01
kV	LTC Pos							
207	207	7.3	7.2	7.4	7.30	10.19		8.42
230	230	7.6	7.5	7.6	7.57	10.07	**All values at**	8.50
253	253	8.1	8	8.2	8.10	10.21	**200 MVA base**	8.88
kV	H+Y							
207	10	26.1	26.2	26.3	26.20			26.84
230	N	27	27.2	27.2	27.13	32.67		27.37
253	-10	28	28.2	28.2	28.13			28.14
	X+Y	15.8	16.1	16	15.97	21.47		16.69

Zero-Sequence

kV	LTC Pos	ZHX0	ZHT0	ZXT0	ZHX0	ZHT0	ZXT0	ZHX0	ZHT0	ZXT0
207	10	6.01	21.20	14.64				7.74	24.07	16.04
230	N	6.24	22.00	14.64	8.93	26.50	20.27	7.89	24.75	16.04
253	-10	6.75	22.91	14.64				8.30	25.62	16.04

Figure 2: Impedance

4) Maximum Flux Density

To minimize saturation effects such as harmonic currents during switching operations on the long 230 kV lines, the transformer must be suitable for 1.4 p.u. voltage without saturating the core. Core loss and excitation current tests are required up to 1.35 p.u. Furthermore, the core temperature rise above ambient shall be limited to 100˚C rise with the core at saturation (2.0 Tesla).

5) Overvoltage

At Kelsey, with a breaker open further down the 230 kV transmission line, the transformer must be suitable for a steady-state voltage of 299 kV (1.3 p.u.).

System experience and studies conducted by the Purchaser to date show that in the lightly damped northern collector system, temporary overvoltages of the saturation or ferroresonant type associated with transformer inrush currents can presently occur with significant duration and magnitude. In the actual system at Radisson with converter transformer energization, saturation overvoltage “envelopes” with peak 138 kV bus voltages of about 1.5 p.u. have been experienced with a very slow decay rate sustaining overvoltages for more than one second. The studies also indicated that the saturation overvoltages following AC fault clearing were generally less in magnitude and duration, but in the worst cases could still contain significant number of overvoltage cycles.

6) AC Harmonics

It is expected that the northern collector system will have higher harmonics contents due to the operation of HVDC converters. Total harmonic distortion is expected to be less than 3%, with no individual harmonic distortion greater than 1.5%.

7) Overvoltage and Frequency

Large frequency excursions can occur in the northern collector system due to load rejection. The envelope would be typical of the response of hydro governers for load rejection. The frequency is expected to rise to about 82 Hz in 3 to 4 seconds for a full load rejection, and decays to the nominal frequency in about 20 seconds.

While frequency in the system can also decrease to as low as 54 Hz, the events causing these do not result in large or significant overvoltages, when compared to the previously stated overvoltages. Assume 54 Hz occurs at less than 1.1 p.u. voltage (1.22 p.u. V/Hz).

8) Transient Recovery Voltage Data

The Contractor shall provide the following after completing the design, to facilitate transient recovery voltage studies for associated circuit breaker requirements:

a) A saturation curve showing the core loss and exciting current characteristics up to and beyond the point at which the air-core reactance line becomes tangent to the magnetization curve. The air-core reactance in ohms shall be provided for all three circuits.

b) All inter-winding, winding-to-ground and terminal-to-ground capacitance values and data pertaining to the natural frequency of oscillations occurring in the auto-transformer due to high current surges.

c) A curve of the overexcitation versus time (Volts per Hertz) capability of the auto-transformer which confirms the capability to operate at the specified overexcited voltage conditions. The Contractor shall confirm that the auto-transformer will perform this duty on an extended basis without any detrimental thermal, electrical (e.g. corona) or mechanical effects.

d) The calculated switching surge capability limit of the LV winding for neutral tap and the tap extremes, and a statement about what is limiting the capability.

9) Cold Temperature Start-Up

Due to the special operating requirements, the transformer must be capable of being energised at -50°C without unit damage of any nature. Special start-up instructions shall be supplied, if required, in the Instruction Manuals.

10) Normal Loading

The auto-transformer shall be subject to the following operating conditions. This involves the determination of vectorial voltages and currents based on the transformer's T-diagram (r+jx) and the loads listed below.

For these calculations, the tap changer is allowed to move to a normal operating position, to satisfy the constraints. The worst cases that meet these constraints are the operating conditions.

Calculate this at the extreme tap positions and at rated tap. For cases that do not fall within the constraints, determine the proper tap position and recalculate at that position.

The tertiary is loaded with 0 to 50 MVAr of capacitance or reactance at 13.8 kV and will operate in the range of 12.4 to 15.2 kV. Note that the TV is connected to a fixed impedance load (constant ohms) and not a fixed MVA load. Hence, the TV load can be greater than 50 MVAr [3 x 13800^2 / (50x10^6) = 11.4 ohms fixed impedance].

These voltages and currents shall then be used to determine the losses and the oil and winding temperatures. Typically the oil temperatures and each winding gradient are determined under different conditions.

Test data shall be used to determine the losses and shutdown currents for the temperature rise test.
An example calculation can be provided upon request.

The light loading is intended as a guide for ONAN cooling design.

With either the light or heavy loading, the tertiary may alternatively be unloaded.

<u>Heavy Loading</u>

The following vectorial loading capability is required with the LV as the source. This means the LV supply is greater than 333 MVA. This load is applicable at any tap position.

Circuit	MVA	Voltage	Power Factor
LV	source	131 - 145	
HV	333	230 - 253	0.9 lag or lead
TV	50	12.4 - 15.2	0 lag or lead

Light Loading

The following vectorial loading capability is required with the HV as the source. This means the HV supply is greater than 200 MVA. This load is applicable at any tap position.

Circuit	MVA	Voltage	Power Factor
LV	source	131 - 145	
HV	200	230 - 253	0.8 lag or lead
TV	30	12.4 - 15.2	0 lag or lead

11) Tertiary

The TV may eventually be used for VAr control and/or harmonic suppression by way of staged shunt reactors or capacitor banks.

The capacitors or reactors will be switched in and out, several times a day, with the transformer energised and under load. Switching can be done in stages of MVArs. Capacitors or reactors may be connected grounded or ungrounded-wye.

The TV will be operated with none of the bushings solidly grounded. The TV will be connected to a two-winding grounded wye - open delta potential transformer c/w lightning arresters. Its purpose is to more readily detect excessive bushing leakage ground currents on the TV through an overvoltage relay across the open delta before they result in a bushing flashover. The potential transformer and arresters will be supplied by the Purchaser. This applies with or without capacitors/reactors.

The tertiary may alternatively be grounded with capacitive voltage transformers and lightning arresters.

Even though the TV is intended to be impedance-grounded as described above, the transformer must still be suitable for continuous operation with one corner of the delta tertiary grounded in any tap position. This applies with or without capacitors/reactors.

12) Overload

The transformer shall be suitable for a 120% planned overload of the LV for 30 minutes as per the other conditions of the ‘Heavy Loading’ described above and the Terminal Station Loading as described in the Technical Requirements, Clause 6.2. At a 35°C ambient temperature, the hotspot temperature must not exceed 120°C with a pre-load of 333 MVA as per the ‘Heavy Loading’ described above. The TV load remains at 50 MVAr lag or lead during the overload.

During all of these loads,

$$0.9 \text{ lag} \leq \text{secondary power factor} \leq 0.9 \text{ lead}$$

TV power factor = 0 lag or lead
12.4 ≤ TV Voltage ≤ 15.2 kV rms

These are determined based on the same type of calculations as in Remark 6.
The Contractor shall also provide a loading study, based on the final test results, to determine the maximum allowable overloads based on the following conditions:

Overload to be determined by manufacturer

MVA Pre-Load HV	MVA Pre-Load TV	MVA Load HV	MVA Load TV	Voltage LV kV	Voltage HV kV	Duration hours	Ambient ℃	Hotspot Limit ℃
333	50	?	50	138	230	0.5,1, 2, 4, 8	-20, -10, 0, 10, 20, 25, 30, 35, 40	120,140
"	40	?	40	"	"	"	"	"
"	30	?	30	"	"	"	"	"
"	0	?	0	"	"	"	"	"
333	50	?	50	138	253	0.5,1, 2, 4, 8	-20, -10, 0, 10, 20, 25, 30, 35, 40	120,140
"	40	?	40	"	"	"	"	"
"	30	?	30	"	"	"	"	"
"	0	?	0	"	"	"	"	"
333	50	?	50	138	207	0.5,1, 2, 4, 8	-20, -10, 0, 10, 20, 25, 30, 35, 40	120,140
"	40	?	40	"	"	"	"	"
"	30	?	30	"	"	"	"	"
"	0	?	0	"	"	"	"	"

Figure 3

The overload limit for oil temperature is 110°C. If any of these overloads result in an overexcitation of the core, the core, clamping structure and tank shall be designed to suit. If a specific overexcitation condition cannot be met, the Contractor shall notify the Purchaser immediately and specify the reason for the limitation.

13) Contingency Loading upon HVDC Load Reduction

When an HVDC load reduction occurs, then northern generators are still producing power. This results in a severe short-term overload of the auto transformer, with expected loads of up to 2000 Amps (144%) on the 138 kV side.

Circuit	MVA	Voltage	Power Factor
LV	source	131 - 145	
HV	478	230 - 253	0.9 lag or lead
TV	0	12.4 - 15.2	n/a

These loads could exist for up to 30 minutes, until the system operators have time to curtail generators. The transformer shall be designed to meet this loading without exceeding 140˚C insulation hotspot temperatures and 160˚C steel hotspot temperatures, at an ambient temperature of +25˚C.

Desired pre-contingency loading is 333 MVA or 100%. However, if the temperatures cannot practically be met, then the Contractor shall state the allowable pre-load, but under no circumstances shall the acceptable pre-load be less than 167 MVA or 50%.

The calculations shall be similar to those of Remark 10, with the tap changer allowed to move, to maintain rated output voltage of 230 kV.

14) Geomagnetically Induced Current (GIC)

The transformer is initially estimated to experience dc currents in the range of 50 to 150 A dc on the 230 kV lines. Long duration base current is 15 A dc. A better estimate should be available after contract award.

A GIC capability study shall be performed as per clause 9 of IEEE C57.163-2015, IEEE Guide for Establishing Power Transformer Capability while under Geomagnetic Disturbances. The manufacturer shall use these base and peak GIC levels along with the generic GIC stepped waveform timing from IEEE C57.163-2015 clause 9.1 GIC Signature. The signature shall cycle for 8 hours minimum or until the cycle temperatures stabilize.

The Purchaser plans to monitor the levels of dc current through the transformer and remove it from service if the values become excessive. The Contractor shall provide time versus dc current withstand curves for the transformer as well as the other requirements of clause 9.3 of IEEE C57.163.

15) PCore test Terminals

PCore Doble (Lapp) test terminals are required for all ungrounded bushing terminals. Copper test terminals are preferred because the bushing terminals are copper. The following catalogue numbers may be used for initial estimation:

245 kV, 1200 A bushings	PCore# 63042-E-70
145 kV, 2000 Amp bushings	PCore# 63043-E-70

All shields must cover the top of the bushing and therefore these PCore Doble test terminals may all require a custom design rather than the specific model specified above.

PCore Doble Test Terminals must be mounted, complete with shields, during factory dielectric testing of all equipment. They must also be installed and carrying current during the temperature rise and load run tests to ensure they are not overheating. They shall be included in the thermal scan.

16) Bird Guards

Bird guards are required for the TV bushings. This may be in the form of netting or rubber terminal covers and is subject to Purchaser's approval.

17) TV Bushings and Conservator Locations

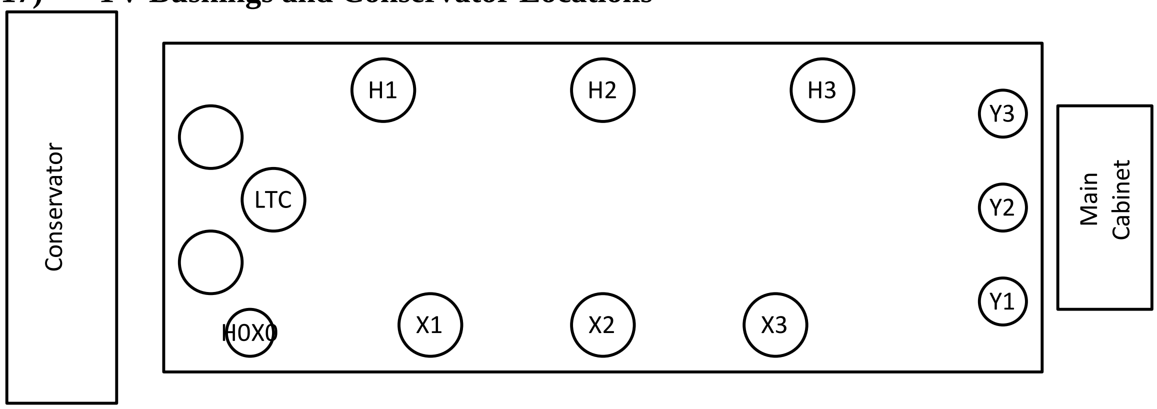


Figure 4

18) TV Bus Supports

An insulator support bracket and 150 kV LIL porcelain station post type insulators shall be provided, located 914 mm from the centreline of the TV bushings and with a 914 mm insulator phase spacing for the Purchaser's incoming leads. The connectors for the TV bushings and station post type insulators shall be mounted level. This entire assembly is subject to the Purchaser's approval and will be finalized at the Contractor's drawings approval stage.

19) CT Test Loop

A CT test loop as described in Technical Requirements, clause 13.5 for HVDC Stations, is required on each turret.

20) Tap Position Numbering

Tap position +10 shall designate the 207 kV position and position -10 shall designate the 253 kV position. Raise shall be designated towards tap position +10.

21) 600 Volt Power Supply

The nearby GSU station supplies 600 Volt AC power so the Contractor shall supply a three-phase 600-208Y transformer and accessories as described in Technical Requirements, Clause 31.10 for GSU transformers.

22) Battery Supply

Kelsey Generating Station uses 250 Vdc battery supply while Radisson Converter Station uses 125 Vdc. Provide any required auxilliary relays (e.g. supervisory relays) for each voltage and ensure all other dc equipment is suitable for 250 Vdc.

23) Apparatus Tests

Further to the production tests as outlined in the Apparatus Tests and Quality Assurance Program Requirements, the following tests shall apply:

a) No load loss and excitation current from 80% to 135% in 5% increments. Air-core reactance and the air-core lines shall be provided for both the HV and LV. The point of core saturation shall also be indicated.

b) HV to LV load losses shall also be measured at 356.25 MVA (125%) at rated tap and both tap extremes.

c) ONAN and ONAF temperature rise test with 3-circuit total losses based on the Light and Heavy Loading criteria respectively at the worst case tap positions. Three-circuit load losses are to be determined by proportioning the appropriate load on each ac resistive component and reactive component on the transformer's T-diagram. Each winding temperature shall be determined based on its own worst case condition and the worst case oil temperature. The calculations to determine this worst case condition are subject to the Purchaser's approval. Preliminary calculations based on the design data shall be reviewed at the Design review.

e) The LV switching surge level shall be attained either by the HV switching surge level or by a separate test. If the level cannot be attained in test, the Contractor shall explain why. Either way, the transformer shall be designed for the required level.

g) A sketch of the tested shunt capacitances combined with calculated values shall be included in the test report. This shall include the bushing capacitance separately.

h) Special Excitation Tests

The Contractor shall obtain a highly accurate power quality meter to measure the 3-phase vectorial voltages and currents during core excitation testing after dielectrics. This would not use the normal meters such as the Haefely measuring system nor oscilloscopes which aren't accurate enough. This requires a power quality analyzer or a Phaser Measuring Unit such as the Dranetz-BMI Power Xplorer series, ERLPHase Tesla PMU recorders or other such devices which samples voltage and current at a rate of at least 256 samples per cycle, with storage and download capability.

The purpose is to use these 3-phase voltage and current phasors (magnitude and phase angle) for the creation of accurate B-H curves by the Purchaser. This would be used for both transient studies and GIC studies.

The meter would need to measure several voltage levels, both in the forward and reverse regions of the B-H curve. For example, measure at 10%, 30%, 50%, 70%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, and as high as practical for the supply, and then begin stepping down again through the same levels. The measurement recording shall provide data for at least 3 cycles at each level.

The test shall be done for at least two tap positions: the neutral and one extreme tap position.

The core should be demagnetized prior to this test.

24) Fibre-Optic Sensors

16 Fibre-optic sensors shall be supplied and installed, connected to the Qualitrol 509 ITM. Some of these will be used for GIC detection.

The sensors shall be monitored during the temperature rise tests. This will be done during both the oil rise tests and during all winding temperature shutdowns for comparison with the shutdown resistances. The entire log of data from the monitoring device shall be provided as a file and a summary of the relevant results shall be printed with the test report.

25) Qualitrol 509 ITM

ITM ordering information is shown below.

ITM 509 Ordering and Set-Up Information

Site	285 MVA Auto		**with a building**
Base System	ITM 509-300	DW	
Enclosure	Panel Mount with 5 kV Surge Protection		
Heater	None		

For transformers:
ONAN/ONAF/ONAF
in-tank LTC
with fibre-optic sensors
Main Conservator oil level potentiometer

without Qualitrol 930 pressure sensors

Main Inputs

		Type	Mulipied Contact	Name	Code	Comment
7	Input 1	100 Ω Pt RTD		OilTemp	B	in WTL termal well
6	Input 2	x Amp CT		HV Wdg	Cx	HV WTI CT
6	Input 3	x Amp CT		LV Wdg	Cx	CV WTI CT
6	Input 4	x Amp CT		TV Wdg	Cx	TV WTI CT
7	Input 5	x Amp Sensor		Fan Pwr	Iy	loop through fan power cables additively
7	Input 6	Potentiometer		Oil Lvl	H	Main conservator oil level
5	Input 7	Dry Contact	✓	Trips	R	Parallel GDR fast gas, LTC Rapid Pressure Rise, Main and LTC PRD, Main and LTC Crit Lo Oil Levels
7	Input 8	Dry Contact	✓	SlowGas	R	Gas detector Relay alarm contacts
	Expansion Module Inputs Inputs					
7	Input 9	Tap Position Resistor Bridge		LTC Pos	V3	2nd resistor bridge
7	Input 10	Dry Contact		R/L Act	R	LTC Raise & Lower Actuation (Reinhausen cam 127)
7	Input 11	Dry Contact		PwrFail	R	Main breaker and LTC Power Fail Alarm
7	Input 12	Dry Contact		LTCLock	R	LTC Oil Temp. Lockout Alarm
7	Input 13	Dry Contact		BreCycl	R	Main Breather cycling (heating system status)
7	Input 14	Dry Contact		BreFail	R	Parallel LTC & Main Consv. Breather malfunction
7	Input 15	4 - 20 mA Loop		Gas Lvl	M	Hydran gas level
7	Input 16	4 - 20 mA Loop		H2O Lvl	M	Hydran moisture level

'x' Indicates current draw, to be chosen based on 2 p.u. current from the bushing CT, and limited to 120% of 'x'.
Therefore use C10 Amp for a 5 Amp secondary bushing CT. Use C5 Amp for a 2 Amp secondary bushing CT. (5, 10, 20 Amp)

'y' Indicates normal motor current draw for the sum of all fans in stage 1 or 2, or sum of stages 1 and 2, or sum of all pumps or LTC motor. (5,10, 20, 50, 100 Amp)

	Relay Designation for Front Panel		Base Logic from Output Relay set-up below						
12	Relay 1	Stage 1 Fans	Fiber 1	or	HV Wdg	or	LV Wdg	or	TV Wdg
12	Relay 2	Stage 2 Fans	Fiber 1	or	HV Wdg	or	LV Wdg	or	TV Wdg
9	Relay 3	Fan Alarm	Fan Pwr	and	Stage 1 Fans	or	Fan Alarm 2		
9	Relay 4	2nd Alarm	LTCLock	or	LTC Vac	or	BreFail	or	PwrFail
9	Relay 5	1st Alarm	Oil Lvl	or	SlowGas	or	OilTemp	or	LV Wdg
8	Relay 6	1st Trip	Trips	or	OilTemp	or	LV Wdg		
8	Relay 7	2nd Trip	Oil Lvl	or	SlowGas				
11	Relay 8	Fan Alarm 2	Fan Pwr	and	Stage 2 Fans				

Figure 5: ITM

ITM Direct Winding

		Length	Quantity
Neoptix T2 Fiber Optic Temperature Sensors	Neoptix CAB-699-Le	Length to suit	16
Tank Wall Plate Assembly with COV-121-1 and CON-159-1	Weld On PLT-201	Steel	1 Plate for 16 sensors
Fibre Optic Extension Cables	Neoptix CAB-700-Le	Length to suit	16
Hot Spot Module Channels Interface	Qualitrol MOD-638-8	8 channel	2
Portable Fibre Optic Thermometer	Qualitrol KIT-057-1		not required

Remote Communiations

Additional Remote Communications Protocol	DNP 3
	MODBUS
	IEC 61850
Additional Remote Communications Ports	Ethernet FX,ST Fibre Optic
Additional Control Functions	
	Data Logging
	Event Recording
	Quantity
Hard Copy of Instruction Manual	9

Configuration file for easy set-up is available from Manitoba Hydro.
Include the actual Qualitrol order form, the Qualitrol Packing Set-up Sheet c/w serial/order number, this set-up information and the final configuration file printout in the Transformer Instruction Manual.

Accessories

			Quantity
100 Ohm Pt RTD for Oil	Length to suit	Qualitrol 103-059-02 CS-41840	2
100 Ohm Pt RTD for Ambient	Length to suit	Qualitrol 103-054-01	0

Accessories Purchased Separately

Thermal Well	Qualitrol 2WTL Thermal Plate	1
Brass Plug	Qualitrol 167-50-29F CS-31450	1
Main Tank Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	1
LTC Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	not required
MR RMV II Oil Level Gauge with two contacts (Lo, Critical Lo)	Qualitrol 032-038-01 CS-36552	n/a
Pressure Sensors	Qualitrol 930-008-01 CS-36480	not required

Additional Communication Accessories (housed with in control cabinet)

USB to DB9 Cable	Qualitrol CAB-049-1	1
USB-A to USB-B, 6 ft.	Qualitrol CAB-050-1	1

Aux are redundant relays for NERC requirements

Output Relay Properties

	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Stage 1 Fans	Stage 2 Fans	Fan Alarm	2nd Alarm
Enabled	yes	yes	yes	yes
Failsafe	yes	yes	no	no
Test Lockout	off	off	off	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	1st Alarm	1st Trip	2nd Trip	Fan Alarm 2
Enabled	yes	yes	yes	yes
Failsafe	no	no	no	no
Test Lockout	off	on	on	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

Figure 5: ITM

Aux are redundant relays for NERC requirements

Output Relay Control Logic	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Stage 1 Fans	Stage 2 Fans	Fan Alarm	2nd Alarm
	Fiber 1	Fiber 1	Input 5	Input 12
Setting	Fiber 1	Fiber 1	Fan Pwr	LTCLock
Set Point	80	85	*TBD	50%
Hysteresis	10	10		50%
Activation Direction	UP	UP	DOWN	UP
and/or/minus	or	or	and	or
	Input 2	Input 2	Relay 1	#N/A
Setting	HV Wdg	HV Wdg	Stage 1 Fans	LTC Vac
Set Point	80	85	50%	50%
Hysteresis	10	10	50%	50%
Activation Direction	UP	UP	UP	UP
and/or	or	or	or	or
	Input 3	Input 3	Relay 8	Input 14
Setting	LV Wdg	LV Wdg	Fan Alarm 2	BreFail
Set Point	80	85	50%	50%
Hysteresis	10	10	50%	50%
Activation Direction	UP	UP	UP	UP
and/or/minus	or	or		or
	Input 4	Input 4		Input 11
Setting	TV Wdg	TV Wdg		PwrFail
Set Point	80	85		50%
Hysteresis	10	10		50%
Activation Direction	UP	UP		UP

* Set Point and Hysteresis is dependent upon number of fans per stage.

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	1st Alarm	1st Trip	2nd Trip	Fan Alarm 2
	Input 6	Input 7	Input 6	Input 5
Setting	Oil Lvl	Trips	Oil Lvl	Fan Pwr
Set Point	20%	50%	5%	*TBD
Hysteresis	10%	50%	5%	
Activation Direction	DOWN	UP	UP	DOWN
and/or/minus	or	or	or	and
	Input 8	Input 1	Input 8	Relay 2
Setting	SlowGas	OilTemp	SlowGas	Stage 2 Fans
Set Point	50%	110	50%	50%
Hysteresis	50%	10	50%	50%
Activation Direction	UP	UP	UP	UP
and/or	or	or		
	Input 1	Input 3		
Setting	OilTemp	LV Wdg		
Set Point	90	120		
Hysteresis	10	10		
Activation Direction	UP	UP		
and/or/minus	or			
	Input 3			
Setting	LV Wdg			
Set Point	105			
Hysteresis	10			
Activation Direction	UP			

Output Current Loop Setup	Loop 1	Loop 2	Loop 3	Loop 4
Input	OilTemp	LV Wdg	LTC Pos	Oil Lvl
and/or				
Input				
or				
Input				
Input#	Input 1	Input 3	Input 9	Input 6
and/or				
Input#				
or				
Input#				
Loop Type	4 - 20 mA Loop	4 - 20 mA Loop	4 - 20 mA Loop	4 - 20 mA Loop
Custom Range	no	no	no	no
Maximum				
Minimum				

Figure 5: ITM

Data Logger	Signal Name	Store Rate	Sample Rate	Sample Type
Channel 1	Input 1 : OilTemp	30 M	1 M	MAX
Channel 2	Input 2 : HV Wdg	30 M	1 M	MAX
Channel 3	Input 3 : LV Wdg	30 M	1 M	MAX
Channel 4	Input 4 : TV Wdg	30 M	1 M	MAX
Channel 5	Input 2 : HV Wdg Current	30 M	1 M	Max
Channel 6	Input 2 : HV Wdg Current	30 M	1 M	Ave
Channel 7	Input 2 : HV Wdg Current	30 M	1 M	Min
Channel 8	Input 3 : LV Wdg Current	30 M	1 M	Max
Channel 9	Input 3 : LV Wdg Current	30 M	1 M	Ave
Channel 10	Input 3 : LV Wdg Current	30 M	1 M	Min
Channel 11	Input 4 : TV Wdg Current	30 M	1 M	Max
Channel 12	Input 4 : TV Wdg Current	30 M	1 M	Ave
Channel 13	Input 4 : TV Wdg Current	30 M	1 M	Min
Channel 14	Input 5 : Fan Pwr	30 M	1 M	Max
Channel 15	Input 5 : Fan Pwr	30 M	1 M	Ave
Channel 16	Input 5 : Fan Pwr	30 M	1 M	Min
Channel 17	Input 6 : Oil Lvl	30 M	30 M	MAX
Channel 18				
Channel 19				
Channel 20				

Event Recorder	Event 1	Event 2	Event 3	Event 4
Enabled	yes	yes	yes	yes
Name	Fan Activation	Alarms	Trips	Breather
System Snapshot	yes	yes	yes	yes
	Relay 1	Relay 3	Relay 6	Input 13
Control Signal	Stage 1 Fans	Fan Alarm	1st Trip	BreCycl
Set Point	50%	50%	50%	50%
Hysteresis	50%	50%	50%	50%
Activation Direction	UP	UP	UP	UP
	or	or	or	or
	Relay 2	Relay 4	Relay 7	Input 13
Control Signal	Stage 2 Fans	2nd Alarm	2nd Trip	BreCycl
Set Point	50%	50%	50%	50%
Hysteresis	50%	50%	50%	50%
Activation Direction	UP	UP	UP	DOWN
		or		
		Relay 5		
Control Signal		1st Alarm		
Set Point		50%		
Hysteresis		50%		
Activation Direction		UP		
Control Signal				
Set Point				
Hysteresis				
Activation Direction				

	Event 5	Event 6	Event 7	Event 8
Enabled	yes	yes	yes	yes
Name	Tap Change	Gas Level	Moisture Level	
System Snapshot	yes	yes	yes	yes
	Input 10	Input 15	Input 16	
Control Signal	R/L Act	Gas Lvl	H2O Lvl	
Set Point	50%	20%	20%	
Hysteresis	50%	5%	5%	
Activation Direction	UP	UP	UP	
Control Signal				
Set Point				
Hysteresis				
Activation Direction				
Control Signal				
Set Point				
Hysteresis				
Activation Direction				
Control Signal				
Set Point				
Hysteresis				
Activation Direction				

Figure 5: ITM

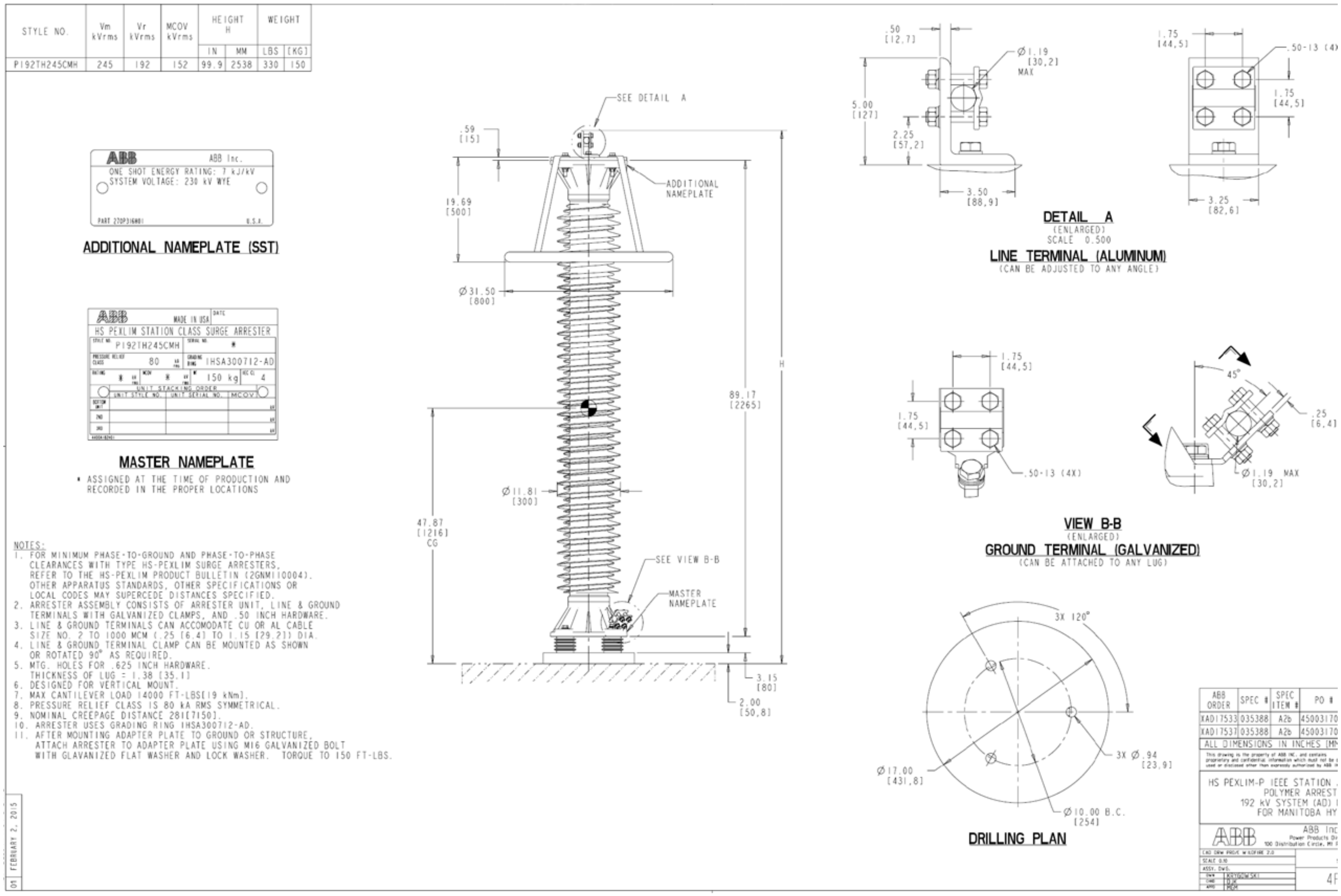


Figure 6: HV Arrester

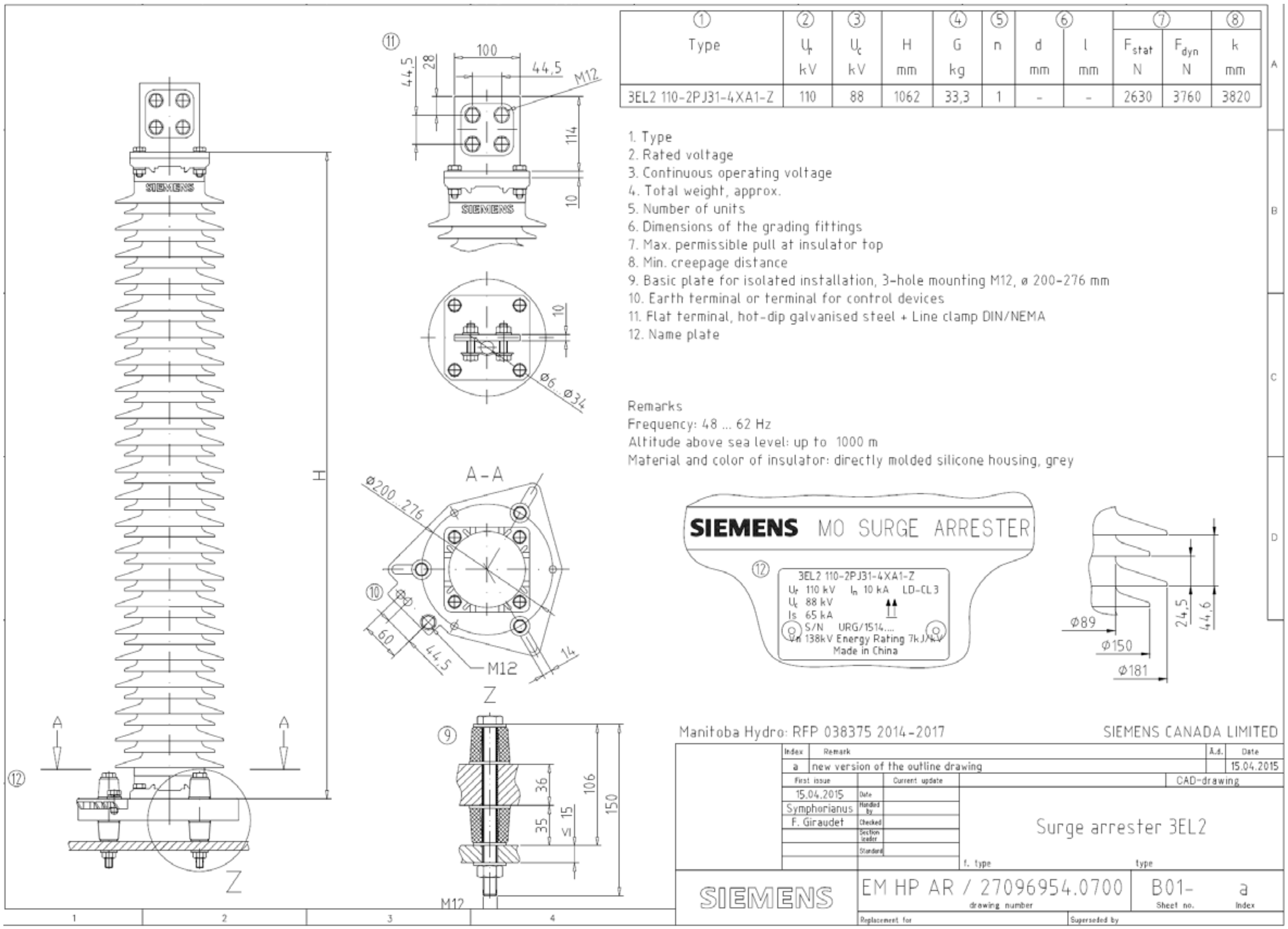


Figure 7: LV Arrester

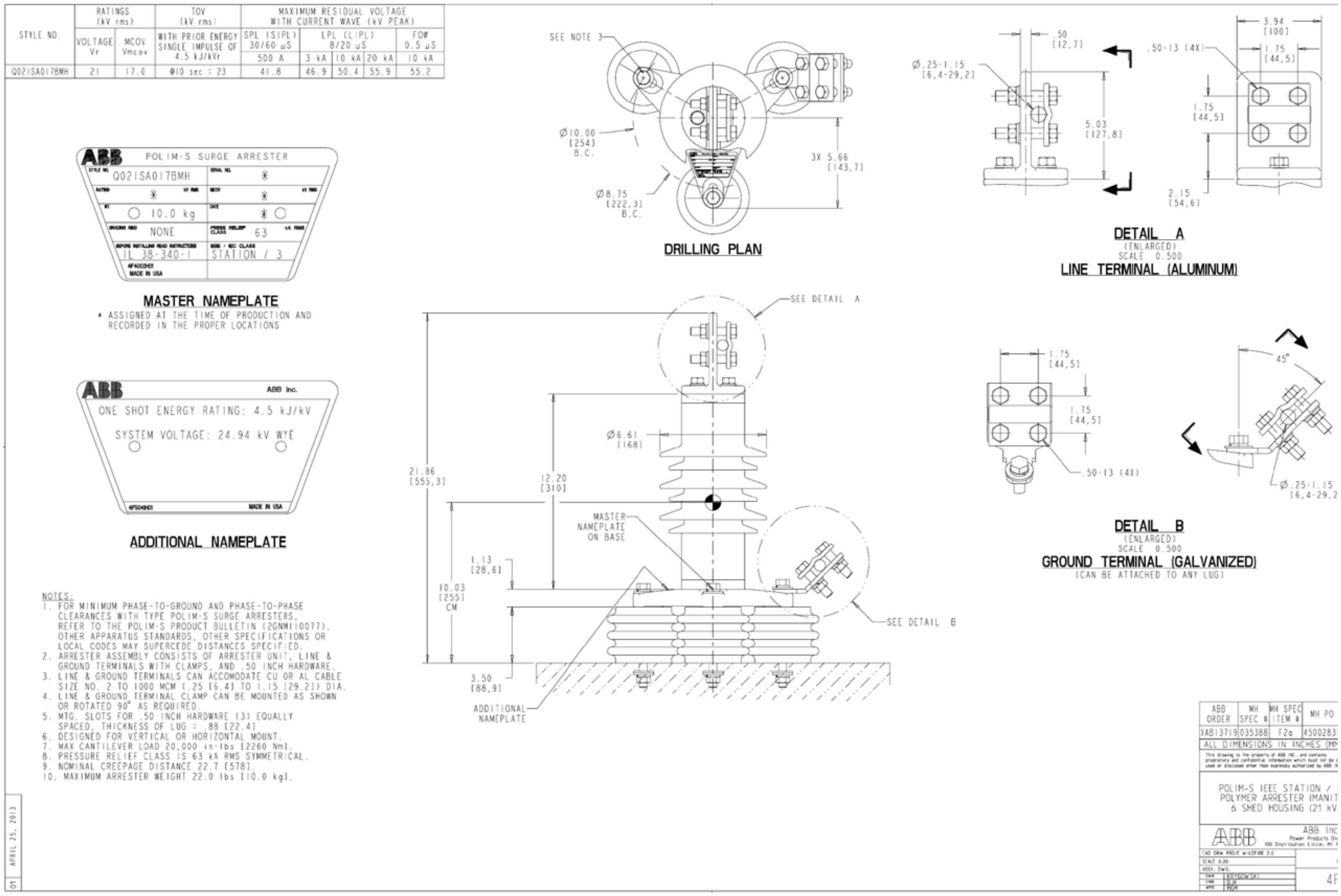


Figure 8: TV Arrester

SPEC ID# 5 — 285 MVA 230-115 kV Auto Transformer

1.	Delivery Location	Manitoba Hydro Waverley Service Centre Door 15 1840 Chevrier Blvd. Winnipeg, MB, Canada GPS: 49°49'21"N, 97°10'36"W
2.	Delivery Date	No current date
3.	Station Type	Terminal Station GPS: 50° 5' 1"N, 97° 9' 41"W
4.	Type of Site	With a Building
5.	Quantity	One (1)
6.	Transformer Type	Outdoor, load tap changing auto transformer suitable for step down operation.
7.	MVA Rating	HV & LV: 171 / 228 / 285 TV: 42 / 56 / 70 MVA at 0 power factor lag or lead Vectorial loading Refer to Remarks 5
8.	Cooling System	ONAN / ONAF / ONAF
9.	Sound Level	81 / 83 / 84 dBA at 230 kV L-L, LTC N
10.	Temperature Rise	65ºC
11.	3-Phase Relationship	Ynad1
12.	Number of Phases	3
13.	Transformer Voltage	HV 230 kV GrdY / 132.8 LV 115 kV GrdY / 66.4 TV 13.8 kV
14.	Normal Operating Voltage Range	225 to 245 kV

SPEC ID# 5 — 285 MVA 230-115 kV Auto Transformer

15. Maximum System Voltage and Pre-Fault Operating Voltage — 110% continuous

16. Maximum Overvoltage
    - 200 milli-seconds — 1.4 p.u.
    - 1 second — 1.3 p.u.
    - continuous — 1.1 p.u.

17. Reactance — At 171 MVA base

HV	LV	TV	%H+L		%L+T
230	126.5	13.8	≥6.7*	36.4†	27.3†
230	138.0	13.8	7.7	36.4†	26.7†
230	103.5	13.8	9.4	36.4†	26.6†

H + T — 35* to approximately 38

L + T — 25* to approximately 28

* no minus tolerance

† preferred value

Impedance is subject to Purchaser's approval

18. Load Tap-changer — LV LTC for LV voltage variation
    +/-10% in +/-8 steps FCBN
    LTC in LV line end, constant flux,
    constant TV voltage

    Neutral end tap changers are not acceptable.

19. De-energised Tap-changer — n/a

20. Load Power Factor — 0.9 Lag to 0.9 Lead
    Refer to Remarks 3 & 5

21. Maximum System Fault Level — n/a

SPEC ID# 5 285 MVA 230-115 kV Auto Transformer

22. Insulation Class & Test Levels

	kV LIL	Chops	SIL
HV:	900	990	745
LV:	550	605	455
H0X0:	110		
TV:	110	121	

23. Bushings

HV: 245 kV
LV: 123 kV
TV: 27.5 kV
Neutral: 15 kV

24. Connectors

HV: 4-hole NEMA pad streamlined corona-free
LV: 4-hole NEMA pad streamlined corona-free
TV: 6-hole NEMA pad
H0X0: 4-hole NEMA pad

All connectors are subject to confirmation and may change at the time of drawing approval.

25. PCore Doble Test Terminals

Required on HV and LV
TV and Neutral Terminal: not required

26. Surge arresters

Not required

27. Surge arrester Support & Bus Assembly

Required for HV, LV and TV

Refer to the drawings of Purchaser-supplied arresters after the Remarks to determine arrester support height.

28. Discharge Counter

one for H1-H2-H3 combined
one for X1-X2-X3 combined

SPEC ID# 5 285 MVA 230-115 kV Auto Transformer

29. GIC Detection	Required
30. WTI Gauge Type	Qualitrol 509 ITM Refer to Remark 16
31. GE Hydran	Required
32. Qualitrol 930 Pressure Gauges	Not required

33. Current Transformers	HV Bushings:		
		6 x 1600/800-5	10L800
		1 x 800/400-5	0.3B1.8 at 800-5
			0.6B0.9 at 400-5
		MCIC approval is not required	
		1 x WTI CT	
		1 x LDC CT	
	LV Bushings		
		3 x 1600-5	10L800
		1 x 1500/750-5	0.3B1.8 at 1500-5
			0.6B0.9 at 750-5
		MCIC approval is not required	
	TV Bushings:		
		3 x 3000-5	10L800
		1 x WTI CT	
	TV inside delta		
		1 x 1600-5	10L800
	Common Winding		
		1 x WTI CT	
	H0X0 Bushing:		
		1 x 200-5	10L400
		1 x 800/400-5	0.3B1.8 at 800-5
			0.6B0.9 at 400-5
		MCIC approval is not required	
		1 x WTI CT	
	Metering CTs are for GIC detection.		
34. AC Auxiliary Voltage	Fans & Pumps:	120/208 V, 3-phase, 4-W	
	Heaters & Lights:	120 V, 1-phase	
	Tap-changer:	120/208 V, 3-phase, 4-W	
35. DC Auxiliary Voltage	**125** V dc for tripping & alarms		
36. Loss Evaluation	No Load:	$8,112 / kW	
	Load:	$5,611 / kW at 171 MVA	
37. Paint Colour	ANSI 70 Grey		

38. Test Variations	Refer to Remark 21
39. Limitations	Refer to Figure 13
40. Quality Assurance Requirements	ISO 9001

Load Tap-changer Control Options (Refer to the Technical Requirements)

41. Motor Voltage	120/208 V, 3-phase, 4-W
42. Fully Automatic Voltage Control	Required
43. Supervisory Control	Required
44. Remote Indication	Required
45. Paralleling	Required This transformers shall be paralleled with an identical transformer.
46. Voltage Sensing VT supplied by	Purchaser

47. Tap-change Direction for Step-up Operation

Pos.	Variation	Direction
+8	LV + 10%	↑ Raise
N		
-8	LV - 10%	↓ Lower

Remarks:

1) **Design Review**
A two-day design review meeting may be required with the Purchaser. If required, this meeting will be held at the Contractor's factory. At this meeting, design personnel will be available for discussion of the design. All drawings will be made available for inspection. Completion of the latest revision of Manitoba Hydro Design Review Document is required prior to the meeting. This shall be submitted to the Purchaser, as complete as possible, at least one (1) week prior to the scheduled design review meeting. The Contractor shall request the latest version of the Manitoba Hydro Design Review Document from the Purchaser prior to completing it.

2) Cold Temperature Start-Up

Due to the special operating requirements, the transformer must be capable of being energised at -50°C without unit damage of any nature. Special start-up instructions shall be supplied, if required, in the Instruction Manuals.

3) Normal Loading

The auto-transformer shall be subject to the following operating conditions. This involves the determination of vectorial voltages and currents based on the transformer's T-diagram and the loads listed below.

For these calculations, the tap changer is allowed to move to a normal operating position, to satisfy the constraints. The worst cases that meet these constraints are the operating conditions.

Calculate this at the extreme tap positions and at rated tap. For cases that do not fall within the constraints, determine the proper tap position and recalculate at that position.

The tertiary is loaded with 0 to 70 MVAr of capacitance or reactance at 13.8 kV and will operate in the range of 12.4 to 15.2 kV. Note that the TV is connected to a fixed impedance load (constant ohms) and not a fixed MVA load. Hence, the TV load can be greater than 70 MVAr single-phase [3 x 13800^2 / (70x10^6) = 8.16 ohms fixed impedance].

These voltages and currents shall then be used to determine the losses and the oil and winding temperatures. Typically the oil temperatures and each winding gradient are determined under different conditions.

Test data shall be used to determine the losses and shutdown currents for the temperature rise test.

An example calculation can be provided upon request.

The light loading is intended as a guide for ONAN cooling design. With either the light or heavy loading, the tertiary may alternatively be unloaded.

Heavy Loading

The following vectorial loading capability is required with the LV as the source. This means the LV supply is greater than 285 MVA. This load is applicable at any tap position.

Circuit	MVA	Voltage	Power Factor
HV	source	230 - 253	
LV	285	110 - 120	0.9 lag or lead
TV	70	12.4 - 15.2	0 lag or lead

Light Loading
The following vectorial loading capability is required with the HV as the source. This means the HV supply is greater than 171 MVA. This load is applicable at any tap position.

Circuit	MVA	Voltage	Power Factor
LV	source	230 - 253	
HV	171	110 - 120	0.8 lag or lead
TV	42	12.4 - 15.2	0 lag or lead

4) Tertiary
The TV may eventually be used for VAr control and/or harmonic suppression by way of staged shunt reactors or capacitor banks.

The capacitors or reactors will be switched in and out, several times a day, with the transformer energised and under load. Switching can be done in stages of MVArs. Capacitors or reactors may be connected grounded or ungrounded-wye.

The TV will be operated with none of the bushings solidly grounded. The TV will be connected to a two-winding grounded wye - open delta potential transformer c/w lightning arresters. Its purpose is to more readily detect excessive bushing leakage ground currents on the TV through an overvoltage relay across the open delta before they result in a bushing flashover. The potential transformer and arresters will be supplied by the Purchaser. This applies with or without capacitors/reactors.

The tertiary may alternatively be grounded with capacitive voltage transformers and lightning arresters.

Even though the TV is intended to be impedance-grounded as described above, the transformer must still be suitable for continuous operation with one corner of the delta tertiary grounded in any tap position. This applies with or without capacitors/reactors.

5) Overload
The transformer shall be suitable for a 120% planned overload of the LV for 30 minutes as per the other conditions of the ‘Heavy Loading’ described above and the Terminal Station Loading as described in the Technical Requirements, Clause 6.2. At a 35°C ambient temperature, the hotspot temperature must not exceed 120°C with a pre-load of 285 MVA as per the ‘Heavy Loading’ described above. The TV load remains at 70 MVAr lag or lead during the overload.
During all of these loads,

$$0.9 \text{ lag} \leq \text{secondary power factor} \leq 0.9 \text{ lead}$$

TV power factor = 0 lag or lead
12.4 ≤ TV Voltage ≤ 15.2 kV rms

These are determined based on the same type of calculations as in Remark 3.

The Contractor shall also provide a loading study, based on the final test results, to determine the maximum allowable overloads based on the following conditions:

Step-down Operation

MVA Pre-Load LV	MVA Pre-Load TV	MVA Load LV	MVA Load TV	Voltage LV kV	Voltage HV kV	Duration hours	Ambient °C	Hotspot Limit °C
285	70	?	70	110	230	0.5,1, 2, 4, 8	-20, -10, 0, 10, 20, 25, 30, 35, 40	120,140
"	56	?	56	"	"	"	"	"
"	42	?	42	"	"	"	"	"
"	30	?	30	"	"	"	"	"
"	0	?	0	"	"	"	"	"
285	70	?	70	115	230	0.5,1, 2, 4, 8	-20, -10, 0, 10, 20, 25, 30, 35, 40	120,140
"	56	?	56	"	"	"	"	"
"	42	?	42	"	"	"	"	"
"	30	?	30	"	"	"	"	"
"	0	?	0	"	"	"	"	"
285	70	?	70	120	230	0.5,1, 2, 4, 8	-20, -10, 0, 10, 20, 25, 30, 35, 40	120,140
"	56	?	56	"	"	"	"	"
"	42	?	42	"	"	"	"	"
"	30	?	30	"	"	"	"	"
"	0	?	0	"	"	"	"	"

Figure 1

The overload limit for oil temperature is 110°C. If any of these overloads result in an overexcitation of the core, the core, clamping structure and tank shall be designed to suit. If a specific overexcitation condition cannot be met, the Contractor shall notify the Purchaser immediately and specify the reason for the limitation.

6) Geomagnetically Induced Current (GIC)

The transformer is initially estimated to experience dc currents in the range of 50 to 150 A dc on the 230 kV lines. Long duration base current is 15 A dc. A better estimate should be available after contract award.

A GIC capability study shall be performed as per clause 9 of IEEE C57.163-2015, IEEE Guide for Establishing Power Transformer Capability while under Geomagnetic Disturbances. The manufacturer shall use these base and peak GIC levels along with the generic GIC stepped waveform timing from IEEE C57.163-2015 clause 9.1 GIC Signature. The signature shall cycle for 8 hours minimum or until the cycle temperatures stabilize.

The Purchaser plans to monitor the levels of dc current through the transformer and remove it from service if the values become excessive. The Contractor shall provide time versus dc current withstand curves for the transformer as well as the other requirements of clause 9.3 of IEEE C57.163.

7) PCore test Terminals

PCore Doble (Lapp) test terminals are required for all ungrounded bushing terminals. Copper test terminals are preferred because the bushing terminals are copper. The following catalogue numbers may be used for initial estimation:

245 kV, 1200 A bushings	PCore# 63042-E-70
123 kV, 2000 Amp bushings	PCore# 63043-E-70
27.5 kV, 4000 Amp bushing	PCore#

This requires a custom design similar to 63080 -70 but with 6 hole NEMA pad and shield.

All shields must cover the top of the bushing and therefore these PCore Doble test terminals may all require a custom design rather than the specific model specified above.

PCore Doble Test Terminals must be mounted, complete with shields, during factory dielectric testing of all equipment. They must also be installed and carrying current during the temperature rise and load run tests to ensure they are not overheating. They shall be included in the thermal scan.

8) Bird Guards

Bird guards are required for the TV bushings. This may be in the form of netting or rubber terminal covers and is subject to Purchaser’s approval.

9) Transient Recovery Voltage Data

The Contractor shall provide the following to facilitate transient recovery voltage studies for associated circuit breaker requirements:

a) A saturation curve showing the core loss and exciting current characteristics up to and beyond the point at which the air-core reactance line becomes tangent to the magnetization curve. The air-core reactance in ohms shall be provided for all three circuits.

b) All inter-winding, winding-to-ground and terminal-to-ground capacitance values and data pertaining to the natural frequency of oscillations occurring in the auto-transformer due to high current surges.

c) A curve of the overexcitation versus time (Volts per Hertz) capability of the auto-transformer which confirms the capability to operate at the specified overexcited voltage conditions. The

Contractor shall confirm that the auto-transformer will perform this duty on an extended basis without any detrimental thermal, electrical (e.g. corona) or mechanical effects.

d) The calculated switching surge capability limit of the LV winding for neutral tap and the tap extremes, and a statement about what is limiting the capability.

10) TV Bushings and Conservator Locations

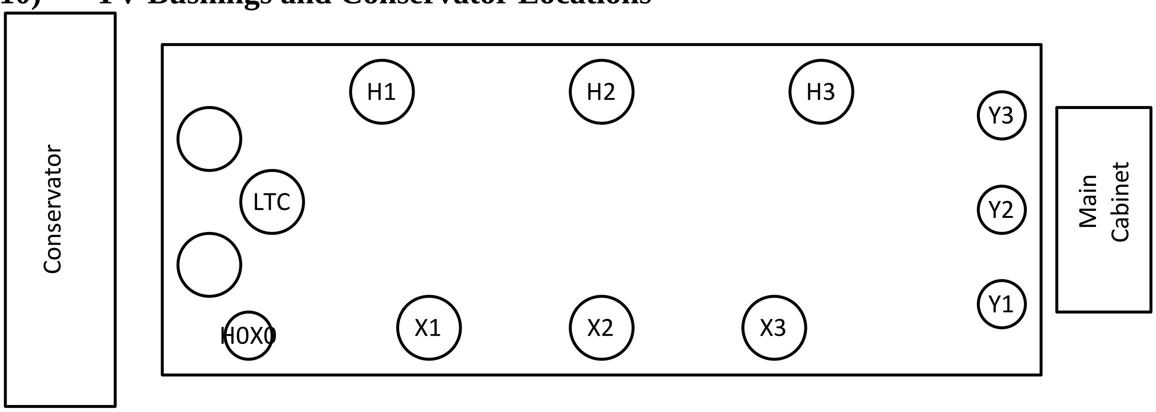


Figure 2

11) Conservator

The conservator must be located on the left-hand side viewed facing the LV bushings and perpendicular to the line of those bushings.

12) TV Bus Supports

An insulator support bracket and 150 kV LIL porcelain station post type insulators shall be provided, located 914 mm from the centreline of the TV bushings and with a 914 mm insulator phase spacing for the Purchaser's incoming leads. The connectors for the TV bushings and station post type insulators shall be mounted level. This entire assembly is subject to the Purchaser's approval and will be finalized at the Contractor's drawings approval stage.

13) CT Test Loop

A CT test loop as described in Technical Requirements, clause 13.5 for HVDC Stations, is required on each turret.

14) Apparatus Tests

Further to the production tests as outlined in the Apparatus Tests and Quality Assurance Program Requirements, the following tests shall apply:

a) No load loss and excitation current from 80% to 135% in 5% increments. Air-core reactance and the air-core lines shall be provided for both the HV and LV. The point of core saturation shall also be indicated.

b) HV to LV load losses shall also be measured at 356.25 MVA (125%) at rated tap and both tap extremes.

c) ONAN and ONAF temperature rise test with 3-circuit total losses based on the Light and Heavy Loading criteria respectively at the worst case tap positions. Three-circuit load losses are to be determined by proportioning the appropriate load on each ac resistive component and reactive component on the transformer's T-diagram. Each winding temperature shall be determined based on its own worst case condition and the worst case oil temperature. The calculations to determine this worst case condition are subject to the Purchaser's approval. Preliminary calculations based on the design data shall be reviewed at the Design review.

e) The LV switching surge level shall be attained either by the HV switching surge level or by a separate test. If the level cannot be attained in test, the Contractor shall explain why. Either way, the transformer shall be designed for the required level.

g) A sketch of the tested shunt capacitances combined with calculated values shall be included in the test report. This shall include the bushing capacitance separately.

h) Special Excitation Tests

The Contractor shall obtain a highly accurate power quality meter to measure the 3-phase vectorial voltages and currents during core excitation testing after dielectrics. This would not use the normal meters such as the Haefely measuring system nor oscilloscopes which aren't accurate enough. This requires a power quality analyzer or a Phaser Measuring Unit such as the Dranetz-BMI Power Xplorer series, ERLPHase Tesla PMU recorders or other such devices which samples voltage and current at a rate of at least 256 samples per cycle, with storage and download capability.

The purpose is to use these 3-phase voltage and current phasors (magnitude and phase angle) for the creation of accurate B-H curves by the Purchaser. This would be used for both transient studies and GIC studies.

The meter would need to measure several voltage levels, both in the forward and reverse regions of the B-H curve. For example, measure at 10%, 30%, 50%, 70%, 80%, 85%, 90%, 95%, 100%, 105%, 110%, 115%, and as high as practical for the supply, and then begin stepping down again through the same levels. The measurement recording shall provide data for at least 3 cycles at each level.

The test shall be done for at least two tap positions: the neutral and one extreme tap position.

The core should be demagnetized prior to this test.

15) Fibre-Optic Sensors

16 Fibre-optic sensors shall be supplied and installed, connected to the Qualitrol 509 ITM. Some of these will be used for GIC detection.

The sensors shall be monitored during the temperature rise tests. This will be done during both the oil rise tests and during all winding temperature shutdowns for comparison with the shutdown resistances. The entire log of data from the monitoring device shall be provided as a file and a summary of the relevant results shall be printed with the test report.

16) Qualitrol 509 ITM

ITM ordering information is shown below.

ITM 509 Ordering and Set-Up Information

Site	285 MVA Auto	with a building
Base System	ITM 509-300 DW	
Enclosure	Panel Mount with 5 kV Surge Protection	
Heater	None	

For transformers:
ONAN/ONAF/ONAF
in-tank LTC
with fibre-optic sensors
Main Conservator oil level potentiometer

without Qualitrol 930 pressure sensors

Main Inputs

		Type	Muliplied Contact	Name	Code	Comment
7	Input 1	100 Ω Pt RTD		OilTemp	B	in WTL termal well
6	Input 2	x Amp CT		HV Wdg	Cx	HV WTI CT
6	Input 3	x Amp CT		LV Wdg	Cx	CV WTI CT
6	Input 4	x Amp CT		TV Wdg	Cx	TV WTI CT
7	Input 5	x Amp Sensor		Fan Pwr	Iy	loop through fan power cables additively
7	Input 6	Potentiometer		Oil Lvl	H	Main conservator oil level
5	Input 7	Dry Contact	✓	Trips	R	Parallel GDR fast gas, LTC Rapid Pressure Rise, Main and LTC PRD, Main and LTC Crit Lo Oil Levels
7	Input 8	Dry Contact	✓	SlowGas	R	Gas detector Relay alarm contacts
	Expansion Module Inputs Inputs					
7	Input 9	Tap Position Resistor Bridge		LTC Pos	V3	2nd resistor bridge
7	Input 10	Dry Contact		R/L Act	R	LTC Raise & Lower Actuation (Reinhausen cam 127)
7	Input 11	Dry Contact		PwrFail	R	Main breaker and LTC Power Fail Alarm
7	Input 12	Dry Contact		LTCLock	R	LTC Oil Temp. Lockout Alarm
7	Input 13	Dry Contact		BreCycl	R	Main Breather cycling (heating system status)
7	Input 14	Dry Contact		BreFail	R	Parallel LTC & Main Consv. Breather malfunction
7	Input 15	4 - 20 mA Loop		Gas Lvl	M	Hydran gas level
7	Input 16	4 - 20 mA Loop		H2O Lvl	M	Hydran moisture level

'x' Indicates current draw, to be chosen based on 2 p.u. current from the bushing CT, and limited to 120% of 'x'.
Therefore use C10 Amp for a 5 Amp secondary bushing CT. Use C5 Amp for a 2 Amp secondary bushing CT. (5, 10, 20 Amp)

'y' Indicates normal motor current draw for the sum of all fans in stage 1 or 2, or sum of stages 1 and 2, or sum of all pumps or LTC motor. (5,10, 20, 50, 100 Amp)

	Relay Designation for Front Panel		Base Logic from Output Relay set-up below						
12	Relay 1	Stage 1 Fans	Fiber 1	or	HV Wdg	or	LV Wdg	or	TV Wdg
12	Relay 2	Stage 2 Fans	Fiber 1	or	HV Wdg	or	LV Wdg	or	TV Wdg
9	Relay 3	Fan Alarm	Fan Pwr	and	Stage 1 Fans	or	Fan Alarm 2		
9	Relay 4	2nd Alarm	LTCLock	or	LTC Vac	or	BreFail	or	PwrFail
9	Relay 5	1st Alarm	Oil Lvl	or	SlowGas	or	OilTemp	or	LV Wdg
8	Relay 6	1st Trip	Trips	or	OilTemp	or	LV Wdg		
8	Relay 7	2nd Trip	Oil Lvl	or	SlowGas				
11	Relay 8	Fan Alarm 2	Fan Pwr	and	Stage 2 Fans				

Figure 3: ITM

ITM Direct Winding

		Length	Quantity
Neoptix T2 Fiber Optic Temperature Sensors	Neoptix CAB-699-Le	Length to suit	16
Tank Wall Plate Assembly with COV-121-1 and CON-159-1	Weld On PLT-201	Steel	1 Plate for 16 sensors
Fibre Optic Extension Cables	Neoptix CAB-700-Le	Length to suit	16
Hot Spot Module Channels Interface	Qualitrol MOD-638-8	8 channel	2
Portable Fibre Optic Thermometer	Qualitrol KIT-057-1		not required

Remote Communications

Additional Remote Communications Protocol	DNP 3
	MODBUS
	IEC 61850
Additional Remote Communications Ports	Ethernet FX,ST Fibre Optic
Additional Control Functions	
	Data Logging
	Event Recording
	Quantity
Hard Copy of Instruction Manual	9

Configuration file for easy set-up is available from Manitoba Hydro.
Include the actual Qualitrol order form, the Qualitrol Packing Set-up Sheet c/w serial/order number, this set-up information and the final configuration file printout in the Transformer Instruction Manual.

Accessories

			Quantity
100 Ohm Pt RTD for Oil	Length to suit	Qualitrol 103-059-02 CS-41840	2
100 Ohm Pt RTD for Ambient	Length to suit	Qualitrol 103-054-01	0

Accessories Purchased Separately

Thermal Well	Qualitrol 2WTL Thermal Plate	1
Brass Plug	Qualitrol 167-50-29F CS-31450	1
Main Tank Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	1
LTC Conservator Oil Level Gauge with 5 k Potentiomer	Qualitrol 042-305-01 CS 43801	not required
MR RMV II Oil Level Gauge with two contacts (Lo, Critical Lo)	Qualitrol 032-038-01 CS-36552	n/a
Pressure Sensors	Qualitrol 930-008-01 CS-36480	not required

Additional Communication Accessories (housed with in control cabinet)

USB to DB9 Cable	Qualitrol CAB-049-1	1
USB-A to USB-B, 6 ft.	Qualitrol CAB-050-1	1

Aux are redundant relays for NERC requirements

Output Relay Properties

	Relay 1	Relay 2	Relay 3	Relay 4
Relay	Stage 1 Fans	Stage 2 Fans	Fan Alarm	2nd Alarm
Enabled	yes	yes	yes	yes
Failsafe	yes	yes	no	no
Test Lockout	off	off	off	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

	Relay 5	Relay 6	Relay 7	Relay 8
Relay	1st Alarm	1st Trip	2nd Trip	Fan Alarm 2
Enabled	yes	yes	yes	yes
Failsafe	no	no	no	no
Test Lockout	off	on	on	off
Latching	off	off	off	off
Manual On	Auto	Auto	Auto	Auto
Actuates on Errors	no	no	no	no
Actuation Delay	0:00:00	0:00:00	0:00:00	0:00:00
Seasonal Set Point	no	no	no	no
Amb Temp Forecast	no	no	no	no
Cooling Eqp Exerciser	off	off	off	off
Exercise Time On	n/a	n/a	n/a	n/a
Exercise Time Cycle	n/a	n/a	n/a	n/a

Figure 3: ITM

Aux are redundant relays for NERC requirements

Output Relay Control Logic	**Relay 1**	**Relay 2**	**Relay 3**	**Relay 4**
Relay	Stage 1 Fans	Stage 2 Fans	Fan Alarm	2nd Alarm
	Fiber 1	Fiber 1	Input 5	Input 12
Setting	Fiber 1	Fiber 1	Fan Pwr	LTCLock
Set Point	80	85	*TBD	50%
Hysteresis	10	10		50%
Activation Direction	UP	UP	DOWN	UP
and/or/minus	**or**	**or**	**and**	**or**
	Input 2	Input 2	Relay 1	#N/A
Setting	HV Wdg	HV Wdg	Stage 1 Fans	LTC Vac
Set Point	80	85	50%	50%
Hysteresis	10	10	50%	50%
Activation Direction	UP	UP	UP	UP
and/or	**or**	**or**	**or**	**or**
	Input 3	Input 3	Relay 8	Input 14
Setting	LV Wdg	LV Wdg	Fan Alarm 2	BreFail
Set Point	80	85	50%	50%
Hysteresis	10	10	50%	50%
Activation Direction	UP	UP	UP	UP
and/or/minus	**or**	**or**		**or**
	Input 4	Input 4		Input 11
Setting	TV Wdg	TV Wdg		PwrFail
Set Point	80	85		50%
Hysteresis	10	10		50%
Activation Direction	UP	UP		UP

* Set Point and Hysteresis is dependent upon number of fans per stage.

	Relay 5	**Relay 6**	**Relay 7**	**Relay 8**
Relay	1st Alarm	1st Trip	2nd Trip	Fan Alarm 2
	Input 6	Input 7	Input 6	Input 5
Setting	Oil Lvl	Trips	Oil Lvl	Fan Pwr
Set Point	20%	50%	5%	*TBD
Hysteresis	10%	50%	5%	
Activation Direction	DOWN	UP	UP	DOWN
and/or/minus	**or**	**or**	**or**	**and**
	Input 8	Input 1	Input 8	Relay 2
Setting	SlowGas	OilTemp	SlowGas	Stage 2 Fans
Set Point	50%	110	50%	50%
Hysteresis	50%	10	50%	50%
Activation Direction	UP	UP	UP	UP
and/or	**or**	**or**		
	Input 1	Input 3		
Setting	OilTemp	LV Wdg		
Set Point	90	120		
Hysteresis	10	10		
Activation Direction	UP	UP		
and/or/minus	**or**			
	Input 3			
Setting	LV Wdg			
Set Point	105			
Hysteresis	10			
Activation Direction	UP			

Output Current Loop Setup	**Loop 1**	**Loop 2**	**Loop 3**	**Loop 4**
Input	OilTemp	LV Wdg	LTC Pos	Oil Lvl
and/or				
Input				
or				
Input				
Input#	Input 1	Input 3	Input 9	Input 6
and/or				
Input#				
or				
Input#				
Loop Type	4 - 20 mA Loop	4 - 20 mA Loop	4 - 20 mA Loop	4 - 20 mA Loop
Custom Range	no	no	no	no
Maximum				
Minimum				

Figure 3: ITM

Data Logger	Signal Name	Store Rate	Sample Rate	Sample Type
Channel 1	Input 1 : OilTemp	30 M	1 M	MAX
Channel 2	Input 2 : HV Wdg	30 M	1 M	MAX
Channel 3	Input 3 : LV Wdg	30 M	1 M	MAX
Channel 4	Input 4 : TV Wdg	30 M	1 M	MAX
Channel 5	Input 2 : HV Wdg Current	30 M	1 M	Max
Channel 6	Input 2 : HV Wdg Current	30 M	1 M	Ave
Channel 7	Input 2 : HV Wdg Current	30 M	1 M	Min
Channel 8	Input 3 : LV Wdg Current	30 M	1 M	Max
Channel 9	Input 3 : LV Wdg Current	30 M	1 M	Ave
Channel 10	Input 3 : LV Wdg Current	30 M	1 M	Min
Channel 11	Input 4 : TV Wdg Current	30 M	1 M	Max
Channel 12	Input 4 : TV Wdg Current	30 M	1 M	Ave
Channel 13	Input 4 : TV Wdg Current	30 M	1 M	Min
Channel 14	Input 5 : Fan Pwr	30 M	1 M	Max
Channel 15	Input 5 : Fan Pwr	30 M	1 M	Ave
Channel 16	Input 5 : Fan Pwr	30 M	1 M	Min
Channel 17	Input 6 : Oil Lvl	30 M	30 M	MAX
Channel 18				
Channel 19				
Channel 20				

Event Recorder	Event 1	Event 2	Event 3	Event 4
Enabled	yes	yes	yes	yes
Name	Fan Activation	Alarms	Trips	Breather
System Snapshot	yes	yes	yes	yes
	Relay 1	Relay 3	Relay 6	Input 13
Control Signal	Stage 1 Fans	Fan Alarm	1st Trip	BreCycl
Set Point	50%	50%	50%	50%
Hysteresis	50%	50%	50%	50%
Activation Direction	UP	UP	UP	UP
	or	or	or	or
	Relay 2	Relay 4	Relay 7	Input 13
Control Signal	Stage 2 Fans	2nd Alarm	2nd Trip	BreCycl
Set Point	50%	50%	50%	50%
Hysteresis	50%	50%	50%	50%
Activation Direction	UP	UP	UP	DOWN
		or		
		Relay 5		
Control Signal		1st Alarm		
Set Point		50%		
Hysteresis		50%		
Activation Direction		UP		
Control Signal				
Set Point				
Hysteresis				
Activation Direction				

	Event 5	Event 6	Event 7	Event 8
Enabled	yes	yes	yes	yes
Name	Tap Change	Gas Level	Moisture Level	
System Snapshot	yes	yes	yes	yes
	Input 10	Input 15	Input 16	
Control Signal	R/L Act	Gas Lvl	H2O Lvl	
Set Point	50%	20%	20%	
Hysteresis	50%	5%	5%	
Activation Direction	UP	UP	UP	
Control Signal				
Set Point				
Hysteresis				
Activation Direction				
Control Signal				
Set Point				
Hysteresis				
Activation Direction				
Control Signal				
Set Point				
Hysteresis				
Activation Direction				

Figure 3: ITM

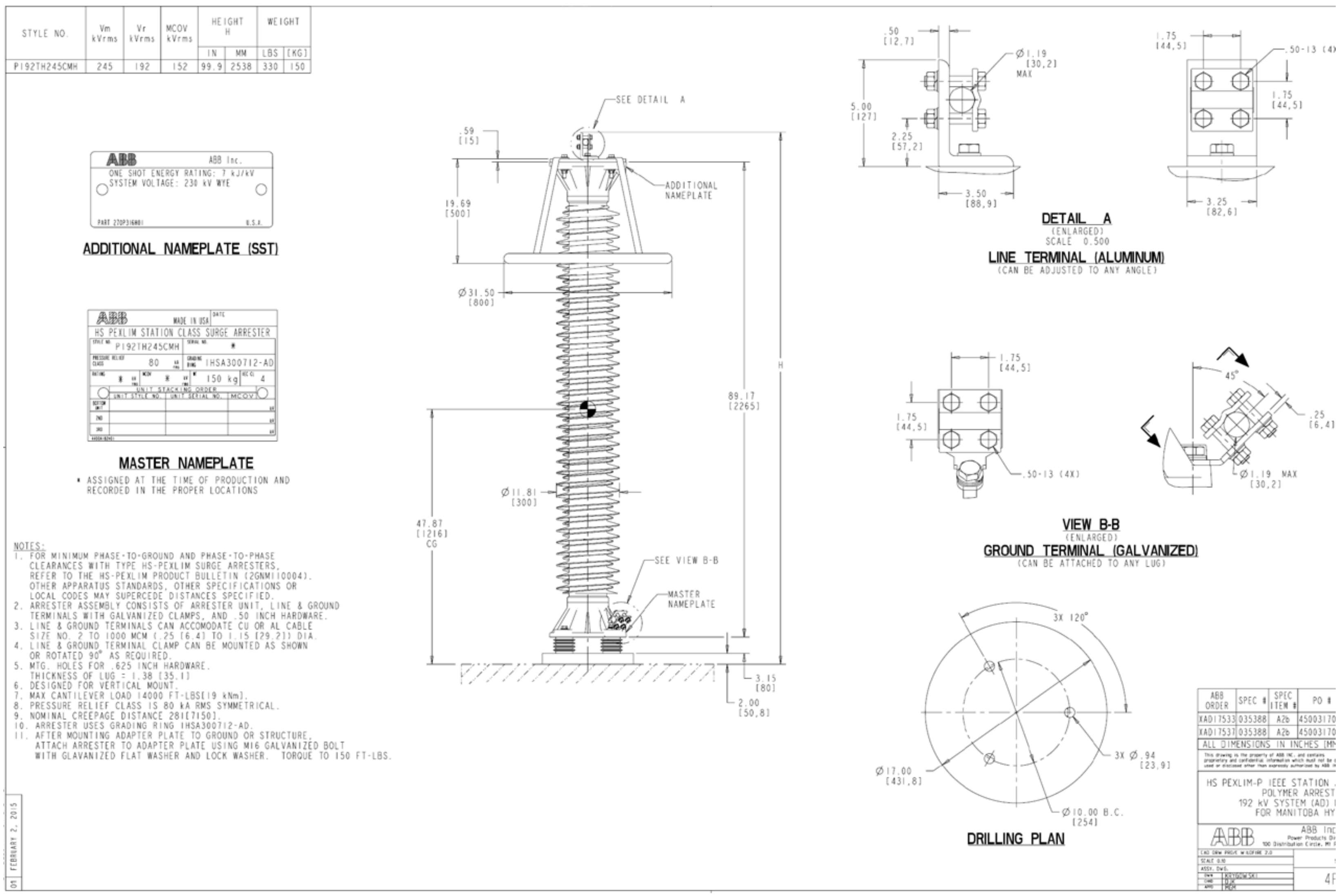


Figure 4: HV Arrester

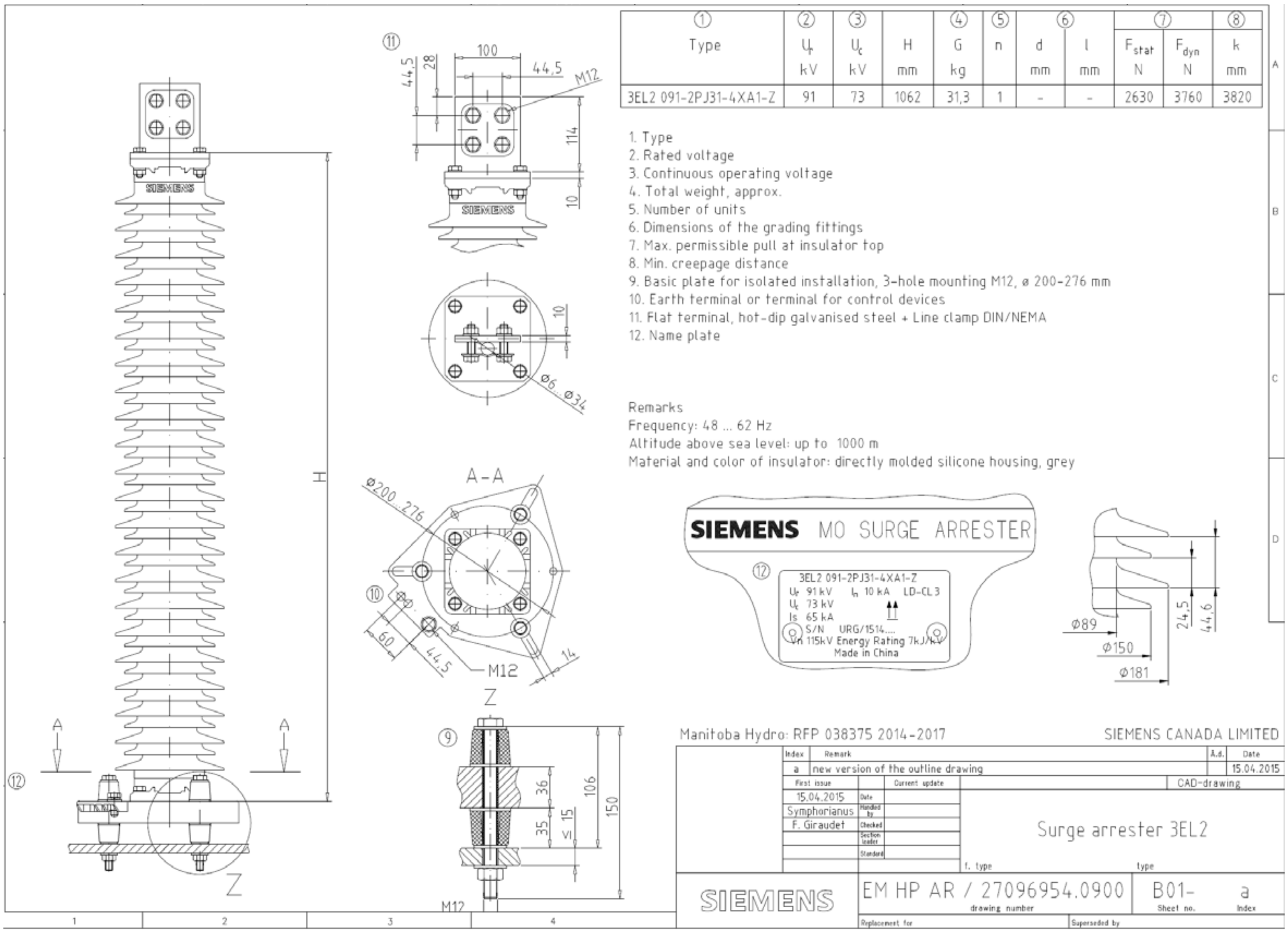


Figure 5: LV Arrester

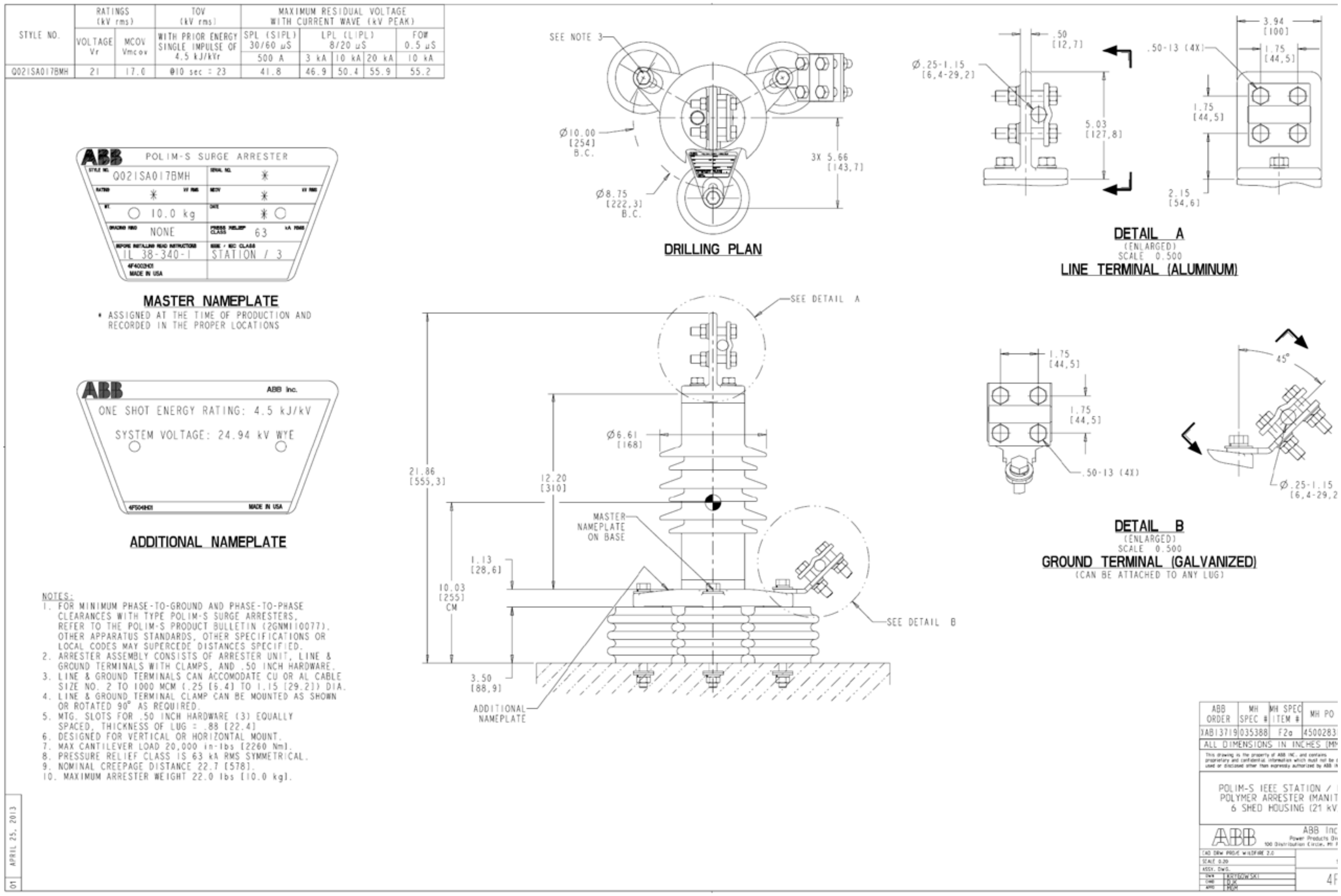


Figure 6: TV Arrester

SPEC ID# 6 Spare Parts for SPEC ID# 1

One (1) spare 550 kV, 2500 A bushing as described in SPEC ID#s 1 and 2(H1).
One (1) spare 145 kV, 600 A bushing as described in SPEC ID# 1 (H2).

SPEC ID# 7 Spare Parts for SPEC ID# 2

One (1) spare 300 kV, 4000 A bushing as described in SPEC ID# 2 (X1).
One (1) spare 72.5 kV, 2000 A bushing as described in SPEC ID# 2 (TV).
One (1) spare 27.5 kV, 3000 A bushing as described in SPEC ID# 2 (H2X2).
One (1) spare oil pump for Spec ID#2.

SPEC ID# 8 CTs Inside of Delta for SPEC ID# 3

Addition of current transformers inside the delta, as shown in SPEC ID# 3, Figure 6:

Current Transformers	Inside Delta at each corner: 12 x 500-5 10L400

The Purchaser reserves the right to request that these CTs be shielded from the leakage and stray magnetic fields, depending upon the layout.

SPEC ID# 9 CTs Outside of Delta for SPEC ID# 3

Addition of current transformers outside of the delta, as shown in SPEC ID# 3, Figure 6:

Current Transformers	Outside of Delta at each corner: 6 x 800-5 10L400

The Purchaser reserves the right to request that these CTs be shielded from the leakage and stray magnetic fields, depending upon the layout.

SPEC ID# 10 Optical CTs Inside of Delta for SPEC ID# 3

Addition of optical current transformers inside of the delta, as shown in SPEC ID# 3, Figure 6:

Current Transformers	Inside Delta at each corner.
	Internal optical CTs will comply with IEC61850-9-2LE and will include corresponding Merging Unit. Merging Unit will have fibre optic ports supporting IEC61850-9-2LE, GOOSE messages, Parallel Redundancy Protocol (PRP) and Precision Time Protocol (PTP) or IRIG-B. Each unit shall include at least 4 inputs and 4 outputs and one unit fail contact.

The Purchaser reserves the right to request that these CTs be shielded from the leakage and stray magnetic fields, depending upon the layout.

SPEC ID# 11 Optical CTs Outside of Delta for SPEC ID# 3

Addition of optical current transformers outside of the delta, as shown in SPEC ID# 3, Figure 6:

Current Transformers	Outside Delta at each corner.
	Internal optical CTs will comply with IEC61850-9-2LE and will include corresponding Merging Unit. Merging Unit will have fibre optic ports supporting IEC61850-9-2LE, GOOSE messages, Parallel Redundancy Protocol (PRP) and Precision Time Protocol (PTP) or IRIG-B. Each unit shall include at least 4 inputs and 4 outputs and one unit fail contact.

The Purchaser reserves the right to request that these CTs be shielded from the leakage and stray magnetic fields, depending upon the layout.

SPEC ID# 12 Power Flow Controller for SPEC ID# 3

Addition of power flow controller control system including hardware and software.

A control system for the PSTs shall be provided. This would include not only regulating the power flow, but also switching of the disconnects, bypasses and breakers. The power flow controller is expected to implement, at least, the switching sequences described in SPEC ID# 3, Remark 21. Additional sequences may become necessary. Time delays shall be adjustable.

The PST should have the flexibility to operate in any of the following manners:

a. power flow control,
b. phase angle control,
c. bypass control,
d. manual control, and
e. automatic reaction to other outside remedial action scheme signals.

Power Flow Control
Set power flow on the 230 kV circuit at a predefined level for overall system economic operation. During contingent situations or other changes in the system, adjust the phase shifter to maintain the predefined power flow on the circuit. This form of control implies automatic and continuous control. The power flow controller includes a deadband function to minimize the number of tap changes. Deadband is typically set at 1.5 tap steps. The power order setpoint is provided either from the station HMI (in local control) or from System Control (in remote/master control).

Phase Angle Control
Adjust phase shifter tap positions to achieve the desired phase angle across both PSTs. Change tap position as required to maintain as the target phase angle. This form of control implies automatic and continuous control. The phase angle controller includes a deadband function to minimize the number of tap changes. Deadband is typically set at 1.5 tap steps. The phase angle setpoint is provided either from the station HMI (in local control) or from System Control (in remote/master control).

Bypass Control
The phase shifter is bypassed for maintenance or for specific conditions. This includes automated switching sequences to remove and insert PSTs at the station.

Manual Control
Disable all automatic control of the phase shifter. Operations initiated by remedial action schemes are still permitted. This form of control allows execution of operator initiated controls from either the station (local control) or System Control Centre (remote/master control).

Remedial Action Scheme Control
If the power flow through the phase shifter is in the south direction and greater than 0 MW, the phase shifter should be able to runback to 0 MW quickly if it receives a signal from a remote Remedial Action Scheme (RAS). The remote RAS is monitoring transmission outlet availability. Insufficient transmission outlet will require the phase shifter to operate near 0 MW.

These controls shall be accessible from both the station's building and from the System Control Centre in Winnipeg.

The station has an existing Local/Master switch. A physical dry contact will be provided to the Power Flow Controller to indicate the switch position. If this switch is in the Local position, operator controls should be allowed at the station. If the switch is in the Master position, operator controls should be allowed from the System Control Centre in Winnipeg.

HMIs shall be provided to allow control from the station's building. The HMI functionality can be implemented within the power flow controller if capable or provided using a standalone device, Magelis XBT GT touchscreen panel or approved equal.

Commands from the System Control Centre in Winnipeg will be passed to the power flow controller control system via a station gateway (not in scope). The power flow controller control system must support either DNP3 slave over Ethernet or IEC 61580 communication protocols to interface with the external system.

Preference is for solutions that use industry proven and widely available products such as the MR TAPCON controller (if suitable for this application). If a general purpose IEC 61131 programmable logic controller is necessary to implement the required system functionality the Modicon M580 platform shall be used.

Below is a list of communicated control commands that should be supported under the different control modes.

a. Control mode selection
   1. Select Auto / Manual control
   2. Select Power Flow Control Mode / Phase Angle Control Mode (applies to Auto)

b. Power Flow Controls (applies when operating under Auto & Power Flow Control Mode)
   1. Set MW target (+- 400MW)
   2. Set ramp rate (preliminary suggestion of 20 to 100 MW/minute)
   3. Set dead band (MW) (preliminary suggestion of 1.5 x step)

c. Phase Angle Controls (applies when operating under Auto & Phase Angle Control Mode)
   1. Set phase angle target (+-80 degrees)
   2. Set ramp rate (degrees/minute)
   3. Set dead band (degrees) (preliminary suggestion of 1.5 x step)

d. Bypass Controls (refer to SPEC ID# 3, Remark 21 for details)
   1. Remove PST B7
   2. Insert PST B7
   3. Remove PST B8
   4. Insert PST B8
   5. Remove both PST B7 and PST B8
   6. Insert both PST B7 and PST B8 (sequentially with adjustable time delay to allow inrush transients to damp out.)

e. Manual Controls
   1. Advance / Retard (split phase shift across PST B7 and PST B8 if both are in-service)
   2. Return to Neutral (return PST B7 and PST B8 to neutral tap if both are in-service)
   3. Advance / Retard PST B7 (B8, if in-service, remains on its current tap)
   4. Return to Neutral PST B7 (B8, if in-service, remains on its current tap)
   5. Advance / Retard PST B8 (B7, if in-service, remains on its current tap)
   6. Return to Neutral PST B8 (B7, if in-service, remains on its current tap)
   7. Open / Close R7
   8. Open / Close BP7
   9. Open / Close B7b
   10. Open / Close R8
   11. Open / Close BP8
   12. Open / Close B8b

Below is a list of statuses that the power follow controller should provide to a station gateway via communications:

1. Controller in Auto
2. Controller in Manual
3. Controller in Power Flow Control Mode
4. Controller in Phase Angle Control Mode
5. Breaker R7 status
6. MOD BP7 status
7. MOD B7a status
8. MOD B7 status
9. Breaker R8 status
10. MOD BP8 status
11. MOD B8a status
12. MOD B8b status
13. PST B7 neutral tap position indication
14. PST B7 tap changer lockout (vacuum bottle lockout, oil temperature lockout, breaker reclose block, incomplete switching operation, motor protective lockout)
15. PST B8 neutral tap position indication
16. PST B8 tap changer lockout

Below is a list of analogs that the power flow controller should provide to a station gateway via communications:

1. MW Set Point
2. MW Ramp Rate
3. MW Dead band
4. Phase Angle Set Point
5. Phase Angle Ramp Rate
6. Phase Angle Dead band
7. B7 Tap Position
8. B8 Tap Position

9. Total Phase Angle (across B7 and B8)

Physical inputs and outputs should be provided to interface with the necessary remedial action schemes. The controller will be required to take actions that may include fast runback to 0MW. Details on what specific actions are required shall be provided at a later date.

Physical inputs and outputs are also required for status and control of breakers, MODs, and disconnects associated with the controller. Physical outputs are required to operate breakers, MODs, and disconnects. Note that the station battery voltage is 125V DC. The wetting voltage of all external circuits and connections will be this voltage.

Preferences is to have the power flow controller's physical inputs accept wet contacts (i.e. sinking inputs) at 125V DC and provide dry contact outputs rated for 125V DC.

The power flow controller shall lock-out the LTC from changing under unsafe conditions. Such conditions could occur because of high voltage (exceeding the tap changer's switching capacity) or because of extremely low or high diverter oil temperature. Such conditions shall be alarmed by the controller.

The control logic shall be designed to prevent excessive tap changer operations due to hunting between two taps (i.e. repeated PST advance-retard cycles).

The control logic will be able to maximize the usage of the phase shifter if needed based on ambient temperature and ensure available overload capability is not exceeded.

The power flow controller control system shall be redundant (i.e. hot-standby). It must be designed such that the failure of a single electronic device does not result in the loss of any required functionality. The active system shall automatically switch over to a standby system in the event of a key component failure.

A design report describing detailed functionality and proposed implementation shall be provided to Manitoba Hydro for approval.

SPEC ID# 13 Insulation Coordination Study for SPEC ID# 3

Addition of a complete insulation coordination study for the PST.

APPARATUS TEST REQUIREMENTS 039857

TABLE OF CONTENTS
APPARATUS TEST REQUIREMENTS

1 GENERAL

The Contractor shall perform all tests mentioned in the Apparatus Tests and Quality Assurance Program Requirements, with the exception of field tests, furnishing all necessary labour and facilities. The Purchaser reserves the right to inspect the Work during manufacture and to witness tests after assembly at the factory or factories, for the purpose of ascertaining that the equipment meets the requirements of Request for Proposal 039857 and the Contractor's warranties.

1.1 Inspection Plan

Within **fourteen (14) weeks** after receipt of a letter of intent or award of a Contract and before commencing manufacture, the Contractor shall submit for the Purchaser's approval **two (2) copies** of the detailed Inspection and Test Plan and Test Summary Sheets as required by the appropriate quality assurance level. The Purchaser shall designate mandatory hold points and return a copy of the Inspection and Test Plan to the Contractor. The Contractor shall maintain the Inspection and Test Plan throughout the life of the Contract and shall submit all revisions for the Purchaser's approval.

1.2 Inspections

The Contractor must give the Purchaser not less than **ten (10) working days** prior notice of the scheduled performance of tests, including pre-tank inspections and other inspections deemed necessary if the Work is in Canada, and not less than 20 working days if in a foreign country.

The Contractor shall confirm the date and time **four (4) working days** if in Canada and **ten (10) working days** if in a foreign country. **Failure to provide the appropriate notice may result in an assessment of 0.5% of the purchase price of the transformer.**

Tests shall be arranged so that as many as possible are conducted together in a program to be approved by the Purchaser. Except when establishing the top oil temperature rise, no power or dielectric tests shall be performed between midnight and 08:00 hours. No final testing will be performed between the week prior to December 25 through the week after December 31. If a failure occurs during test that requires the testing to be extended or rescheduled to a different date, all extra incurred costs to witness the re-test and/or investigation of the failure shall be at the expense of the Contractor.

Inspectors shall be provided internet access and be allowed to take photographs of the specific transformer being inspected.

1.3 Failures

The Purchaser reserves the right to request additional testing to prove or disprove any test failure or occurrence or also any workmanship and/or materials used in the manufacture of the transformer.

All failures or unexplainable occurrences shall be investigated to the complete satisfaction of the Purchaser. The Purchaser may also request that the transformer be disassembled in an attempt to locate the possible cause of the failure or occurrence, even if the unit has been re-tested prior to disassembly and has successfully passed the test that initiated the failure or occurrence.

1.4 Change/Correction Submissions

The Purchaser shall be advised of any major design changes, all non-conforming items and all test failures which have occurred. The Purchaser shall be advised prior to any corrective action(s) being taken so that the Purchaser's representative or the Inspector can inspect each failure or non-conforming item(s) and approve the proposed corrective action(s). The Contractor shall keep a log of the failures or non-conforming items detailing investigative tests, engineering and manufacturing instructions and corrective actions taken and a written report shall be submitted with the certified test reports.

1.5 DGA Submission

All dissolved gas in oil results shall be submitted upon receipt to the Purchaser for their written approval of the results. The transformer shall not be disassembled for shipping until written approval has been received. The Contractor must allow a total of **five (5) working days**, from the receipt of the dissolved gas in oil results, for the review and comment of dissolved gas in oil results without affecting the delivery of the transformer.

1.6 Test Reports

The Contractor shall furnish **six (6) copies** of all certified test reports and curves to the Purchaser within **two (2) weeks** after the completion of tests and **five (5) working days** prior to shipping. The Contractor must allow a total of five (5) working days, from the receipt of the test report, for the Purchaser's review and comment without affecting the delivery of the transformer. **Failure to provide the test reports five (5) working days prior to shipping shall result in an assessment of 0.5% of the contract price for the transformer.**

All errors and omissions found during the **five (5) working day** review of the test report must be addressed to the satisfaction of the Purchaser, prior to the shipping of the transformer or associated parts.

1.6.1 Approval

A written release from the Purchaser shall be sent to the Contractor, upon approval of the final certified test report, with all corrections and failure reports, prior to shipment of the transformer and associated parts. Should the preparation and approval of the final certified test report affect the delivery date of the transformer, all assessments shall remain in effect.

1.6.2 Composition

In addition to hard paper copies of the test reports, electronic copies shall also be provided for each unit. The certified test report including a copy of the transformer nameplate drawing, impulse waveforms and the ‘Manitoba Hydro - Standard Specification Data and Test Summary’ sheets shall be supplied in electronic format as well.

The certified test reports shall include a summary of the guaranteed test results and contain a complete record of all tests conducted, including repetitive impulse and/or other dielectric tests as applicable.

1.6.3 Impulse Oscillograms

Impulse oscillograms, including voltage, current, voltage and current comparisons, and admittance transfer function comparisons, shall be included in the test report. Chopped wave currents shall also be included in the test report.

1.6.4 Transformer Data and Test Summary

The certified test reports shall also include a completed copy of the Purchaser’s ‘Manitoba Hydro - Standard Specification Transformer Data and Test Summary’, all shop work sheets and all associated calculations as applicable. The same shall apply to the design, production and field tests. The ‘Manitoba Hydro - Standard Specification Transformer Data and Test Summary’ is available as a Microsoft Excel 97 or Excel 98 workbook (accompanying Request for Proposal 039857 at the time of Request for Proposal issuance).

This workbook also requires the serial numbers for the tap changers, bushings, arresters and the voltage regulating relay.

1.6.5 Curves

The certified test reports shall also include the following curves:

1.1.1.1. calculated inrush current (assume infinite bus);

1.1.1.2. calculated short-time overvoltage (time in seconds vs. Volts per Hertz);

1.1.1.3. calculated damage curve (I^2t) per ANSI C57.109;

1.1.1.4. excitation curve extending into saturation and providing air-core reactances from the HV, LV, and if applicable, TV sides. (refer to Subsection 2.2.5 No-Load Loss of these Apparatus Tests and Quality Assurance Program Requirements).

1.6.6 Fibre-Optics

The certified test reports shall also include a sketch showing the location of fibre optic probes. The sketch shall show the exact location of the probe (section, bay, upper or lower surface, inside or outside duct, etc.) and shall also show how it is mounted and held in place.

The probe labelling in the test report shall conform to that used in the sketches, test plan and the nameplate. Each probe shall have a unique identifier correlated back to its factory serial number. Both shall be listed in the test report. Redundant probes shall not be labelled identically. The serial number tags shall not be removed from the probes.

1.6.7 Buried Tertiary

For transformers with a buried tertiary, the test report shall also provide the calculated equivalent-T positive-sequence and zero-sequence impedances (%IR and %IX) of the transformer for the maximum, rated, neutral and minimum LTC tap positions in the maximum, rated and minimum DTC tap position at the ONAN rating. This must be labelled as calculated values and it is in addition to the tested HV to LV impedances. If tested values are available for the tertiary, calculated values are not required.

1.6.8 Dewpoint

Dewpoint results (if applicable) shall also be included in the test report.

1.6.9 Component Test Reports and Serial Numbers

Each assembly, its individual components, and equipment supplied by others shall be tested in accordance with the appropriate equipment standards as specified in the Technical Requirements and CAN/CSA-C88-M90 and additional tests as defined in these Apparatus Tests and Quality Assurance Program Requirements. Serial numbers and test results for these components shall be included in the test report. This includes, but is not limited to:

(a) Bushings;
(b) Current transformers;
(c) Tap-changers;
(d) Coolers;
(e) Pumps;

(f) Fans;
(g) Auxiliary transformers;
(h) Series transformers;
(i) Reactors;
(j) Fibre-optic sensors;
(k) Voltage regulating relays

The Contractor shall provide the Purchaser with an approved certificate issued by Measurement Canada, An Agency of Industry Canada Measures Canada, Un Organisme d'Industrie Canada (MCIC) for current transformers used for revenue metering applications.

1.6.10 Tap changer Serial Numbers

The serial number(s) of the load tap changer shall be included in the test report along with the load tap changer test report(s).

1.6.11 Fibre-Optic Serial Numbers

The serial number(s) of the fibre-optic probes shall be included in the test report along with the fibre-optic probe test report(s).

1.6.12 Voltage Regulating Relay Serial Numbers

The serial number(s) of the voltage regulating relay(s) shall be included in the test report.

2 TRANSFORMER PRODUCTION TESTS

Production tests, design tests and type tests shall be performed on each completely assembled transformer in accordance with the latest revision of CAN/CSA-C88-M90. Type test results are not acceptable. All transformers and shunt reactors, including all in a multiple order of identical transformers or shunt reactors, are required to be fully tested in accordance with the Contract.

The following schedule of tests shall apply unless otherwise specified in the Supplementary Technical Requirements. All test results for losses and impedance shall be corrected to their appropriate temperatures with a 20ºC ambient temperature.

Transformers and reactors must be fully assembled prior to testing.

Some typical test schedules are given as examples at the end of this section, demonstrating what is expected for transformers with re-connections and/or series transformers.

2.1 Load Tests

2.2 Interstrand Shorts

CTC and other multi-strand enamelled conductor shall be tested for shorts after winding. The conductor shall be free of shorts.

2.2.1 dc Resistance

Winding resistance measurements on all taps and all windings. Buried windings or inaccessible windings shall be measured prior to tanking.

This test shall be done at least twice: once before tanking the core and coils, and once when oil-filled.

This test is also required on components such as LTC reactors and series transformers prior to being mated with the main transformer windings.

2.2.2 Polarity & Phase

Polarity and phase relationship to be verified by voltage application.

2.2.3 Ratio

Ratio tests on all taps and on all phases. Buried windings or inaccessible windings shall be measured prior to tanking.

This test is also required on components such as LTC reactors and series transformers prior to being mated with the main transformer windings.

2.2.4 Reactor Magnetizing Current

LTC reactors shall be tested at 100% voltage for magnetizing current prior to being mated with the main transformer windings.

2.2.5 No-Load Loss

No-load losses and exciting currents at 85%, 90%, 95%, 100%, 105%, 110% and 115% of rated voltage on rated tap position. If applicable, also perform in the tap positions that generate the maximum and minimum no-load losses at 85%, 90%, 95%, 100%, 105%, 110% and 115% of rated voltage.

The form factor of all applied voltages shall be recorded for all readings. Load-tap-changing transformers shall be guaranteed and tested for no-load losses at rated voltage with the tap-changer(s) in the rated position.

For load-tap-changing transformers having a switching reactor or series transformer or variable flux design, no-load loss and exciting current shall also be measured in the LTC tap position to generate the maximum and minimum no-load loss and excitation current at 85%, 90%, 95%, 100%, 105%, 110% and 115% rated voltage.

2.2.6 LTC Full Voltage Operation

Load-tap-changers shall also be operated at rated voltage across the full tap range. An oscillograph recording shall be made of this test. The speed of the oscillograph shall be across at least three (3) consecutive tap positions so that the Purchaser can readily evaluate the operation of the load-tap-changing equipment and related arcing contacts. The test shall be done twice: from LTC position -1 through +1, and from +1 to -1, ensuring reversing switch action each time. These oscillographs shall be included in the test report, and it shall clearly show the oscillations. The test is done twice to ensure proper timing.

The data file for the measured waveforms shall be provided when requested.

2.2.7 Positive-Sequence Load Loss & Impedance

Shunt reactors shall be measured at 100%, 110% and 125% voltage.

Positive-sequence load loss, % resistance and % reactance at rated current for the ONAN and top MVA ratings. This shall include the following tap positions unless specified otherwise by the Purchaser on the Test Summary Sheets:

(a) on maximum DTC tap position and on:
  maximum;
  rated;
  neutral;
  minimum LTC tap positions;

(b) on rated DTC tap position and on
  maximum;
  rated;
  neutral;
  minimum LTC tap positions;

(c) on minimum DTC tap position and on
  maximum;
  rated;
  neutral;
  minimum LTC tap positions;

(d) For 12.47 x 24.94 kV re-connectables with 12.47 kV ±20%:
  each of the above DTC positions and
  +10% tap in the 12.47 kV connection;
  -10% tap in the 12.47 kV connection;
  on intermediate DTC or LTC tap positions where required.

Load losses shall be guaranteed and tested with the tap-changer in the maximum current (for maximum losses) position as well as the rated DTC and rated LTC tap positions for the ONAN MVA rating.

2.2.8 Connection Integrity Test

This test entails operating the transformer at significant load in every tap position. The tap changers will be moved in both directions, stopping in each tap position for approximately 2 minutes.

This test may be performed either after the load loss testing, or during or after all temperature rise testing prior to dielectrics. It may be done as a part of the 12 hour run provided the temperature has restabilized correctly at the end of the 12 hour run. If ‘m’ & ‘n’ exponent testing is required, this integrity test must be done before or after the temperature rise test depending upon the oil time constant test.

Tap positions to be loaded are
DTC 5, 4, 3, 2, 1, 2, 3, 4, 5
(in LTC position used for temperature rise)
LTC -16, -15, -14, ..., -1, N, +1,..., +16, +15, +14,..., +1, N, -1,...,-16
(in DTC position used for temperature rise)

It is not the intent of this test to get exactly the right current flowing in each case. The intent is to test each internal connection under some significant load and determine whether it produces gas. It also checks the operation of the tap changer drive mechanism in both directions.

Likewise, exact measurement of time is not required.

The test may be done using one supply transformer setup and one capacitor bank setup, and then simply raising the voltage to an approximately correct or fixed value. For example, a convenient voltage might be the voltage that would be used for the temperature rise test tap position. When testing the LTC taps, simply change taps approximately every 2 minutes, and if the Contractor deems it necessary, adjust the voltage to suit.

DGA samples shall be taken before this integrity test, at the end of the integrity test, and approximately six hours (4 hours or 12 hours is also acceptable) after the end of the test. If the timing is right, the DGA sample at the start of the temperature rise test is acceptable.

If the tap changer drive mechanism is motorized, the motor shall be used to drive the tap changer, and not the hand crank.

2.2.9 LTC Full Current Operation

Load-tap-changers shall also be operated at rated current across the full tap range. An oscillograph recording shall be made of this test. The speed of the oscillograph shall be across at least three (3) consecutive tap positions so that the Purchaser can readily evaluate the operation of the load-tap-changing equipment and related arcing contacts. The test shall be done twice: from LTC position -1 through +1, and from +1 to -1, ensuring reversing switch action each time. These oscillographs shall be included in the test report, and it shall clearly show the oscillations. The test is done twice to ensure proper timing.

The data file for the measured waveforms shall be provided when requested.

2.2.10 Zero-Sequence Load Loss and Impedance

Zero-sequence load loss, % resistance and % reactance
on rated DTC tap position and on
  maximum;
  rated;
  minimum LTC tap positions;
on minimum impedance tap position;
on maximum impedance tap position.

This test is required on all units. The test circuit used shall be defined for all windings. The current level for this test should be as high as is practically possible to avoid errors due to non-linearity.

The test shall be done with at least three different current levels (e.g., 15%, 25%, 33% current in each leg) to show that the zero-sequence impedance has stabilised.

2.2.11 Temperature Rise

Shunt reactors shall be tested at 110% voltage.

Temperature rise tests shall be performed at the ONAN and the maximum MVA ratings.

Transformers utilizing a reactor-type tap-changer must have the oil rise portion of this test performed in the most onerous bridging position but with the maximum total losses of any position.

Winding shutdowns are required on all three phases of all loaded circuits for the base ONAN and the maximum MVA rating. A cooling curve is required at the top rating.

The test report must show a calculated winding hotspot temperature rise. This should be based on the tested average winding gradient but it can be from an actual hotspot gradient calculation. Either way, the hotspot must be determined based on the tested oil rise, the calculated winding stray losses and the thermal characteristics at the expected hotspot location.

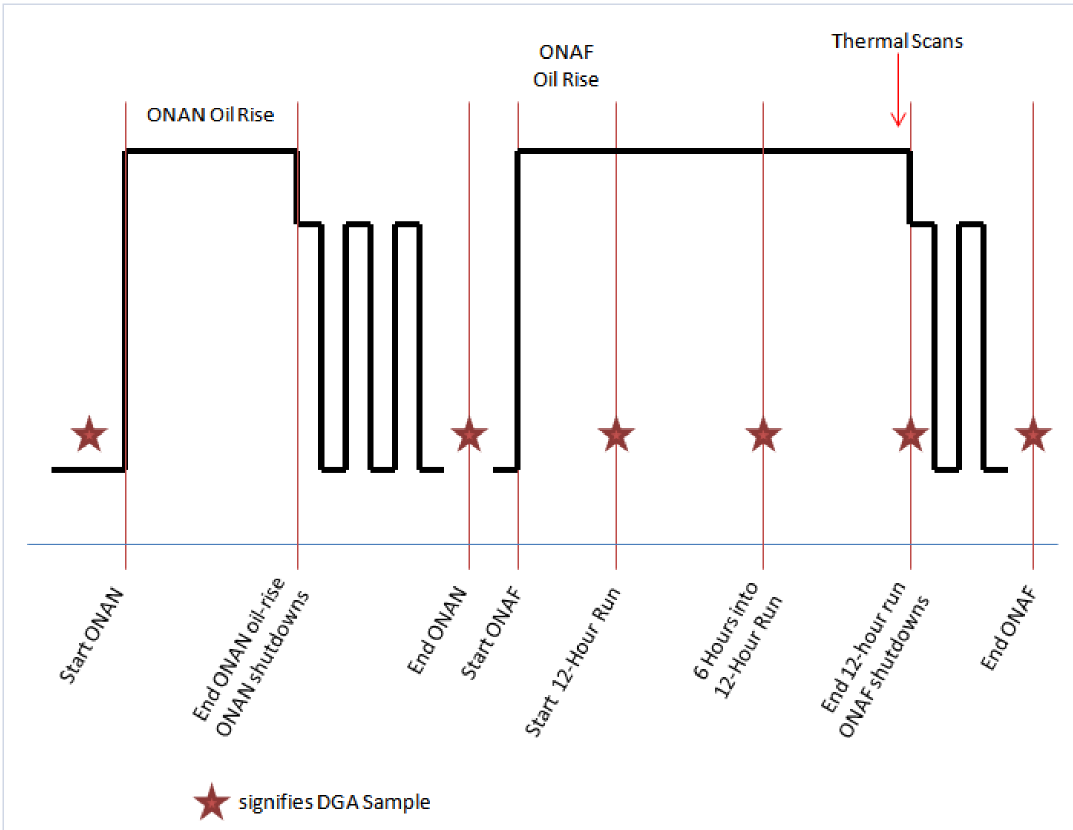
The highest MVA rating run to establish the oil rise shall be extended out for 12 hours once a steady state temperature rise has been established.

Oil samples for gas in oil analysis shall be taken at the start of the 12-hour run (once oil temperature levels-off), 6 hours after the steady state has been reached and at the end of the run.

If fibre-optic temperature probes are installed, they must be monitored during the temperature rise test. Any limitations to this monitoring should be discussed well in advance of the test.

2.2.12 Thermal Scan

Each tank wall surface and cover shall be scanned for hotspots with an infrared thermometer in the last hour of the load run test or the heat run of the highest MVA rating. There shall be a minimum of nine (9) evenly distributed points measured about the tank wall surface or cover. The location and measured temperatures of the tank wall and cover shall be identified on a scaled down version of the outline drawing that shall be included in the test report. This drawing shall identify the hotspot location.



Typical Temperature Rise Test Profile

2.2.13 Additional Tests

Additional temperature rise tests on the power transformer shall be done if specified in the Supplementary Technical Requirements. These tests shall derive the 'm' and 'n' exponents as per the ANSI C57.12.91 standard. The oil time constant shall also be derived.

The 'm' exponent is derived by performing two additional winding temperature tests at two additional different currents: 70% and 130%. These are in addition to the standard 100% test. It need only be done on the hottest phase of each normally loaded circuit or winding as determined by the 100% test. Cooling curves are required. The watts per pound method is not acceptable for these tests including the 100% test.

The 'n' exponent is derived by performing two additional oil rise tests: 85% and 130% of the heatrun load loss. This is in addition to the standard total loss test.

If the 130% load is too onerous for continuous steady-state loading, the Contractor shall determine the maximum 3-hour load that can be applied. The transformer shall be tested at this load, preferably 150%, for 3 hours. The ultimate steady-state top oil and average oil rises shall be extrapolated from these results.

The oil time constant can be derived either by heat-up or cool-down of the transformer under steady-state conditions. For both methods, all of the cooling must be operational. When the oil temperature rise reaches the time constant value, the test is concluded and the duration is the oil time constant.

In the heat-up method, the loading must be constant. The time constant value for the heat-up method is when the oil temperature rise increases by (1-1/e) x 100 = 63.2% of the final rise (starting from zero). Since this is not initially known, the test must usually be extended to ensure that the value has been met.

In the cool-down method, the pre-load must also be a steady-state condition with steady-state temperatures as defined by ANSI C57.12.90. The load is then removed and the test is begun. In the cool-down method, the time constant is when the oil temperature rise decreases to 1/e x 100 = 36.8% of the initial temperature rise.

DGA samples shall be drawn after each ampacity change in this testing.

If the fibre-optic sensors are purchased, they shall be monitored during these extra tests.

2.3 Dielectric Tests

Dielectric tests including impulse tests shall be performed after the temperature rise test or load run test, where applicable. Any occurrence internal or external during the dielectric tests must be reported to the Purchaser's representative or Inspector prior to proceeding with any further tests.

2.3.1 Static Electrification Test

The static electrification test is required only for pumped transformers. It shall be performed with all coolers operational, N + 1 coolers, this test shall be done immediately following the temperature rise test and prior to dielectric tests. The test is to determine the degree of static electrification by measuring leakage current produced by each winding as a result of oil circulation. During this test all pumps shall be turned on with the fans off so as to maintain a more consistent oil temperature throughout the duration of the test. One terminal of each winding shall be separately grounded through ammeters with appropriate measuring ranges with the ability to measure microamps. The oil temperature and amp meter readings shall be recorded on a chart recorder or other suitable devices throughout the entire duration of the test. The test shall be performed until the current in each winding stabilizes to a steady state value where the time elapsed from the start of the test to current stabilization occurs is Ts. The pumps shall be turned off and the current decay characteristic shall be observed and recorded. Prior to each induced test, the pumps must be operated for Ts, upon which the pumps may be shut off and the induced test shall commence immediately.

2.3.2 Impulse

Impulse tests shall be performed on all terminals, including neutrals that are reconnectable to line leads in the following sequence:

for windings without non-linear resistors:

RFW,
RCW,
CW,
CW,
FW,
FW;

for windings with non-linear resistors:

RFW,
80%-FW,
FW,
RCW,
CW,
CW,
FW,
FW,
80%-FW,
RFW.

This sequence also applies to neutral terminals suitable for ungrounded operation, otherwise, the neutral receives a reduced and two (2) full waves. The sequence of application shall be from the highest to the lowest voltage ratings.

Chopped waves shall include the current oscillograms, scaled for a total time range of about 20-30 μs (4 or 5 μs per division).

Each unit shall be tested with its own bushing in place. In cases where a bushing has to be replaced, this bushing shall be impulse tested as an individual unit.

A log shall be supplied listing each impulse shot, including all calibrations, misfires and incorrect shots.

2.3.3 Switching Surge

Switching surge tests are required on all terminals rated 115 kV and above. It may be done applied or induced. For some transformers such as 115-66 kV, this may need to be a line-to-line test rather than a line-to-neutral test. If the required levels cannot be obtained on all terminals within 10% with one test by varying the tap-changer position, then multiple tests shall be done.

A log shall be supplied listing each impulse shot, including all calibrations, misfires and incorrect shots.

2.3.4 Applied Voltage

Applied voltage tests are required.

2.3.5 3-Phase Partial Discharge

3-phase partial discharge tests and/or induced voltage tests. Transformers utilizing a reactor-type tap-changer must have this test performed in the most onerous bridging position.

Prior to this test, operate the pumps for the prescribed time as described in section 2.3.1 Static Electrification Test.

Upon completion of the 1-hour test run at 1.5 times maximum operating voltage, the voltage shall be further reduced to its maximum operating voltage and the readings shall be monitored every 5 minutes for 20 minutes.

The maximum RIV reading during this period shall not exceed 50 µV. The transformer will be rejected if it exceeds the RIV levels as specified for either the CAN/CSA-C88-M90 test or the maximum operating voltage test. The measurements shall be made in accordance with ANSI/IEEE C57.113.

In addition to RIV readings, partial discharge measurements using the apparent charge method shall also be made and recorded. The partial discharge shall not exceed300 pC absolute and 100 pC variation between phases at 1.5 times the maximum operating voltage.

Measurement of partial discharge shall be made at all winding terminals rated 66 kV and above and the results of all tests shall be included in the certified test reports.

2.3.6 1-Phase Partial Discharge

On all transformers with a neutral connection rated at 350 kV LIL and above, a 1 phase partial discharge test and/or induced voltage test shall be conducted with the neutral floating. The H2 bushing shall be grounded and the H1 and H3 bushings shall be floating. The test sequence shall be done in the same manner as the 3-phase induced test except that the test levels will be different.

The enhanced or 7200 cycle test level shall be chosen so that the neutral is equal to the voltage to ground applied during the applied voltage test of the neutral in question. Partial discharge shall be recorded at this level. For a 350 kV LIL neutral, the test level is 140 kV RMS to ground.

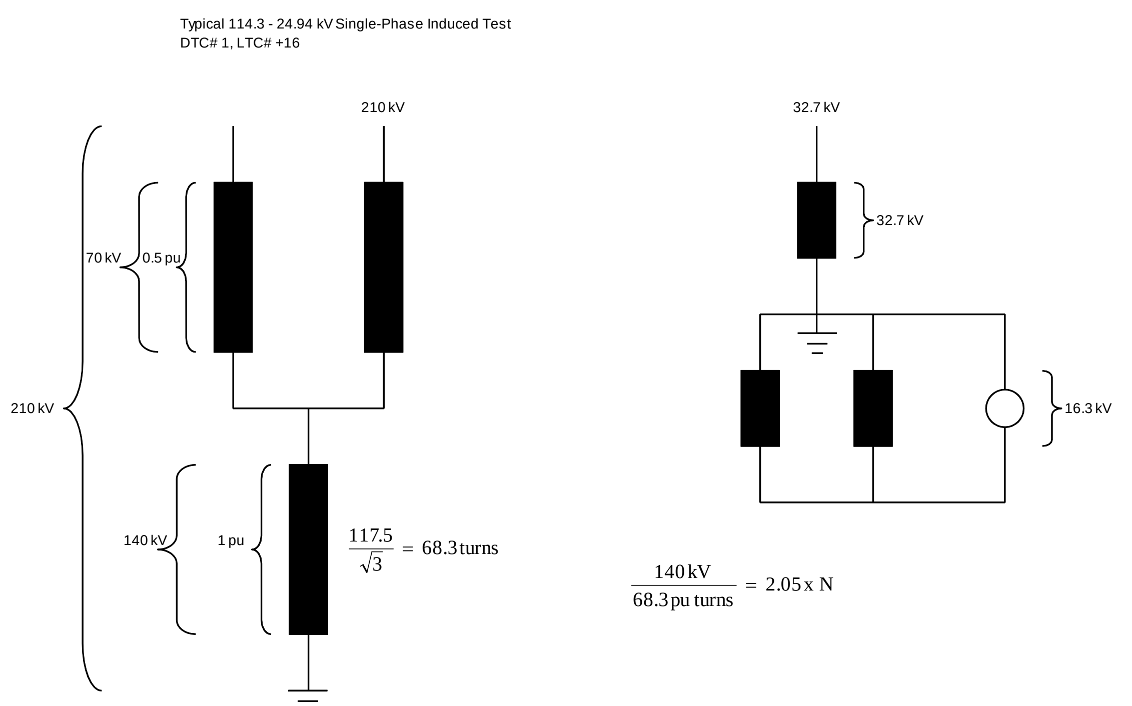
Prior to this test, operate the pumps for the prescribed time as described in section 2.3.1 Static Electrification Test.

The 1-hour level is chosen by the 'PD-free' level of the bushing and/or the tap changer. For a 350 kV LIL bushing, the PD-free level is typically 47 MCOV x 1.5 = 71 kV. The 1-hour test level is thus 71 kV RMS to ground. Only the bushings and/or on-load tap-changer may limit the 1-hour level of this test. The remainder of the transformer must be designed to withstand this level.

Partial discharge shall be measured prior to and during the enhanced level, and every 5 minutes thereafter. Partial discharge shall be measured on all floating terminals. The acceptance criteria shall be the same as the 3-phase induced test.

Upon completion of the 1-hour test run, the voltage on the neutral bushing shall be further reduced to the bushing's maximum continuous operating voltage level and the readings shall be monitored every 5 minutes for 20 minutes.

The position of the tap-changer(s) may be decided by the manufacturer.



2.4 Sound Level Tests

The Equipment shall be designed and constructed to meet the sound level requirements of CAN/CSA-C88-M90 in the LTC tap position that produces the maximum sound level with no plus tolerance, unless specified otherwise in the Supplementary Technical Requirements.

Sound level tests shall use the 1/3-octave band test. Both the fundamental A weighted sound level and the 1/3-octave spectrum A weighted sound level shall be reported. The individual measurements at each point shall be included in the test report.

L_{Aeq} 125, 250, 315, 400, 500, 630 Hz

Both open-circuit and short-circuit sound level tests shall be done. Guaranteed sound level applies to the open-circuit test, at 100% voltage unless otherwise specified in the Supplementary Technical Requirements, and for any tap position.

2.4.1 Open-Circuit Sound Level Test

This test is done by applying voltage to the primary, secondary or tertiary, while the others are open-circuit.

This shall be done in the most onerous tap position, and also at neutral tap position if necessary. Series transformers shall be in their extreme positions and reactors (preventive-auto) shall be in their bridging positions. The tap position will be chosen by the Purchaser.

The test shall be done at 100% and 110% voltage, or the highest continuous overvoltage specified in the Supplementary Technical Requirements.

2.4.2 Short-Circuit Sound Level Test

This test is done by applying voltage to the primary or secondary, while the other is short-circuit. For transformers with three-circuits, such as with a tertiary winding, the tertiary may be open-circuit. For four-circuit and six-circuit transformers, the dual LV circuits shall be paralleled.

This shall be done in the most onerous tap position, and also at neutral tap position if necessary. Series transformers shall be in their extreme positions and reactors (preventive-auto) shall be in their bridging positions. The tap position will be chosen by the Purchaser.

This test shall be done at the at the maximum continuous VA nameplate rating of the transformer. If requested by the Purchaser, it shall also be done at the base VA nameplate rating.

2.5 Oil Tests

2.5.1 Oil Sample

Oil sample test including PCB level, power factor test, water content and suspended particle count. This test shall be done for all transformers, including transformers to be shipped without oil.

2.5.2 DGA

Dissolved gas-in-oil samples must be taken on all units as follows:

(a) one sample prior to the application of any power or dielectric tests;

(b) temperature rise test samples if applicable:
  i) - prior to the test;
  ii) - after the ONAN test;
  iii) - after the top rating oil rise levels off;
  iv) - 6 hours after the oil rise levels off;
  v) - 12 hours after the oil rise levels off;
  vi) - end of temperature rise test.

(c) one sample shall be drawn prior to the start of the dielectric tests;

(d) one sample shall be drawn immediately following completion of the dielectric tests;

(e) units subjected only to excitation and load loss tests shall have a further sample drawn immediately following the 1-hour excitation measurement test;

(f) samples shall also be taken after any failure of the transformer during testing.

The Contractor shall obtain back-up samples of each oil sample taken in case questions arise over the results of the samples submitted to the Purchaser for analysis. Backup oil samples shall not be discarded and must be retained until after approval by the Purchaser.

Test results of the gas in oil analysis shall be submitted to the Purchaser for approval prior to shipment of any unit. The Purchaser reserves the right to request additional testing where gas in oil test results would seem to warrant further investigation.

In addition to samples for gas in oil analysis, the Purchaser may request the Contractor to take special oil samples for analysis by the Purchaser's own laboratory. The Purchaser will supply the sample containers and arrange for shipment to the Purchaser's laboratory facility.

2.6 Tests after Dielectrics

2.6.1 Overvoltage Run & No-Load Loss after Dielectrics

A 1 hour excitation measurement shall be done after completion of all insulation tests.

Prior to the 1-hour run, the transformer shall have the losses recorded at 85%, 90%, 95%, 100%, 105%, 110% and 115% rated voltage of the principal DTC and/or LTC tap position(s).

Should the principal DTC and /or LTC tap position(s) not generate the highest excitation current, then the measured losses shall also be recorded at 85%, 90%, 95%, 100%, 105%, 110% and 115% rated voltage of the tap position that generates the highest excitation current and the unit left energised for a 1-hour period at 110% rated voltage of this tap position.

After completion of the 1-hour excitation test, the losses shall be measured and recorded at 85%, 90%, 95%, 100%, 105%, 110% and 115% rated voltage of the tap position that generates the highest excitation current. Also, the losses shall be measured and recorded at 85%, 90%, 95%, 100%, 105%, 110% and 115% of the rated voltage for the principal DTC and /or LTC tap position(s). **For evaluation of the guaranteed loss values, the above last excitation loss test results shall be used.** If the excitation loss at rated voltage for the principal DTC and/or LTC tap position(s) exceeds the original excitation loss by more than 4%, acceptance shall be obtained from the Purchaser before shipping release.

The test report will also include a saturation curve showing core loss in kW and excitation current in percent versus voltage in percent. The excitation current curve will extend up to and beyond the point at which the air core reactance line becomes tangential to the magnetisation curve. The curves shall use tested values between 85 and 115% voltage. The air-core reactance in ohms shall also be specified for all terminals. The curve should either be provided with a change of scale for the excitation current axis or two curves should be provided for clarity.

2.6.2 Single-Phase No-Load Excitation

After 2.6.1 Overvoltage Run & No-Load Loss after Dielectrics, perform a single-phase, 10 kV excitation current test on each phase and each terminal, with the transformer oil-filled. These tests may be done using the normal core loss testing equipment, or it may be done using a Doble M4100 or other such equipment that accurately measures excitation current. Each test shall be done at the tap extremes, rated tap and neutral tap. The purpose of the test is future reference comparison in determining if turns are shorted in the windings

2.7 Final Tests Prior to Shipping

The following tests shall be performed upon completion of all other tests and prior to shipment.

2.7.1 Insulation Power Factor

(a) **Oil-Filled Test with Bushings**
Transformer insulation power factor and capacitance shall be measured on a fully assembled transformer, filled with oil, between each winding and ground, and between each winding and every other winding. This test shall be done in both connections for a re-connectable transformer. This shall include:

For two-winding transformer
i) H to ground with guarded X
ii) H to grounded X
iii) X to ground with guarded H
iv) X to grounded H
v) H & X to ground

For three to six-winding transformer (excluding buried Tertiary)
vi) H to ground with guarded X & Y
vii) H to grounded X with guarded Y
viii) H to grounded Y with guarded X
ix) X to ground with guarded H & Y
x) X to grounded Y with guarded H
xi) X to grounded H with guarded Y
xii) Y to ground with guarded H & X
xiii) Y to grounded X with guarded H
xiv) Y to grounded H with guarded X
xv) H & X to grounded Y
xvi) H & Y to grounded X
xvii) X & Y to grounded H
xviii) X to grounded H

For auto-transformer
xix) H&X to ground with guarded Y
xx) H&X to grounded Y
xxi) Y to ground with guarded H & X
xxii) Y to grounded H & X
xxiii) H & X & Y to ground

These values, together with the temperature of oil at the time of the test, shall be included in the certified test reports. The maximum transformer insulation power factor shall be 0.5% corrected to a temperature of 20ºC.

(b) **Air-Filled Test with Bushings, without Oil**
This is a reference for field tests, done in the shipping connection.

(c) **Shipping Test**
This is a reference to check for shipping damage and is only required on transformers shipped with either or both the oil and bushings removed.

(d) **Core Ground**
The power factor and capacitance of the core ground shall be measured from the external terminal using a low voltage bridge (not 10 kV). This shall be done twice, once with the transformer oil-filled, and again prior to shipping in the shipping state. This is required on all cores including the LTC reactor and series transformer. Short and guard the windings during these tests. The purpose of the test is to confirm that the connection to the core is intact.

(e) **Clamp Ground**
The power factor and capacitance of the clamp ground shall be measured from the external terminal using a low voltage bridge (not 10 kV). This shall be done twice, once with the transformer oil-filled, and again prior to shipping in the shipping state. This is required on all cores including the LTC reactor and series transformer. Short and guard the windings during these tests. The purpose of the test is to confirm that the connection to the clamp is intact.

2.7.2 SFRA

Manitoba Hydro uses both the Megger FRAX and Doble M5100 instruments for this test, but primarily uses the FRAX.

A Sweep Frequency Response Analysis (SFRA) shall be done using either a Megger FRAX or Doble M5100 instrument on all transformers and shunt reactors 7.5 MVA and larger. A complete set of tests shall be done by supplying, shorting and opening each circuit. The test report shall include full documentation of the test including cable lengths, where connected, grounding lead routing, etc. All of this shall be shown by diagram, text and photographs. Each test report shall also include a CD containing the files for comparison with tests on site.

All SFRA tests shall be done with the core ground resistor shorted-out.

Ensure the transformer cores are demagnetized prior to performing any SFRA testing.

All SFRA tests shall be done in the rated DTC position and the maximum '+' LTC position (e.g. DTC# 2, LTC +16). The transformer shall be shipped in this position so as to ease testing upon delivery.

(a) **Oil-Filled Test**
The SFRA shall be done on a fully assembled transformer filled with oil. This test shall be done in both connections for a re-connectable transformer.

(b) **Air-Filled Test with Bushings, without Oil**
This is a reference for field tests done in the shipping connection.

(c) **Shipping Test**
This is a reference to check for shipping damage and is only required on transformers shipped with either or both the oil and bushings removed.

For transformers shipped without bushings, each blanking plate covering a bushing turret shall include a spark-plug type epoxy bushing. The spark plug shall be solidly connected to the transformer lead using insulated wire. This spark plug shall be used during the test without bushings. Any shipping protection which interferes with access to this bushing shall be removable to allow access to the terminal using large clamp connectors.

2.7.3 Insulation Resistance

The windings, shielding cylinders, core and clamp insulation resistance measured at 2500 V shall indicate a minimum resistance of 200 megohms to ground.

2.7.4 Bushing Insulation Power Factor

The insulation power factor and capacitance of all bushings shall be measured and the values for both C1 and C2 recorded in the certified test reports. Values which differ substantially from those recorded on the bushing nameplate shall be subject to approval by the Purchaser prior to shipment.

2.7.5 CT Re-test

All current transformers shall be tested for damage due to power transformer testing. This shall be done after all other testing, including after applied potential testing of the wiring. As a minimum, this shall include dc resistance and ratio. Ratio shall be performed last to ensure the CT core is not saturated.

3 TRANSFORMER DESIGN TESTS

The Purchaser requires all tests to be performed on each transformer or shunt reactor. No tests are considered to be design or type tests.

4 CURRENT TRANSFORMER TESTS

Current transformers shall be fully tested in accordance with CSA CAN3-C13-M. A check of current transformer characteristics shall be made after final assembly into the tank and shall include:

(a) ratio of each tap position, by injecting the necessary current into the transformer, but not exceeding the maximum MVA for the transformer, to generate 5 A or a current value as limited by the maximum MVA at the secondary terminals of the CT;
(b) polarity in relation to the main transformer terminals;
(c) polarity in relation to the CT Test Loop if provided;
(d) dc resistance;
(e) excitation measurements (at least five (5) points);
(f) induced voltage test; and
(g) applied potential test.

An additional check shall also be made after all testing as described in Subsection 2.7.5 CT Re-test of these Apparatus Tests and Quality Assurance Program Requirements.

5 AUXILIARY WIRING AND FUNCTIONAL TESTS

All auxiliary wiring and devices shall be functionally tested. All wires shall be tested for continuity and insulation integrity and checked according to the wiring diagram. This check shall be done by the test personnel and not by the person who wired the panel.

The installed wiring shall receive an applied potential test at 1.5 kV.

Wiring and functional tests shall be included in the certified test reports.

6 MECHANICAL TESTS

6.1 Weld Tests

On transformers rated 95 MVA or greater, all welds that form part of the oil containment or affect structural integrity shall be tested using dye penetrant to ASTM E165.

In addition, all structural and those welds associated with the lifting bollards and jacking steps shall be tested using the magnetic particle method to ASTM E709.

This should be carried out on welds within at least 300 mm of the lifting/jacking point, or as directed by the Purchaser's representative or Inspector.

All other welds shall be inspected visually.

Any defective welds shall be cut out and re-worked. Any defective welds that are re-worked shall be reported to the Purchaser's representative or Inspector.

6.2 Pressure Test

6.2.1 LTC Compartment for LTC with the Selectors Mounted in a Separate Tank

The tap-changer compartment(s) shall be pressure and vacuum tested in both directions prior to mounting on the transformer. After the tap-changer is mounted on the transformer, it shall be pressure tested between the main tank and the tap-changer compartment(s) to check the integrity of the oil seal between the main tank and the tap-changer compartment(s). This test shall be conducted by applying a pressure of 50kPa to the main tank and the main tank must be filled with oil. The duration of the pressure test shall be 16 hours for hot oil (above 60ºC). The pressure test shall be done after all factory tests are completed. All internal tap-changer components shall be examined for deficiencies or excess wear at the same time the tap changer is open for the pressure test.

6.2.2 Assembled Transformer

All tanks, welds, radiators, valves and other parts necessary for a complete transformer of any size shall be tested for oil leaks and strength by applying to the complete tank, filled with oil, a pressure not less than 50 kPa gauge applied at the top of the oil-filled conservator for a period of 24 hours with oil temperature being greater than 50ºC at the bottom of the main tank.

On transformers subjected to the temperature rise test, the pressure test shall commence upon completion of the temperature rise test.

If any leaks occur, tests shall be rerun after all leaks have been stopped.

NOTE: Pressure tests shall be carried out on fully assembled units, including oil-filled conservators. Tests on individual parts will not be accepted unless prior approval has been obtained from the Purchaser.

6.3 Vacuum Test

The Contractor shall evacuate the tank, excluding coolers and the conservator, to 27 Pa (200 µm Hg, 0.27 mbars) absolute gas pressure, or better, using a McLeod gauge.

The Contractor shall shut off the valves to the vacuum pump, stop the pump, remove the vacuum hose from the valve, blank off the valve and open it. After approximately 10 minutes, the Contractor shall measure the tank vacuum. This shall be the initial vacuum P1 at time t = 0 minute. P1 shall be not greater than 200 µm Hg.

The duration (T) of the test shall be determined by the tank volume (V) for the test:

$T = 1.4 \times V$

T: time in minutes rounded up to the next half minute.

V: tank oil volume in cubic metres

1 m3 = 1000 litres
220 Imperial gallons
264 US gallons

The tank vacuum P_2 shall be recorded after time T has elapsed.

The increase in pressure

$$P_2 - P_1$$

shall not exceed 13.5 Pa (100 µm Hg, 0.135 mbar).

6.4 Gas Detector System Operating Test

After the completion of all dielectric tests, the gas detector system on the transformer shall be tested by injecting 500 millilitres of dry air into the transformer. The air to be injected into the transformer from the top of a calibrated chamber of at least 1000 millilitre capacity. The bottom of this chamber shall be piped via a valve to a larger chamber containing transformer oil, and capable of being pressurised in order to drive the required 500 millilitres of air into the transformer in a few seconds. The injection point shall be as far as possible from the main gas detector system collecting point on top of the tank. After a duration of 15 minutes, at least 250 millilitres of the air shall have collected in the gas detector relay.

Transformers fitted with pumps shall verify that under the normal start-up sequence with ambient oil, the sudden surge will not trip the gas detector relay contacts.

6.5 Pump Pressure Surge Test

Transformers fitted with pumps shall verify that under the normal startup sequence with ambient oil, the sudden surge from the pumps will not trip the pressure monitor system contacts.

6.6 Operational Switching Test

All switching equipment, when completely assembled, shall be operated ten (10) times in the normal manner through the complete cycle, unless additional operations are warranted or requested by the Purchaser or its representative.

7 ACCEPTANCE TESTS

The power transformer may be acceptance-tested at the Purchaser's test facility. This is a fully functional test lab with facilities to perform all the tests prescribed by this RFP. Acceptance testing may be limited to dielectric testing at full test levels or may include load tests. Acceptance testing is done at the Purchaser's expense.

The Contractor will be permitted to have its representative present during the tests at the Contractor's own expense. If results of any of the tests are not satisfactory to the Purchaser, the Contractor shall, at the Contractor's own expense, make all necessary corrections. Additional tests will then be made, under the Purchaser's direction, to demonstrate to the Purchaser's satisfaction the effectiveness of these corrections. These additional tests will be at the Contractor's expense. Until the necessary corrections have been made, the conditions of the Contract shall not be considered fulfilled.

8 FIELD TESTS

The Purchaser may, at its option, require that tests be made after the Equipment has been placed in service in order to demonstrate that all performance guarantees have been met. Such tests will be at the Purchaser's expense. The Contractor will be permitted to have its representative present during the tests at the Contractor's own expense. If results of any of the tests are not satisfactory to the Purchaser, the Contractor shall, at the Contractor's own expense, make all necessary corrections. Additional tests will then be made, under the Purchaser's direction, to demonstrate to the Purchaser's satisfaction the effectiveness of these corrections. These additional tests will be at the Contractor's expense. Until the necessary corrections have been made, the conditions of the Contract shall not be considered fulfilled.

9 QUALITY ASSURANCE PROGRAM REQUIREMENTS

In addition to the provisions of the General Conditions respecting Inspection and Testing, the Work shall comply with the quality assurance program requirements of ISO 9001-2000 as specified in the Supplementary Technical Requirements.

The Contractor must prepare and submit to the Purchaser a Quality Assurance Program Manual or Document, including inspection and test information in accordance with the ISO 9001-2000, that is acceptable to the Purchaser. A

Contractor who has previously provided a Quality Assurance Program Manual or Document in connection with other work for the Purchaser, may refer to that manual or document, provided that it conforms to the Contractor's current practice and to the requirements of ISO 9001-2000.

The Purchaser shall have sole and final discretion in determining whether a quality assurance program is the equivalent of ISO 9001-2000.

The Contractor shall grant authorised representatives of the Purchaser and the Inspector access to the Contractor's factory and to the factory or factories of all its subcontractors, at any time during the Contractor's or subcontractors' normal business hours to enable such representatives and the Inspector to verify that the Contractor and its subcontractors are satisfactorily carrying out the Work and that the Work complies with the requirements of the quality assurance program.

A full description of all test failures and non-conforming items which affect safety, interchangeability, standard design practice and/or performance and reliability shall be submitted, in writing, to the Inspector. The Purchaser's approval of proposed corrective actions is required before proceeding with the Work.

10 TYPICAL TEST SCHEDULE EXAMPLES

Minimum Transformer Testing Requirements and Order for
138 or 114.3 kVY - 12.47 x 24.94 kVY

12.47 kV shipping connection

	MH Clause	Comment
Tests prior to Vapour-Phase		
LTC Reactor (Preventive Auto) dc Resistance	2.2.1	
LTC Reactor (Preventive Auto) Magnetizing Current	2.2.4	at full magnetizing current
LTC Reactor Core and Clamp Insulation Resistance	2.7.3	
Core and Clamp Insulation Resistance	2.7.3	main transformer, LTC reactor
12.47 kV connection		
dc Resistance	2.2.1	
Ratio	2.2.3	
24.94 kV connection		
dc Resistance	2.2.1	
Ratio	2.2.3	
Test after Tanking and Filling		
24.94 kV connection		
DGA prior to test	2.5.2	
Oil Sample	2.5.1	Dielectric strength etc.
dc Resistance	2.2.1	
Polarity and Phase Relationship	2.2.2	
Ratio	2.2.3	
Insulation Power Factor & Capacitance	2.7.1	with oil & bushings
Core & Clamp Power Factor and Capacitance	2.7.1	with oil & bushings
Core and Clamp Insulation Resistance	2.7.3	main transformer, LTC reactor
SFRA	2.7.2	with oil & bushings (2/+16)
Low-Current CT Tests	4	
No-load Loss & Exciting Current	2.2.5	N, -1
LTC Full Voltage Operation	2.2.6	
Open-Circuit Sound Level	2.4.1	-1
Positive-sequence Load Loss & Impedance	2.2.7	(1,2,5)/(-16,N,+16) , 2/-1, 5/-1
Full-Current CT Test	4	
LTC Full Current Operation	2.2.9	Approx rated ONAF current
Short-Circuit Sound Level	2.4.2	-1
Zero Sequence Load Loss & Impedance	2.2.10	2/(-16,N,+16) , 1/+16, 5/-16
DGA prior to Dielectrics	2.5.2	
Impulse	2.3.1	LV
3-Phase Partial Discharge	2.3.4	1/+15
DGA after Dielectrics	2.5.2	
Link Change to 12.47 kV Connection		
dc Resistance	2.2.1	
Polarity and Phase Relationship	2.2.2	
Ratio	2.2.3	
Insulation Power Factor	2.7.1	
Core and Clamp Insulation Resistance	2.7.3	
Positive-sequence Load Loss & Impedance	2.2.7	(1,2,5)/(-16,-8,N,+8,+16) , 2/-1, 5/-1
Zero Sequence Load Loss & Impedance	2.2.9	2/(-16,N,+16) , 1/+16, 5/-16
Temperature Rise	2.2.11	5/-1
DGA prior to test	2.5.2	
DGA after ONAN shutdowns	2.5.2	
DGA once ONAF oil rise levels off	2.5.2	
DGA 6 hours into 12 hour ONAF run	2.5.2	
Connection Integrity Test	2.2.8	
Thermal Scan in last hour of 12 hour run	2.2.12	
DGA 12 hours into 12 hour ONAF run	2.5.2	
DGA after ONAF shutdowns	2.5.2	
Impulse	2.3.1	HV, HVN, LV, LVN
Switching Surge	2.3.2	HV
Applied Voltage	2.3.3	HV, LV
3-Phase Partial Discharge	2.3.4	1/+15
1-Phase Partial Discharge for HVN	2.3.5	
DGA after Dielectrics	2.5.2	
No-load Loss & Exciting Current	2.6.1	N, -1
1 Hour 110% Overvoltage Run	2.6.1	-1
No-load Loss & Exciting Current after 1 Hour Run	2.6.1	N, -1
DGA after Power Testing	2.5.2	
Insulation Power Factor and Capacitance	2.7.1	with oil & bushings
Bushing Insulation Power Factor and Capacitance	2.7.4	
Gas Detector Operation	6.4	
Core and Clamp Insulation Resistance	2.7.3	main transformer, LTC reactor
SFRA	2.7.2	with oil & bushings (2/+16)
Auxilliary Wiring & Functional	5	
CT Re-Test	2.7.5	
Drain Oil		
Insulation Power Factor and Capacitance	2.7.1	with bushings, without oil
SFRA	2.7.2	with bushings, without oil (2/+16)
Vacuum Test	6.3	
Final Tests prior to Shipping		Label as "Shipping Condition"
Insulation Power Factor and Capacitance	2.7.1	without bushings, without oil
Core & Clamp Power Factor and Capacitance	2.7.1	without bushings, without oil
SFRA	2.7.2	without bushings, without oil (2/+16)
Core and Clamp Insulation Resistance	2.7.3	main transformer, LTC reactor
Dew Point	1.6.8	

Minimum Transformer Testing Requirements and Order for
138 or 114.3 kVY - 12.47 x 24.94 kVY

24.94 kV shipping connection

	MH Clause	Comment
Tests prior to Vapour-Phase		
LTC Reactor (Preventive Auto) dc Resistance	2.2.1	
LTC Reactor (Preventive Auto) Magnetizing Current	2.2.4	at full magnetizing current
LTC Reactor Core and Clamp Insulation Resistance	2.7.3	
Core and Clamp Insulation Resistance	2.7.3	main transformer, LTC reactor
24.94 kV connection		
dc Resistance	2.2.1	
Ratio	2.2.3	
12.47 kV connection		
dc Resistance	2.2.1	
Ratio	2.2.3	
Test after Tanking and Filling		
12.47kV connection		
DGA prior to test	2.5.2	
Oil Sample	2.5.1	Dielectric strength etc.
dc Resistance	2.2.1	
Polarity and Phase Relationship	2.2.2	
Ratio	2.2.3	
Insulation Power Factor	2.7.1	
Core & Clamp Power Factor and Capacitance	2.7.1	with oil & bushings
Core and Clamp Insulation Resistance	2.7.3	
SFRA	2.7.2	with oil & bushings (2/+16)
Low-Current CT Tests	4	
No-load Loss & Exciting Current	2.2.5	N, -1
LTC Full Voltage Operation	2.2.6	
Open-Circuit Sound Level	2.4.1	-1
Positive-sequence Load Loss & Impedance	2.2.7	(1,2,5)/(-16,-8,N,+8,+16) , 2/-1, 5/-1
Full-Current CT Test	4	
LTC Full Current Operation	2.2.9	Approx rated ONAF current
Short-Circuit Sound Level	2.4.2	-1
Zero Sequence Load Loss & Impedance	2.2.10	2/(-16,N,+16) , 1/+16, 5/-16
Temperature Rise	2.2.11	5/-1
DGA prior to test	2.5.2	
DGA after ONAN shutdowns	2.5.2	
DGA once ONAF oil rise levels off	2.5.2	
DGA 6 hours into 12 hour ONAF run	2.5.2	
Connection Integrity Test	2.2.8	
Thermal Scan in last hour of 12 hour run	2.2.12	
DGA 12 hours into 12 hour ONAF run	2.5.2	
DGA after ONAF shutdowns	2.5.2	
DGA prior to Dielectrics (if necessary)	2.5.2	
Impulse	2.3.1	LV
3-Phase Partial Discharge	2.3.4	1/+15
DGA after Dielectrics	2.5.2	
Link Change to 24.94 kV Connection		
dc Resistance	2.2.1	
Polarity and Phase Relationship	2.2.2	
Ratio	2.2.3	
Insulation Power Factor	2.7.1	
Core and Clamp Insulation Resistance	2.7.3	
Positive-sequence Load Loss & Impedance	2.2.7	(1,2,5)/(-16,N,+16) , 2/-1, 5/-1
Zero Sequence Load Loss & Impedance	2.2.9	2/(-16,N,+16) , 1/+16, 5/-16
Impulse	2.3.1	HV, HVN, LV, LVN
Switching Surge	2.3.2	HV
Applied Voltage	2.3.3	HV, LV
3-Phase Partial Discharge	2.3.4	1/+15
1-Phase Partial Discharge for HVN	2.3.5	
DGA after Dielectrics	2.5.2	
No-load Loss & Exciting Current	2.6.1	N, -1
1 Hour 110% Overvoltage Run	2.6.1	-1
No-load Loss & Exciting Current after 1 Hour Run	2.6.1	N, -1
DGA after Power Testing	2.5.2	
Insulation Power Factor and Capacitance	2.7.1	with oil & bushings
Bushing Insulation Power Factor and Capacitance	2.7.4	
Gas Detector Operation	6.4	
Core and Clamp Insulation Resistance	2.7.3	
SFRA	2.7.2	with oil & bushings (2/+16)
Auxilliary Wiring & Functional	5	
CT Re-Test	2.7.5	
Drain Oil		
Insulation Power Factor and Capacitance	2.7.1	with bushings, without oil
SFRA	2.7.2	with bushings, without oil (2/+16)
Vacuum Test	6.3	
Final Tests prior to Shipping		Label as "Shipping Condition"
Insulation Power Factor and Capacitance	2.7.1	without bushings, without oil
Core & Clamp Power Factor and Capacitance	2.7.1	without bushings, without oil
SFRA	2.7.2	without bushings, without oil (2/+16)
Core and Clamp Insulation Resistance	2.7.3	
Dew Point	1.6.8	

Minimum Transformer Testing Requirements and Order for
66 kV - 12.47 x 24.94 kVY

24.94 kV shipping connection

	MH Clause	Comment
Tests prior to Vapour-Phase		
LTC Reactor (Preventive Auto) dc Resistance	2.2.1	
LTC Reactor (Preventive Auto) Magnetizing Current	2.2.4	at full magnetizing current
LTC Reactor Core and Clamp Insulation Resistance	2.7.3	
Core and Clamp Insulation Resistance	2.7.3	main transformer, LTC reactor
24.94 kV connection		
dc Resistance	2.2.1	
Ratio	2.2.3	
12.47 kV connection		
dc Resistance	2.2.1	
Ratio	2.2.3	
Test after Tanking and Filling		
12.47kV connection		
DGA prior to test	2.5.2	
Oil Sample	2.5.1	Dielectric strength etc.
dc Resistance	2.2.1	
Polarity and Phase Relationship	2.2.2	
Ratio	2.2.3	
Insulation Power Factor	2.7.1	
Core & Clamp Power Factor and Capacitance	2.7.1	with oil & bushings
Core and Clamp Insulation Resistance	2.7.3	
SFRA	2.7.2	with oil & bushings (2/+16)
Low-Current CT Tests	4	
No-load Loss & Exciting Current	2.2.5	N, -1
LTC Full Voltage Operation	2.2.6	
Open-Circuit Sound Level	2.4.1	-1
Positive-sequence Load Loss & Impedance	2.2.7	(1,2,5)/(-16,N,+16) , 2/-1, 5/-1
Full-Current CT Test	4	
LTC Full Current Operation	2.2.9	Approx rated ONAF current
Short-Circuit Sound Level	2.4.2	-1
Zero Sequence Load Loss & Impedance	2.2.10	2/(-16,N,+16) , 1/+16, 5/-16
Temperature Rise	2.2.11	5/-1
DGA prior to test	2.5.2	
DGA after ONAN shutdowns	2.5.2	
DGA once ONAF oil rise levels off	2.5.2	
DGA 6 hours into 12 hour ONAF run	2.5.2	
Connection Integrity Test	2.2.8	
Thermal Scan in last hour of 12 hour run	2.2.12	
DGA 12 hours into 12 hour ONAF run	2.5.2	
DGA after ONAF shutdowns	2.5.2	
DGA prior to Dielectrics (if necessary)	2.5.2	
Impulse	2.3.1	LV
3-Phase Partial Discharge	2.3.4	1/+15
DGA after Dielectrics	2.5.2	
Link Change to 24.94 kV Connection		
dc Resistance	2.2.1	
Polarity and Phase Relationship	2.2.2	
Ratio	2.2.3	
Insulation Power Factor	2.7.1	
Core and Clamp Insulation Resistance	2.7.3	
Positive-sequence Load Loss & Impedance	2.2.7	(1,2,5)/(-16,-8,N,+8,+16) , 2/-1, 5/-1
Zero Sequence Load Loss & Impedance	2.2.9	2/(-16,N,+16) , 1/+16, 5/-16
Impulse	2.3.1	HV, HVN, LV, LVN
Applied Voltage	2.3.3	HV, LV
3-Phase Partial Discharge	2.3.4	1/+15
DGA after Dielectrics	2.5.2	
No-load Loss & Exciting Current	2.6.1	N, -1
1 Hour 110% Overvoltage Run	2.6.1	-1
No-load Loss & Exciting Current after 1 Hour Run	2.6.1	N, -1
DGA after Power Testing	2.5.2	
Insulation Power Factor and Capacitance	2.7.1	with oil & bushings
Bushing Insulation Power Factor and Capacitance	2.7.4	
Gas Detector Operation	6.4	
Core and Clamp Insulation Resistance	2.7.3	
SFRA	2.7.2	with oil & bushings (2/+16)
Auxilliary Wiring & Functional	5	
CT Re-Test	2.7.5	
Drain Oil		
Insulation Power Factor and Capacitance	2.7.1	with bushings, without oil
SFRA	2.7.2	with bushings, without oil (2/+16)
Vacuum Test	6.3	
Final Tests prior to Shipping		Label as "Shipping Condition"
Insulation Power Factor and Capacitance	2.7.1	without bushings, without oil
Core & Clamp Power Factor and Capacitance	2.7.1	without bushings, without oil
SFRA	2.7.2	without bushings, without oil (2/+16)
Core and Clamp Insulation Resistance	2.7.3	
Dew Point	1.6.8	

Minimum Transformer Testing Requirements and Order for
66 kV - 4.16 x 12.47 kVY

4.16 kV shipping connection   ST: Series Transformer

	MH Clause	Comment
Tests prior to Vapour-Phase		
LTC Reactor (Preventive Auto) dc Resistance	2.2.1	
LTC Reactor (Preventive Auto) Magnetizing Current	2.2.4	at full magnetizing current
LTC Reactor Core and Clamp Insulation Resistance	2.7.3	
ST Ratio	2.2.3	
ST dc Resistance	2.2.1	
Core and Clamp Insulation Resistance	2.7.3	main transformer, series transformer, LTC reactor
4.16 kV connection		
dc Resistance	2.2.1	
Ratio	2.2.3	
12.47 kV connection		
dc Resistance	2.2.1	
Ratio	2.2.3	
Test after Tanking and Filling		**12.47 kV Connection**
12.47 kV connection		
DGA prior to test	2.5.2	
Oil Sample	2.5.1	Dielectric strength etc.
dc Resistance	2.2.1	
Polarity and Phase Relationship	2.2.2	
Ratio	2.2.3	
Insulation Power Factor	2.7.1	
Core and Clamp Insulation Resistance	2.7.3	
SFRA	2.7.2	with oil & bushings (2/+16)
Low-Current CT Tests	4	
No-load Loss & Exciting Current	2.2.5	N, +/-1, +/-15, +/-16 as necessary
LTC Full Voltage Operation	2.2.6	
Positive-sequence Load Loss & Impedance	2.2.7	(1,2,5)/(-16,N,+16) , 2/(+/-1, +/-15) as necessary
Full-Current CT Test	4	
LTC Full Current Operation	2.2.9	Approx rated ONAF current
Short-Circuit Sound Level	2.4.2	-15 or +15 worst case
Zero Sequence Load Loss & Impedance	2.2.10	2/(-16,N,+16) , 1/+16, 5/-16
DGA prior to Dielectrics	2.5.2	
Impulse	2.3.1	LV, LVN
3-Phase Partial Discharge	2.3.4	1/+15
DGA after Dielectrics	2.5.2	
Link Change to 4.16 kV Connection		
dc Resistance	2.2.1	
Polarity and Phase Relationship	2.2.2	
Ratio	2.2.3	
Insulation Power Factor	2.7.1	
Core and Clamp Insulation Resistance	2.7.3	
No-load Loss & Exciting Current	2.2.5	N, +/-1, +/-15, +/-16 as necessary
Open-Circuit Sound Level	2.4.1	-15 or +15 worst case
Positive-sequence Load Loss & Impedance	2.2.7	(1,2,5)/(-16,N,+16) , 2/(+/-1, +/-15) as necessary
Zero Sequence Load Loss & Impedance	2.2.10	2/(-16,N,+16) , 1/+16, 5/-16
Temperature Rise	2.2.11	5/-1 or 5/-15 or whichever worst case
DGA prior to test	2.5.2	
DGA after ONAN shutdowns	2.5.2	
DGA once ONAF oil rise levels off	2.5.2	
DGA 6 hours into 12 hour ONAF run	2.5.2	
Connection Integrity Test	2.2.8	
Thermal Scan in last hour of 12 hour run	2.2.12	
DGA 12 hours into 12 hour ONAF run	2.5.2	
DGA after ONAF shutdowns	2.5.2	
Impulse	2.3.1	HV, HVN, LV, LVN
Applied Voltage	2.3.3	HV, LV
3-Phase Partial Discharge	2.3.4	1/+15
DGA after Dielectrics	2.5.2	
No-load Loss & Exciting Current	2.6.1	N, +/-1, +/-15, +/-16 as necessary
1 Hour 110% Overvoltage Run	2.6.1	-15 or +15 worst case
No-load Loss & Exciting Current after 1 Hour Run	2.6.1	N, +/-1, +/-15, +/-16 as necessary
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REQUEST FOR PROPOSAL 040432

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS

500kV AC TRANSMISSION LINES

Type Issue Date Here **DRAFT 3**

MANITOBA HYDRO DISCLAIMER

Manitoba Hydro does not represent or warrant that any electronic files provided hereunder are usable by the recipient, are error-free, or are free of viruses or other harmful or destructive properties. Such electronic files provided hereunder, and any content/part thereof, are provided on an "as is" basis, without warranty of any kind. The entire risk as to use of and/or reliance on such electronic files is assumed by the recipient.

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NOTE: To open any supplied Word documents, your Macro Security level must be set to Medium.

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS

REQUEST FOR PROPOSAL 040432

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DEFINITIONS

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS FEBRUARY 2017
DRAFT 3

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS

REQUEST FOR PROPOSAL 040432

DEFINITIONS

“Confidential Information” means any and all information, regardless of form, format or medium, of or concerning or related to the Purchaser, the Work, etc. depending on situation, customer information, and Personal Information, which has or shall come into the possession or knowledge of the Contractor.

“Contract” means the entire agreement entered into between the Purchaser and the Contractor upon execution of the Cover Agreement for performance of the Work by the Contractor in accordance with the Contract Documents.

"Contract Administrator" the duly appointed representative of the Purchaser who shall from time to time exercise power, authority or discretion as is required under the contract.

“Contract Documents” means the Cover Agreement, Definitions, General Conditions, the General Requirements, Purchaser’s Drawings, if any, the Technical Requirements, the Contract Forms listed in the Cover Agreement, all appendices and attachments to the foregoing documents, and amendments to any of them duly executed by both the Purchaser and the Contractor.

“Contractor” shall mean the party or parties named as such in the Contract and the legal personal representatives, successors and assigns of the Contractor.

“other contractor” or **“another contractor”** shall mean any person, firm or corporation employed by or having a contract directly or indirectly with the Purchaser otherwise than through the Contractor.

“DDP” shall mean “Delivered Duty Paid” per Incoterms 2010.

“Engineer” shall mean the engineer, engineers, or firm of consulting engineers, as the case may be, appointed in writing by the Purchaser to take charge of the Work, or a designated part (including the design) thereof, acting directly or through his or their properly authorized assistants or agents.

“Equipment” means all documents, designs, computer software, computer hardware, plant, materials, apparatus, tools, components, machinery, equipment, hardware, systems and other things required for the execution and completion of the Work and the remedying of any defects, or otherwise in respect of, and involving, Contractor’s performance of obligations under the Contract.

“Inspector” shall mean the person, firm or corporation authorized by the Purchaser to inspect the Work to be done and/or material to be furnished pursuant to the Contract acting directly or through his or their properly authorized assistants or agents.

“ID#” or “ITEM” shall mean a separate and designated part of the Work to be proposed, as defined in the Form of Proposal.

“Manitoba Business” is a business which is registered to do business in the Province of Manitoba, and the firm, or its principals, maintains their facilities, equipment and staff in Manitoba on a continuous basis.

“Personal Information” has the meaning given in The Freedom of Information and Protection of Privacy Act (Manitoba) and the Personal Information Protection and Electronic Documents Act (Canada).

“plant” shall mean all vehicles, transportation equipment, construction equipment, erection and installation equipment, falsework, forms, scaffolding, cofferdams, crushers, boilers, temporary storehouses and other temporary structures, lumber, timber, materials, power tools, machinery, appliances and apparatus which are brought on or constructed upon the site by the Contractor for the performance of the Work.

"Proponent" shall mean, as the context requires, any party or parties proposing on one or more of the various classes of work covered by the Instructions to Proponents, the General Requirements, the General Conditions, and the Technical Requirements.

"Purchaser" shall mean Manitoba Hydro, its successors and assigns.

"Site" shall mean the place or places where the Work is to be carried out for the Purchaser, and the immediate vicinity of such place or places.

"subcontractor" shall mean a person, firm or corporation having a contract with the Contractor for part of the Work, including without limitation the furnishing of labour, material, equipment or apparatus therefor.

"Superintendent" shall mean the duly appointed representative of the Contractor on duty at the site.

"tools" shall mean all small hand tools, other than power 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 or by any employee of the Contractor for the performance of the Work.

"Work" or "Services" shall mean all of the various classes of work to be done, executed and performed, whether temporary or permanent, and other equipment, apparatus, machinery and materials to be furnished and supplied by the Contractor pursuant to the Contract.

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.

END OF DEFINITIONS

INSTRUCTIONS TO PROPONENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS FEBRUARY 2017
DRAFT 3

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS
REQUEST FOR PROPOSAL 040432

INSTRUCTIONS TO PROPONENTS

1 INVITATION

To be evaluated, a Proposal **must** be submitted not later than the Closing Date which is:

16:00:00 hours Manitoba local time
MARCH 8, 2017 (the "Closing Date")

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

Proposals not submitted through MERX will not be accepted.

1.1 Delivery and Receipt of Submissions

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

(a) the timely delivery of any information or documentation, including, without limitation, the RFP by MERX, in connection with this RFP;
(b) the timely receipt of any proposals, revisions, amendments, notice of withdrawals, or any other information or documentation from any Proponent or potential Proponent, or;
(c) the working order, functioning or malfunctioning, of any electronic information system (including MERX).

2 PURPOSE

Issuing this RFP, Manitoba Hydro desires to contract with an experienced Contractor for the test, design, manufacture and supply of 500kV AC Implosive Connectors.

Proponents are encouraged to review the balance of the RFP for additional information concerning Manitoba Hydro's anticipated commercial and technical needs in respect of any potential Contract.

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

By submitting a proposal, the Proponent agrees to the terms and conditions set out in this RFP.

3 GENERAL INTERPRETATION

Defined words and phrases used in this Request for Proposal have the meanings ascribed to them in the Definitions section or as expressly defined elsewhere in this Request for Proposal. Headings are used for convenience only, and they shall not affect the interpretation or meaning of the clauses, terms and conditions or the Request for Proposal or any resulting Contract.

4 ENQUIRIES

Enquiries concerning Request for Proposal 040432, including technical enquiries, should be in writing, using the Proposal Clarification Form, attached as Appendix A and addressed as follows:

ATTENTION: Mr. Marlon Watts
Purchasing Department, Manitoba Hydro
Request for Proposal 040432 - DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS
FAX: (204) 360-6130
E-mail: mwatts@hydro.mb.ca

Enquiries should be submitted not less than seven (7) calendar days prior to the Closing Date. Enquiries received after that time may not be considered or answered.

At the sole discretion of Manitoba Hydro, enquiries and any response(s) may be issued to the enquiring party only, or to all prospective Proponents. A Proponent shall not be entitled to rely on any response or interpretation received in respect of an enquiry unless that response or interpretation was provided via an addendum to the Request for Proposal.

5 PROPOSAL EVALUATION AND NEGOTIATION

5.1 General

Manitoba Hydro desires, through an evaluation and negotiation process, to determine if basis exists to award one (1) or more Contracts for performance of the Work described in this RFP.

Manitoba Hydro may select one (1) or more Proponent(s) for negotiation of a potential Contract.

Proposals submitted in respect to this RFP are for information and evaluation/negotiation/discussion purposes only.

5.2 Technical and Commercial Terms

The RFP describes the anticipated scope of work and anticipated technical and commercial needs of Manitoba Hydro. Manitoba Hydro is interested in receiving proposals that meet the technical and commercial needs outlined in this RFP.

With respect to technical needs, the Proponent may note in its proposal any technical exceptions which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative solution for addressing the matter in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

With respect to commercial needs, the Proponent may note in its proposal any commercial terms which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative wording for addressing the term(s) in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

5.3 Evaluation

Evaluation of proposals is expected to commence shortly after the Closing Date.

Manitoba Hydro reserves the right to complete or terminate evaluation of proposals at any time, or to extend the time of evaluation, without notifying Proponents.

Upon completion or termination of evaluation, Proponents may be notified that evaluation is complete.

5.4 **Presentations**

During evaluation of proposals, one (1) or more Proponents may be invited to attend at Manitoba Hydro's facilities in Winnipeg to make a presentation or participate in an interview concerning its proposal.

5.5 **Amendments/ Further Information/Clarifications**

During evaluation and negotiations, Manitoba Hydro reserves the right to request one (1) or more Proponents to:

(a) amend its proposal;
(b) provide additional, missing, and/or other information or documentation concerning its proposal; and
(c) clarify any matter(s) concerning its proposal.

In respect of any such matters, Manitoba Hydro shall have no duty or obligation to advise any other Proponent of any of the same, or to request them to vary their proposal as a result of any of the same.

5.6 **Negotiation Process**

Upon completion or termination of evaluation of proposals, Manitoba Hydro may select one (1) or more Proponents for negotiation of a Contract(s).

Manitoba Hydro will notify a Proponent if it has been selected for negotiations.

Manitoba Hydro reserves the right to terminate negotiations at any time.

Proponents are advised that Manitoba Hydro may conduct any negotiation through an intensive process. Such process may require a Proponent to make representative(s), who have sufficient decision-making authority, available for telephone, video-conference, and/or in person negotiating sessions.

5.7 **Requirement for Contract**

Until the execution of a Contract between Manitoba Hydro and a Proponent, there shall be no legal or other binding obligations created on the part of either party with respect to a Contract, the Work, or any matters related to the Work.

5.8 **Manitoba Hydro Privilege/Discretion**

Manitoba Hydro makes no representation or warranty that responding to this RFP will result in any negotiations or any Contract. Manitoba Hydro is under no obligation to evaluate any proposal, enter into any negotiations, or to award a Contract, with any Proponent or other person.

Manitoba Hydro reserves the right to cancel this RFP either before or after the Closing Date and regardless of whether or not any proposals have been received for any reason whatsoever.

Manitoba Hydro reserves the right to re-issue or tender all or any part of the work and services contemplated in this RFP at any time, including after the Closing Date, for any reason whatsoever.

Manitoba Hydro reserves the right to accept, waive or reject any non-compliance or irregularity, including without limitation, the right to accept, waive, or reject non-compliance or irregularity with respect to the requirements of the Instructions to Proponents and/or the submission requirements of this RFP.

Notwithstanding anything to the contrary in this RFP, Manitoba Hydro reserves the right to:

(a) negotiate any or all terms and conditions of a Contract with any one (1) or more Proponents, but not necessarily all Proponents, and to do so serially or concurrently and at any time;
(b) negotiate and enter into a Contract on terms and conditions different than those contained in the RFP and/or any Proposal;
(c) choose not to enter into negotiations with any one (1) or more Proponents;
(d) terminate negotiations with any one (1) or more Proponents at any time;
(e) choose not to award any Contract to any Proponent;
(f) terminate this procurement process at any time for any reason;
(g) choose to not offer the same or substantially the same or comparable terms and conditions of a proposed Contract to more than one (1) Proponent with which Manitoba Hydro may conduct negotiations; and
(h) enter into separate Contracts for different or identical portions of the Work, with any one (1) or more Proponents.

6 ADDENDA

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

7 FORM OF PROPOSAL

The Proponent is requested to use the Form of Proposal attached hereto. If any Form of Proposal page is found to have insufficient space, the Proponent is requested to attach a sheet or sheets immediately after such page.

The Proponent is encouraged to include in their proposal thorough and sufficient information concerning matters under consideration.

8 SCHEDULE OF RFP ACTIVITIES

The schedule of activities concerning this RFP includes the following:

Description	Date
Closing Date for submission of proposals	As per subsection 1.1 of these INSTRUCTIONS TO PROPONENTS
Complete Evaluation of Proposals	March 9, 2017
Negotiations with Selected Proponent	March 23, 2017
Award of Contract	March 31, 2017

Manitoba Hydro may change the said schedule and dates and information without notice (including without notice to any actual or potential Proponent(s)) at any time including before and after the Closing Date of this RFP.

9 SIGNING OF PROPOSALS

A proposal submitted by:

(a) an individual shall be signed by the individual in the presence of a subscribing witness;
(b) a corporation shall be signed by the properly authorized signing officer or officers and the corporate seal affixed or by the properly authorized signing officer or officers in the presence of a subscribing witness or witnesses; or,
(c) a partnership or joint venture shall be signed by all partners or joint venturers in the presence of a subscribing witness or witnesses.

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. Each signature shall be accompanied by a printed name.

10 JOINT VENTURES/CONSORTIA

Proponents which are comprised of more than one legal entity, such as a joint venture or consortium of corporations, are to identify their duly appointed leader in the proposal.

Proponents are to execute the 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.

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 Contract awarded.

A copy of a written agreement binding the legal entities involved in each proposal shall be provided to Manitoba Hydro upon request. If no such writing exists at the time of request, it may be necessary for such entities to document their arrangement to fulfill such requirement at any time, including after the time and date of closing for receipt of proposals and before or after an award of a Contract.

Where a Proponent is or includes a First Nation Band, the proposal shall be accompanied by a Band Council Resolution authorizing the provision of the proposal on behalf of the First Nation Band.

11 AMENDMENT OF PROPOSAL

A Proponent may amend its submitted Proposal on MERX at any time prior to the Closing Date. A Proponent may not amend its Proposal after the Closing Date except at the written request of Manitoba Hydro.

In order to advance toward a formal and binding contract during negotiations, Manitoba Hydro may issue a written request to the Preferred Proponent(s) for specific amendment(s) to its Proposal, and if the Proponent finds the request satisfactory, shall provide the requested amendment(s) via fax or letter.

All amendments must be signed by the person or persons having the authority to bind the Proponent.

Manitoba Hydro shall consider each Proponent's Proposal to be the Proponent's best position for entering into negotiations and for seeking award of a contract to perform the Work.

12 WITHDRAWAL OF PROPOSAL

At any time throughout the procurement process prior to execution of an agreement, a Proponent may revoke and withdraw a submitted Proposal by either removing the Proposal from MERX, if withdrawal is prior to the Closing Date, or by providing written notice to Manitoba Hydro via FAX or letter, if withdrawal is after the Closing Date.

Written notice of withdrawal of a Proposal must be duly signed by the authorized representative of the Proponent.

Manitoba Hydro is under no obligation to return withdrawn Proposals.

13 LANGUAGE

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

14 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 a proposal, satisfactory to Manitoba Hydro, that the Proponent has the ability, experience, capital and plant required to undertake and perform the Work successfully, and complete it within the time specified.

Manitoba Hydro may inspect any Plant and /or facilities that the Proponent proposes to use for doing the Work.

15 ESTIMATED QUANTITIES

Any quantities stated in the Request for Proposal or Form of Proposal are estimates only. Manitoba Hydro makes no guarantee with respect to any of same.

16 UNBALANCED PROPOSALS

Unbalanced unit prices or lump sum prices proposed may not be considered by Manitoba Hydro.

17 PROPONENT'S EXPENSES

The Proponent shall be responsible for all expenses concerning or related to the preparation of its proposal, including any subsequent discussions and/or negotiations.

18 PROPOSED PRICES

Proposed prices shall be stated in Canadian currency and shall include all customs duties, surcharges, insurance premiums, permit and licence fees, Workers Compensation and vacation pay assessments, and all other payroll benefits. Canadian Goods and Services Tax (GST) and Manitoba provincial retail sales tax

(PST) shall be treated as specified in the Form of Proposal for each ITEM. All other applicable taxes shall be included and shall not be subject to any adjustment. No payment shall be made to the Contractor for sales tax (if any) which may be imposed by Canada or Manitoba in respect of the Contractor's plant, tools and any other items not included in the Work.

Prices in the accepted proposal, if any, shall be firm and not subject to adjustment for changes or unexpected contingencies of any kind whatsoever, including without restricting the generality of the foregoing, changes in wages, material costs, or taxes which may in future be imposed by lawful authority within or outside of Canada.

19 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 Business.

20 CORRUPT OR FRAUDULENT PRACTICES

Manitoba Hydro has the right at any time to reject any Proposal submitted by a Proponent or terminate negotiations with a Proponent if, in Manitoba Hydro's determination, the Proponent has engaged in any Corrupt, Fraudulent, Collusive, Coercive or Obstructive Practice or has breached any laws regarding corruption or fraud. For these purposes the following defined terms shall apply:

(a) **"Coercive Practice"** means impairing or harming, or threatening to impair or harm, directly or indirectly, persons or their property to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(b) **"Collusive Practice"** means an arrangement between two or more persons (including, without limitation, a Proponent and any other person) designed to achieve an improper purpose, including but not limited to the establishment of prices for the Work at artificial, non-competitive levels in the procurement process or in entering of the Contract.

(c) **"Corrupt Practice"** means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(d) **"Fraudulent Practice"** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, Manitoba Hydro, a Proponent, or any other person, to obtain a financial or other benefit or to avoid an obligation in the procurement process, or in the negotiation and signing of the Contract.

21 EVALUATION CRITERIA

In order to determine best value to Manitoba Hydro, proposals received will be evaluated using the following criteria (in no particular order of preference):

(a) Total evaluated cost (includes unit prices, transportation costs, Purchaser's cost to inspect manufacturing facilities and type testing)
(b) Technical compliance of the proposal (absence of deviations from the Technical Requirements of this RFP);
(c) Commercial compliance (absence of deviations from the commercial terms and conditions of this RFP);
(d) Delivery Dates (includes production schedule and available production capacity)
(e) Demonstrated track record and previous experience;

All things being reasonably equal, the following additional criteria will be considered in the evaluation:

(f) Manitoba content

For the purposes of evaluation, Manitoba Hydro may take into account any or all of the information received from a Proponent under or pursuant to the RFP, Manitoba Hydro's knowledge of, and past experience with, the Proponent (including Proponent's performance on previous contracts with Manitoba Hydro, if any), and any information about the Proponent received from third parties and deemed reliable by Manitoba Hydro.

22 WAIVER

By submitting a proposal, the Proponent acknowledges Manitoba Hydro's rights under Request for Proposal 040432 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.

END OF INSTRUCTIONS TO PROPONENTS

GENERAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS FEBRUARY 2017
DRAFT 3

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS
REQUEST FOR PROPOSAL 040432

GENERAL REQUIREMENTS

1 SCOPE OF THE WORK

The Work shall consist in all that is required for the supply and delivery of implosive connectors consisting of but not limited to, the following ITEMS:

(a) Full-tension mid-span conductor splice connections,
(b) Full-tension conductor terminations for securing conductor to a support structure, and
(c) Partial tension conductor terminations for conductor jumpers.

Descriptions of ITEMS of the Work listed above are provided as a general overview. A detailed scope and requirements of the Work are provided in the Technical Requirements. The Work and any ITEM forming part of the Work shall also, in all respects, comply with the terms and conditions of the Contract.

2 DELIVERY DATE

The Purchaser expects that all ITEMs of the Work shall be delivered by **October 31, 2017**

In carrying out the Work, the Contractor shall have reasonable latitude to organize the sequence of the Work, provided that the various stages of the Work are completed by the specified date(s) or the date(s) proposed by the Contractor and accepted by the Purchaser.

3 DELIVERY POINT(S)

If the Purchaser chooses delivery by the Contractor, the ITEMS of the Work shall be delivered to:

Gate 6
59029 Hwy 207
Dugald, Manitoba

Prior to dispatching implosive devices, the Contractor must inform the Manitoba Hydro magazine keeper about incoming load. The Contractor must receive confirmation that the load will be received upon delivery.

When the implosive devices are to be shipped to a construction site, arrangements may be made with Manitoba Hydro for direct delivery with special coordination for proper storage.

Anyone who offers for transport, transports, or handles implosive sleeves, detonators, or shock tubing must hold a valid Transportation of Dangerous Goods certificate.

4 DELIVERY OR LOADING OF THE WORK

4.1 Delivery of the Work

If the Purchaser chooses delivery of the Work by the Contractor, the Contractor shall prepare the Work for shipment in such a manner as to protect the Work from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation, loading, shipping, transporting, unloading, handling, or lifting. The Contractor shall be responsible for verifying the carrier's right-of-way clearances and weight limitations, if any, and for making all shipping arrangements.

The Contractor shall:

(a) Have a valid Transportation of Dangerous Good (TDG) Certificate.

(b) Give notice to the Purchaser about the type and quantity of the explosives being dispatched. The Contractor shall not dispatch the load before receiving confirmation that the Purchaser is prepared to receive the load.

(c) Ensure that the explosives are shipped in appropriate means of containment (original packaging) and the TDG safety marks are placed on the containers with the implosive devices.

(d) Ensure legal and proper documentation and transfer of the shipment. The load of explosives cannot be left unattended at the receiving site.

4.2 Loading of the Work

If the Purchaser chooses to have the Work loaded, blocked, braced and secured by the Contractor at the Contractor's shipping facility or factory for transportation by the Purchaser or the Purchaser's designated carrier to the final destination, the Contractor shall prepare the Work for shipment in such a manner as to protect it from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation and loading.

5 WORK SAFETY

The Contractor shall comply with all laws, regulations and bylaws relating to the Work, duly enacted by federal, provincial and municipal authorities. The Contractor shall ensure all handling and transportation occur in accordance with:

(a) The Explosives Act (Canada), and
(b) Transportation of Dangerous Goods Regulations.

In addition, the Contractor shall comply with those rules/guidelines/policies set forth by the Purchaser.

6 FOREIGN NATIONALS WORKING IN CANADA

The following provisions apply to all workers employed by the Contractor or under the Contractor's control or for whom the Contractor is otherwise responsible under the Contract, who are NOT citizens of Canada or 'permanent residents' of Canada (as defined in the Immigration and Refugee Protection Act). Such persons are defined, collectively, in the Immigration and Refugee Protection Act as 'foreign nationals', which term is used below and has the same meaning.

The Contractor shall ensure that all workers who are foreign nationals and who perform services under the Contract in Canada are legally authorized to work in Canada. The Contractor shall obtain and maintain all necessary work permits, visas and documentation for such foreign nationals, and shall comply with all conditions imposed on the Contractor, as 'employer' of the foreign nationals, under the Immigration and Refugee Protection Act and regulations.

Before permitting any foreign nationals to perform services under the Contract in Canada, the Contractor shall, by notice in writing to the Engineer,

(a) list all such foreign nationals by name;
(b) certify that the said foreign nationals are legally authorized to perform services under the Contract in Canada; and
(c) provide copies of their respective work permits, and visas or other documentation if applicable.

Furthermore, the Contractor shall provide copies of work permit or visa renewals to the Engineer if applicable, so that at no time is any foreign national performing services under the Contract in Canada without the requisite legal authority.

7 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, R.S.M. 1987, c. W200.

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 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.

END OF GENERAL REQUIREMENTS

GENERAL CONDITIONS

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS FEBRUARY 2017
DRAFT 3

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS

REQUEST FOR PROPOSAL 040432

GENERAL CONDITIONS

1 INTENT

1.1 The Work

The Contractor shall fully and completely fulfill its obligations in respect of the Contract, and shall fully and completely perform the Work in every detail and within the timeframe(s) required, all in accordance with the Contract. The Contractor shall do or cause to be done and shall furnish any and everything necessary for such purposes all in accordance with the Contract.

The Contractor shall carry out the Work, and the performance and execution of the Work:

(a) in accordance with the Contract;
(b) in the manner (if any) specified in the Contract;
(c) in a good and workmanlike manner;
(d) using new materials that are free of defects and are of the specified quality, if specified, otherwise of suitable quality as determined by the Engineer; and
(e) with properly equipped facilities and non-hazardous materials, except as otherwise specified in the Contract.

1.2 Application to Engineer

The Contractor shall apply to the Engineer for any explanation which the Contractor may require as to the meaning and intent of any provision in the Contract or in any document forming part thereof, and the Contractor shall be liable for any loss, damage or expense which the Purchaser may incur, suffer or be put to as a result of the Contractor's failure to obtain such explanation.

1.3 Interpretation

Defined words and phrases used in the Contract have the meanings ascribed to them in the Definitions forming a part of this Request for Proposal, or as expressly defined elsewhere in the Contract. Headings are used for convenience only and do not affect the interpretation or meaning of the Contract.

2 CORRUPTION AND FRAUD

The Contractor declares and undertakes in relation to the Contract that it:

(a) has not acted and will not act unfairly or dishonestly so as to cause loss to the Purchaser or deprive the Purchaser of its rights;
(b) has not offered, given, demanded or accepted any bribe or other improper benefit or advantage to any person and will not do so;
(c) has not provided false, inaccurate or misleading information to any person and will not do so;
(d) has not authorized, acquiesced or turned a blind eye to any form of corruption and will not do so;
(e) did not collaborate, directly or indirectly, with any person in competition for this or other contracts with the Purchaser during the procurement process;
(f) will not, in respect of any design services to be provided under the Contract, deliberately, knowingly, with willful blindness or recklessness, provide or approve a design which will provide an improper benefit or advantage to any person or which is in excess of the Purchaser's requirements and has not been fully disclosed and approved by the Purchaser;
(g) will not deliberately, knowingly or with willful blindness or recklessness, carry out, instruct, authorize, condone or be a party to provision of work, materials, equipment or services not of a quality and quantity required under the Contract; or
(h) will not conceal defective work, material, equipment or services.

3 AUTHORITY OF THE ENGINEER

3.1 No Authority to Amend Contract

The Engineer has no authority to amend the Contract.

3.2 Exercise of Authority

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:

(a) whenever carrying out duties or exercising authority, express 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.

3.3 Replacement

The Purchaser may, with notice to the Contractor, replace the Engineer.

3.4 Giving Effect

The Contractor and the Purchaser shall give effect to each determination of the Engineer unless and until revised pursuant to the ARBITRATION Section of the General Conditions.

4 CLARIFICATIONS AND CHANGES TO THE WORK

4.1 General

There will be four (4) mechanisms for clarifying 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	Contractor / Engineer	Clarification to the Work
Extra Work Order (EWO)	Purchaser	Approves change to the Work, related to the Contract Scope
Amending Agreement	Purchaser	Approves change to the Work, not related to the Contract Scope or Amends Terms of the Contract

Each of these mechanisms are described in this Section of the General Conditions.

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 or an Extra Work 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.

4.2 Clarifications to the Work

4.2.1 Work Instructions

Work Instructions are instructions and clarifications issued by the Engineer using the Work Instruction form set out in Appendix B: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 may be issued in response to a Request for Information from the Contractor or may be issued at the initiative of the Purchaser or Engineer.

Work Instructions are enforceable clarifications or refinements of the Contract, not amendments thereto.

Upon receipt of a Work Instruction, the Contractor shall promptly proceed with the Work as clarified therein.

The Contractor is not entitled to additional compensation or to changes in the time for performance of the Work as a result of the issuance of a Work Instruction.

4.2.2 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 28 days, the recipient will notify the requestor in writing.

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 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 28 days or notify the requestor of a required extension to the response period.

4.3 **Changes to the Work**

The Purchaser shall have the right, without notice to sureties on any bond, and without invalidating the Contract, 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, including additions, deductions, alterations and extras.

Such changes must in all cases be in writing signed by the Purchaser titled “Extra Work Order” and issued by the Engineer to the Contractor.

Upon receipt of a written Extra Work Order from the Engineer, the Contractor shall promptly proceed with the changes in the Work.

Adjustments to the Contract Price as a result of the changes directed by the Engineer in an Extra Work Order shall be determined in accordance with the PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK Section of these General Conditions.

4.3.1 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work.

When initiated by the Engineer, the Proposal for Extra Work is a formal request for quotation for additional work required. The Contractor’s responding quotation 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. The quoted price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

When initiated by the Contractor, the Proposal for Extra Work is a formal proposal for an alternate to the Work. The proposed price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

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 14 days, the requesting party shall be notified in writing.

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 14 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 quotation, 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. The Proposal for Extra Work may be accepted by the Purchaser providing written notice to the Contractor in the form of an Extra Work Order issued by the Engineer.

When the Contractor initiates a Proposal for Extra Work, the proposal shall be valid for a period of 14 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 issued by the Engineer.

4.3.2 Extra Work Orders

Extra Work Orders are formal approval of changes to the Work by the Purchaser where the change is related to or within the original Contract scope of the Work. The Purchaser through the Engineer may issue a written Extra Work Order using the Extra Work Order set out in Appendix B: Manitoba Hydro Forms for Clarification and Changes to the Work.

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 the Proposal for Extra Work Subsection of these General Conditions or the preceding sentence, if the Purchaser requires the Contractor to proceed with a change in the Work 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.

4.4 Contract Amendments

No amendment to any other terms or conditions of the Contract, other than those recognized to be made by Extra Work Order as provided in the Contract, shall be made unless first approved and authorized in writing by both the Purchaser and the Contractor. Such amendments shall be documented in an amending agreement signed by both parties.

5 PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK

The method for pricing and payment of all adjustments to the Contract Price due to changes to the Work by virtue of Extra Work Order pursuant to the CLARIFICATION AND CHANGES TO THE WORK Section of these General Conditions or pursuant to the CONTRACTOR CLAIMS Section of these General Conditions (hereinafter “Claims”), shall be as follows unless otherwise agreed to between the Purchaser and the Contractor.

5.1 **Additions to the Work or Claims**

5.1.1 Lump Sum

Where the Engineer has directed that an addition to the Work or Claim be dealt with by lump sum, the Contractor shall prepare and submit to the Engineer a detailed quoted lump sum cost of the requested addition or Claim. The quote shall not include any mark-up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The quoted lump sum cost shall include the following details as a minimum:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing cost
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

In respect of travel, airfare shall be limited to economy class, receipts shall be required.

(the “Quoted Cost”).

The Quoted Cost shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Quoted Cost was not accepted. Within the next 5 days, the Contractor will be entitled to submit a revised Quoted Cost.

Following such five (5) day period, the Engineer may either:

i) accept the latest Quoted Cost of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,

ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Quoted Cost of the addition or Claim as documented by issuance of an Extra Work Order;

5.2 **Deductions from the Work**

5.2.1 Credit for Deduction from the Work

Where a deduction from the Work is proposed by the Purchaser through issuance by the Engineer of a Proposal for Extra Work to the Contractor setting out such deduction, the Contractor shall prepare and submit to the Engineer a detailed quoted credit for the requested deduction. The quoted credit shall represent the cost to the Contractor to perform the Work to be deducted and shall not include any mark up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The Contractor shall submit a detailed breakdown of the proposed credit and at a minimum include the following:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing hours and rates for specific processes
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

(the "Deduction Credit")

The Deduction Credit shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Deduction Credit was not accepted. Within the next five (5) days, the Contractor will be entitled to submit a revised Deduction Credit.

Following such 5 day period, the Engineer may either:

i) accept the latest Deduction Credit of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,
ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Deduction Credit as documented by issuance of an Extra Work Order.

6 CONTRACTOR CLAIMS

6.1 Notice of Intent to Claim

If the Contractor determines it is entitled to additional costs to perform the Work 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work 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 Contract Price or to any adjustment to the Contract Schedule, and the Purchaser shall be discharged from all liability in connection with the claim.

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.

6.2 Claim Documentation

Within 21 days after the Contractor has given written Notice of Intent to Claim in accordance with the Notice of Intent to Claim Section of these General Conditions, 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;
(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 request.

All subsequent communications with the Engineer respecting a claim or potential 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 of the General Conditions, each party shall take reasonable steps to mitigate its losses.

6.3 Determination of Claim

The Engineer shall proceed in accordance with this Section of the General Conditions to determine:

i) the extension (if any) of the time for completion of the Work in accordance with the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of these General Conditions; and,

ii) the adjustment (if any) to the Contract Price to which the Contractor is entitled to pursuant to the Contract.

Whenever a provision of the Contract provides that the Engineer shall proceed in accordance with this Subsection 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 Subsection, 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 a fair 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 extension of time or an adjustment to the Contract Price, or both, are warranted in the opinion of the Engineer, the Engineer shall document such changes in an Extra Work Order. 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 the ARBITRATION Section of these General Conditions.

For any claims made in accordance with this Section 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 the ARBITRATION Section of the General Conditions.

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 this Section of these General Conditions.

The Contractor shall not delay or hold up performance of the Work during resolution of a claim pursuant to this Section or originating pursuant to the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of the General Conditions or during referral of any such claim to arbitration as permitted above.

7 REQUESTS FOR EXTENSIONS OF TIME

The Contractor shall be entitled, subject to the CONTRACTOR CLAIMS Section of the General Conditions, to an extension of time for completion of the Work if completion of the whole of the Work is or will be delayed by any of the following causes:

(a) legal strikes or walkouts;
(b) any peril insured against pursuant to the INSURANCE Section of the General Conditions;
(c) unpreventable accident;
(d) terrorism, war or delay caused by war;
(e) vandalism or malicious mischief not reasonably preventable by the Contractor;
(f) riot or civil commotion;
(g) acts of God;
(h) lawful orders of civil or military authorities; or
(i) a cause of delay giving an entitlement to extension of time 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 Subsection 9.1 Notice of Intent to Claim of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c), (d), (e), (f), (g), (h), and (i) above resulted in a delay to the completion of the Work; and,
ii) 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.

Other than as stated in this section and the PURCHASER CAUSED DELAY Section of the General Conditions, 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.

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.

8 PURCHASER CAUSED DELAY

If the Contractor suffers delay and/or incurs additional costs in relation to the Work as a result of:

(a) an Extra Work Order issued by the Engineer without the agreement or in absence of the agreement of the Contractor;
(b) negligence or default on the part of the Purchaser;
(c) negligence or default on the part of another contractor for whom the Purchaser is responsible; or
(d) deviation from the Contract or temporary suspension of the Work by direction of the Engineer;

then the Contractor shall give notice to the Engineer in accordance with the Notice of Intent to Claim Subsection of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c) and (d), 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;
ii) 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,
iii) the resulting adjustment, if any, to the Contract Price for the substantiated amount of resulting additional costs to the Contractor.

9 SCHEDULE OF THE WORK

The Contractor shall submit to the Engineer within 20 working days of the effective date of the Contract, a time chart or schedule containing all or such part of the following information as the Engineer requires:

(a) the scheduled date of completion of design and submission of working drawings to the Engineer for approval;
(b) the scheduled date of start and completion of type test
(c) the scheduled date of completion of all orders for material required for the Work;
(d) the scheduled date of completion of manufacture, fabrication and/or assembly of the Work;
(e) the scheduled date of completion of delivery of the Work (and where applicable, unit sections thereof) to the site; and
(f) such other information as is requested in writing by the Engineer.

The Contractor shall also submit reports on the progress of the Work to the Engineer containing such detailed information as the Engineer from time to time requires on the design, material, manufacture, fabrication, assembly, shipment and delivery of the Work. The Contractor shall grant authorized representatives of the Purchaser and Inspector access to the Contractor's factory and to the factory or factories of all subcontractors, during the Contractor's or subcontractor's normal business hours, to enable such representatives to ascertain the state of the Work and the progress being made thereon by the Contractor or subcontractor.

10 LANGUAGE, DIMENSIONS AND WEIGHTS

All communication, including without limitation all notices, documents, notes on drawings, and submissions, required or permitted under the Contract, shall be in English.

Any Work shall be executed in the SI (Metric) System of Units except for bolts and nuts. Dimensions shall be shown in metres and millimetres and weights shall be shown in kilograms and metric tonnes.

11 SUBCONTRACTS

The Contractor shall not, without the prior approval in writing of the Purchaser, assign the Contract, nor make a subcontract with any person, firm or corporation for the execution of any portion of the Work, other than for materials or for any part of the Work for which the manufacturer or supplier is named in the Contract. If the Contractor wishes to sublet any part of the Work, the Contractor shall first submit to the Purchaser for approval, a description of the part of the Work which the Contractor wishes to sublet and the name or names of the subcontractor or subcontractors it wishes to employ. Any approval given by the Purchaser as provided for in the immediate preceding sentence shall not relieve the Contractor from any obligation or liability for the full and complete performance of the Work, all in accordance with the Contract.

If the Purchaser gives its approval thereto in writing, and the Contractor enters into one or more subcontracts, 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.

All work done by a subcontractor shall, for the purposes of the Contract, be deemed to be done by the Contractor and payment therefore 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 therefore. 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.

If the Purchaser so requests, the Contractor shall furnish the Purchaser with duplicate copies of all orders placed by the Contractor with subcontractors.

12 COOPERATION BETWEEN CONTRACTORS

The Contractor shall cooperate with all other contractors who may be performing Work on behalf of the Purchaser, and with the workers who may be employed by the Purchaser on any work at/in the vicinity of the Site. 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 materials and equipment of the Purchaser or of other contractors.

13 INSURANCE

The Contractor shall provide, maintain and pay for the insurance coverage listed below. The Contractor shall supply the Purchaser with a certified copy of the required policy of insurance and all renewals thereof. A Certificate of Insurance may be submitted in place of the policy provided that all terms and conditions of required coverage are specified therein. All documentation must be submitted to the Purchaser prior to the commencement of the Work or delivery of goods or services.

The policy shall be endorsed to provide the Purchaser with not less than 30 days' written notice in advance of cancellation, change or amendment restricting coverage, and to show the Purchaser as an Additional Insured.

The Contractor shall be responsible for any deductible amounts under the policy except where such amounts may be excluded from the Contractor's responsibility. Should a loss be sustained, the Contractor shall act on behalf of both the Purchaser and the Contractor for the purpose of adjusting the amount of loss with the insurance companies.

13.1 General Liability Insurance

General Liability Insurance, shall provide limits of not less than $2 000 000 (CAD) inclusive, per occurrence, for bodily injury, death, and damage to property including loss of use thereof.

The General Liability Insurance shall include insurance coverage for the following:

(a) Premises Property and Operations
(b) Products and Completed Operations
(c) Blanket Contractual Liability
(d) Cross Liability
(e) Non-owned Automobile Liability
(f) Occurrence Property Damage
(g) The Purchaser named as Additional Insured

14 IMPORTS

The Contractor shall be the importer of all non-Canadian goods and services.

15 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 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.

16 MATERIALS AND LABOUR

Unless otherwise specified in the contract, the Contractor shall furnish all material and shall perform all labour necessary for the due and proper design, manufacture, fabrication, completion and delivery of the Work.

All work done and materials supplied pursuant to the contract shall be of specified quality, if specified, otherwise of suitable quality as determined by the Engineer.

17 INVOICES

The invoices to be submitted by the Contractor shall be satisfactory to the Purchaser in both form and content. The Contractor shall also provide supporting documents and receipts if requested by the Purchaser.

18 RECORDS

The Contractor shall:

(a) keep full and detailed records, books, accounts, correspondence, instructions, drawings, receipts, vouchers, memoranda, and records of labour force, plant, tools, equipment, hours worked, rates required to properly appraise the progress of the Work, (herein "records"), necessary for the proper administration of the Contract and the Work.

(b) provide the Engineer and/or the Purchaser with copies of any records when requested, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(c) provide the Engineer and/or the Purchaser with reasonable access to any premises and to inspect and/or audit records, and permit copies to be made of same, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(d) preserve records for a period of not less than three (3) years from the date of the Completion Certificate.

19 CONFLICTS

For the entire duration of the Contract, the Contractor and its agents shall not provide equipment or services to any other person(s) in a manner which conflicts with the Contract.

20 CONFIDENTIALITY

The Contractor shall keep the Confidential Information confidential, using no less a standard than measures the Contractor uses to keep its own highly confidential information secret, but in any event not less than a reasonable standard of care.

Confidential Information may only be used by the Contractor for providing Services to the Purchaser and for no other purpose whatsoever.

The Contractor shall not, without the prior written consent of the Purchaser, disclose or otherwise make available any Confidential Information to any other Person, except to such directors, officers, and employees of the Contractor who have a need to access Confidential Information to perform their obligations to the Contractor for Hydro. The Contractor shall be responsible for any breach of the terms of this Section by it or any such Person.

The Contractor shall deliver Confidential Information to the Purchaser immediately on demand from the Purchaser and, on demand from Hydro, certify in writing to Hydro within ten (10) days of such demand that Confidential Information has been erased or destroyed.

The Contractor acknowledges that any failure to comply with the provisions of this Section hereof, shall cause irreparable harm to Hydro which cannot be adequately compensated for in damages, and accordingly acknowledges that Hydro shall be entitled, in addition to any other remedies available to it, interlocutory and permanent injunction relief to restrain any anticipated, present, or continuing breach of this Contract.

The Contractor's obligations pursuant to this Section hereof shall continue without limitation of time.

The Contractor shall

(a) have in place and utilize systems, media, policies, and procedures, for the storage of, security for, access to, handling of, transfer of, and destruction of, Personal Information that would satisfy the requirements of: (i) The Freedom of Information and Protection of Privacy Act (Manitoba) as if that Act applies to Contractor; and (ii) the Personal Information Protection and Electronic Documents Act (Canada) requirements for protection of Personal Information; and conform to ISO 27000;

(b) secure Personal Information against unauthorized and accidental access, disclosure or attack.

21 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 the type/sample/routine 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, at the Contractor's expense, 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 the USE OF FAULTY OR DEFECTIVE WORK Section of the General Conditions.

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. The Contractor shall be liable for all 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 invoice therefore certified correct by the Purchaser. The Purchaser may, at the Purchaser's option, apply moneys due or to become due from the Purchaser to the Contractor in or towards payment of such costs, charges and expenses, in which event the Contractor shall remain liable for any deficiency.

22 USE OF FAULTY OR DEFECTIVE WORK

Until all faulty or defective work has been made good or altered as provided by the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions, the Purchaser shall have the right to use any such faulty or defective work at the Contractor's sole risk, and without thereby in any way affecting the Purchaser's rights under the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions 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.

23 CONTRACTOR'S LIABILITY

23.1 The Work

Unless otherwise specifically provided in the Contract, the Work shall be and remain at the risk of the Contractor and the Contractor shall make good loss thereof or damage thereto occurring between the effective date of the Contract and the date of the COMPLETION CERTIFICATE issued in respect thereof, or the date of final payment, whichever shall first occur.

23.2 Labour and Materials

The Contractor 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.

23.3 Injury to Persons or Property

If, at any time after the effective date of the Contract and before the date of the COMPLETION CERTIFICATE, or if at any time thereafter while the Contractor, its officers, servants, agents, employees or subcontractors are on the site for the purpose of making good any breakage, defect or failure in the Work pursuant to the WARRANTY Section of the General Conditions, there shall occur any injury (including loss of life), loss or damage to any person or property, other than property forming part of the Work, caused by or resulting from defective plant, material, workmanship, fabrication, or construction or by anything done, or omitted to be done, or permitted to be done by the Contractor, its officers, servants, agents, employees or subcontractors (but not otherwise), then the Contractor shall 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 by any person, firm or corporation for, or by reason, or on account of such injury, loss or damage, or anything relating thereto.

24 INTELLECTUAL PROPERTY

Drawings, reports, manuals, documents, and other and/or similar materials (herein “Drawings”) produced/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 Drawings shall remain with the Contractor. The Contractor shall grant the Purchaser a perpetual, royalty free, non-transferable (save and except transferable to the Purchaser’s affiliates or transferable to any entity created after the effective date of the Contract and to which the Purchaser assets are assigned or otherwise transferred) limited licence to use, copy, and to allow third parties to use, the Drawings and all proprietary information in the Drawings as may be required for the purpose of proposing, installing, operating, repairing, maintaining, modifying, replacing and/or upgrading the Work, or any part thereof.

25 PAYMENTS BY THE CONTRACTOR

The Contractor shall promptly pay all assessments, premiums, levies, taxes, permit and licence fees and shall promptly pay for all materials, labour, and services obtained or required by the Contractor in the execution of the Contract. If the Contractor fails to pay the same, or unduly delays payment, the Purchaser may, at the Purchaser’s option, make such payment or payments for and on behalf of the Contractor, and thereafter the Contractor shall on demand, pay the Purchaser an amount equal to the aggregate of all the sums so paid by the Purchaser, plus interest on the sums so paid at an interest rate equal to the Prime Rate of interest charged by the Purchaser’s bank plus 3% per annum calculated from the date of payment by the Purchaser to the date when moneys are next due and payable by the Purchaser to the Contractor under the Contract, plus the sum of $10.00 (CAD) as a service charge in respect of each cheque issued by the Purchaser for or on behalf of the Contractor pursuant to this Section of the General Conditions, or the Purchaser may, at its option, deduct the aforesaid sums, interest and service charge from any moneys due or to become due to the Contractor from the Purchaser, provided that no payment by the Purchaser as aforesaid shall be held to relieve the Contractor from the Contractor's liabilities and obligations under the Contract.

The Contractor shall keep a record of the pro rata share of accrued interest on holdbacks due all subcontractors.

26 WARRANTY

If, within 24 months from the date when the Work has been accepted by the Purchaser, the Work or any part thereof becomes broken or defective or fails due to faulty or improper design, material, workmanship, manufacture, fabrication, shipment or delivery, or fails to meet the requirements of the contract, then the Contractor, upon notification in writing from the Purchaser, shall forthwith make good every such breakage, defect or failure without cost (including without limitation, transportation costs to and from the place where the Work was delivered) to the Purchaser.

If, after such notification, 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 all costs, charges and expenses incurred by the Purchaser in connection therewith and shall forthwith pay to the Purchaser an amount equal to such costs, charges and expenses upon receipt of invoices therefore certified correct by the Purchaser.

The Contractor's liability under this Section of the General Conditions shall be in lieu of any warranty or condition implied by law as to the quality, design or fitness of the Work for any particular purpose, and save as in this Section of the General Conditions expressed the Contractor shall not be liable for defects in any work after the Work has been taken over by the Purchaser or for any injury or damage resulting from any such defects.

Provided the Contractor is not otherwise in default under the terms of the contract, and subject to the provisions of the CONTRACTOR'S LIABILITY and RESPONSIBILITY AS TO PATENTS Sections of the General Conditions, the Contractor's liability in respect of the Work, whether in contract, tort or otherwise, shall cease upon the fulfilment by the Contractor of the Contractor's obligations under this Section of the General Conditions; provided further that any part of the Work made good under this Section of the General Conditions shall be subject to all provisions of this Section of the General Conditions for a further period of 24 months from the date when the same has been made good as aforesaid.

Where more than one unit section of equipment is included in the Work, the said period of 24 months shall be deemed to commence when each unit section of the Work has been taken over by the Purchaser.

27 INSPECTION AND TESTING

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 or Inspector. Any special tests which the Purchaser requires are set forth in Request for Proposal 040314. The Contractor shall co-operate with the Engineer or Inspector and shall make available every facility which the Contractor possesses for inspecting and testing.

All work, materials and equipment condemned by the Engineer or Inspector shall be removed and rebuilt or replaced in accordance with the Contract at the Contractor's expense 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 work shall be promptly repaired and made good at the Contractor's own proper cost and expense.

If the Purchaser 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, proper operation 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 the USE OF FAULTY OR DEFECTIVE WORK, CONTRACTOR'S LIABILITY, CONTRACTOR'S DEFAULT, TERMINATION FOR BREACH, WARRANTY and INTERPRETATION OF THE CONTRACT Sections of the General Conditions.

28 COMPLETION CERTIFICATE

Subject to the provisions of the WARRANTY Section of the General Conditions, 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, the Purchaser will issue a COMPLETION CERTIFICATE (see SAMPLE ONLY COMPLETION CERTIFICATE included as Appendix C) to the Contractor, and from and after the date of said Certificate, the Purchaser shall be deemed to have accepted and taken over the Work, or the unit section thereof, as the case may be.

29 CONTRACTOR'S DEFAULT

If the Contractor:

(a) abandons the Work;
(b) fails to perform the Work in accordance with the terms and provisions specified in the Contract;
(c) fails to perform the Work within the time or times specified in the Contract;
(d) becomes bankrupt or insolvent, or makes an assignment for the general benefits of creditors;
(e) permits any execution to be levied on the Contractor's real or personal property or on any portion of the Work;
(f) assigns or sublets the Contract without the consent in writing of the Purchaser;
(g) loses control of the Work for any cause whatsoever, except by act of God, lawful orders of civil or military authorities, or the public enemy;
(h) refuses or neglects to follow the instructions of the Purchaser;
(i) fails to meet the Purchaser's requirements for material, plant, methods and/or labour within a reasonable time;
(j) refuses or neglects to use measures to protect the Work from damage;
(k) is guilty of carelessness or incompetence in the execution of the Work;
(l) delays the Work or any part thereof unnecessarily or unreasonably; or
(m) is in default of any other of its covenants or obligations in, or arising from, the Contract;

then the Purchaser may, at its option, and without prejudice to any other rights or remedies:

i) at the Contractor's expense, 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; and/or
ii) at the Contractor's risk and expense, remove unsuitable or inefficient material, plant and tools from the site; and/or
iii) at the Contractor's expense, take over and carry on the Work to the extent necessary to avoid loss or waste or damage to the Work already performed; and/or
iv) give notice of intention to terminate the Contract as provided in the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions.

30 TERMINATION FOR BREACH OF CONTRACT

If the Contractor makes default in any manner set forth in the CONTRACTOR'S DEFAULT Section paragraph (b), (c), (h), (i), (j), (k), (l), or (m) of the General Conditions, the Purchaser may give written notice to the Contractor of intention to terminate the Contract, stating the reasons therefore. If the Contractor does not remedy or take steps to remedy the default to the satisfaction of 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 the CONTRACTOR'S DEFAULT Section paragraph (a), (d), (e), (f) or (g) of the General Conditions, 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 thereafter. The Purchaser may, at its 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 may think fit, for the account and at the expense of the Contractor, and the Contractor shall be liable to the Purchaser for any excess cost occasioned the Purchaser.

At any time after the Purchaser has terminated the Contract, the Purchaser, with such assistance 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's material, plant, and tools at the site may be utilized by the Purchaser, without payment, for the purpose of completing the Work, and may be sold by the Purchaser by private sale or by public auction, either for cash or credit, and upon such terms and conditions as the Purchaser deems most advantageous, but without the Purchaser being liable for loss which may be occasioned thereby. The proceeds of such sale shall be applied in and towards the satisfaction of any money due or to become due to the Purchaser from the Contractor under the Contract.

Upon any termination of the Contract as provided herein, 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. 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 or due completion 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 moneys due or to become due to the Contractor. 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.

31 TERMINATION FOR CONVENIENCE

Notwithstanding the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions, the Purchaser may terminate the Contract (for whatever reason the Purchaser deems fit and at any time during the Work) on 30 days' written notice. The Purchaser shall pay for fees and expenses incurred to the date of the termination.

Without restricting its other remedies, the Purchaser may immediately terminate the Contract in writing if the equipment or services are unsatisfactory, inadequate, or improperly performed, the Contractor fails to comply with the Contract, or the Contractor becomes bankrupt or insolvent.

32 RESPONSIBILITY AS TO PATENTS

The Contractor shall pay all royalties payable under or in respect of, and shall fully 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 of, any and all letters patent, registered design, trade mark or copyright of any apparatus or component part thereof forming part of or used in or 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 this proposing document, but such indemnity shall not cover any use of the Work otherwise than for the purpose indicated by or reasonably to be inferred from this proposing document.

In the event of any claim being made or action brought against the Purchaser arising out of the matters referred to in this Section of the General Conditions, the Contractor shall be promptly notified thereof and may at its own expense conduct 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 conduct by the Contractor of such negotiations or litigation shall be conditional upon the Contractor having first given to the Purchaser such reasonable security as shall from time to time be required by the Purchaser to cover the amount ascertained, or agreed, or estimated, as the case may be, of any compensation, damages, expenses, and costs for which the Purchaser may become liable in respect of such infringement or alleged infringement as aforesaid. The Purchaser shall, at the request of the

Contractor, afford all available 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, replace such work with a non-infringing work or modify it so that it becomes non-infringing or remove the said enjoined work and refund the sums paid therefor.

33 OWNERSHIP OF EQUIPMENT AND SUPPLIES

Any equipment and supplies provided by Manitoba Hydro to the Contractor for use pursuant to the Contract shall remain the property of Manitoba Hydro and shall be returned to Manitoba Hydro upon request.

34 ENUREMENT

The Contract shall enure and be binding upon the parties and their executors, administrators, heirs, successors and permitted assigns.

35 ASSIGNMENT OF RIGHTS AND OBLIGATIONS

The Contractor shall not assign any of its rights or obligations arising under the contract without the written consent of the Purchaser, which consent may be arbitrarily withheld.

36 SURVIVAL OF TERMS

Sections RECORDS, CONFIDENTIALITY, LIABILITY, ENUREMENT, INTELLECTUAL PROPERTY, OWNERSHIP OF EQUIPMENT AND SUPPLIES of the General Conditions shall survive the termination or expiration of the Contract.

37 INTERPRETATION OF THE CONTRACT

The Purchaser's decision shall govern 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 the Purchaser shall be the sole judge of the quality, quantity, suitability and efficiency of labour, workmanship, materials, plant, apparatus, equipment, appliances and methods used, furnished or supplied by the Contractor pursuant to the Contract.

The Contract shall be interpreted according to the laws of the Province of Manitoba, Canada.

38 OBSERVANCE OF LAWS AND REGULATIONS

Until the Work shall have been fully completed and accepted by the Purchaser, the Contractor shall be liable for the due and proper observance, both by itself, and by its servants, agents, employees and subcontractors, of all statutes, by-laws, rules and regulations in any way affecting or relating to the Work, which are lawfully imposed by any federal, provincial or municipal authority.

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 statutes, by-laws, rules and regulations by the Contractor, its servants, agents, employees and subcontractors.

39 APPLICABLE LAWS

The Contract shall be governed by the laws of the Province of Manitoba, Canada.

40 NOTICES

Every notice or communication required or permitted to be given or served pursuant to the Contract shall be in writing, and shall be delivered personally or by fax:

To the Purchaser:
TBD

To the Contractor:
TBD

To the Engineer:
TBD

In addition to forgoing, the Purchaser may effectually give notice to the Contractor:

(a) by giving same on the Superintendent, whether personally, or by fax to the Superintendent's designated Manitoba office; or
(b) by giving same to Contractors address and contact particulars included in the Contract.

Notice given or served by personal service shall be deemed effectually given and received upon such personal service, and notice given or served by fax shall be deemed effectually given and received on the first (1st) calendar day after the day of transmission.

The Contractor acknowledges and agrees that the Engineer is an employee of the Purchaser.

41 ARBITRATION

41.1 Notice of Dissatisfaction Concerning Engineer Determinations

A party shall be conclusively deemed to have accepted a determination by the Engineer issued under any provision of the Contract, 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 seven (7) 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.

41.2 Amicable Settlement of Disputes

The Purchaser and the Contractor shall make all reasonable efforts to resolve any 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 Engineer and Contractor's representative fail to resolve the dispute, 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 a Vice President for the Purchaser and the equivalent senior executive of the Contractor.

41.3 Final and Binding Arbitration

If the dispute has not been resolved within a reasonable time, 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, together with a concise statement of the matters in dispute.

41.4 **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.

41.5 **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.

41.6 **Venue**

Arbitration proceedings shall be conducted at Winnipeg, Manitoba.

41.7 **Work to Continue**

The Contractor shall not suspend, delay or interfere with 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 above, nor during arbitration proceedings.

END OF GENERAL CONDITIONS

Manitoba Hydro

TECHNICAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS FEBRUARY 2017
DRAFT 3

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS

REQUEST FOR PROPOSAL 040432

TECHNICAL REQUIREMENTS

1 SCOPE OF THE WORK

These Technical Requirements set out the Purchaser's requirements with respect to the design, material procurement, manufacture, supervision, labour, plant, tools, equipment, quality control, shop assembly and testing, packaging, shipping, delivery, and warranty of Implosive Connectors to be used on the Manitoba-Minnesota 500 kV AC Transmission Line from Dorsey to Iron Range.

Implosive connectors are required to provide:

(a) Full-tension mid-span conductor splice connections,
(b) Full-tension conductor terminations for securing conductor to a support structure, and
(c) Partial tension conductor terminations for conductor jumpers.

2 REFERENCE STANDARDS AND REGULATIONS

The latest revisions of the following standards, current at the time and the date of the execution of the Contract, shall apply.

Canadian Standards Association (CSA):

CAN/CSA-C57	Electric Power Connectors for Use in Overhead Line Conductors
CAN/CSA-C83	Communication and Power Line Hardware
CAN/CSA-G164	Hot Dip Galvanizing of Irregularly Shaped Articles - Metals and Metal Products
CAN/CSA C108.3.1	Limits and Measurement Methods of Electromagnetic Noise from AC Power Systems, 0.15-30 MHz
CAN/CSA-ISO 9001	Quality management systems –Requirements

International Electrotechnical Commission (IEC):

IEC 61284	Overhead lines – Requirements and tests for fittings

American National Standards Institute (ANSI):

ANSI/NEMA CC 1	Electrical Power Connection for Substations

The American Society of Mechanical Engineers (ASME):

B18.21.1	Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers

American Society for Testing and Materials (ASTM):

A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
E23	Standard Test Methods for Notched Bar Impact Testing of Metallic Materials
E1417	Standard Practice for Liquid Penetrant Testing

In case of conflict between this Technical Specification and these referenced standards, the requirements of this Technical Specification shall take precedence.

Handling of explosive products shall be done in full compliance with all the regulatory requirements at the federal, provincial and municipal levels, as they may apply:

Government of Canada:
Explosives Act (Canada)
Transportation of Dangerous Goods Regulations

3 SERVICE AND ENVIRONMENTAL CONDITIONS

All Implosive Connectors shall perform satisfactorily for reliable operation under system parameters and environmental conditions as listed in Table 1 and Table 2.

Table 1
Operating System Parameters

Parameter	**Specified Value**
Nominal Line-Line Voltage	500 kV
Maximum Continuous Operating Voltage	575 kV
System Configuration	AC 3-phase
Nominal Line Load	2,000 Amps
Emergency Line Load	2,500 Amps
Maximum Conductor Operating Temperature	100 ˚C
Maximum Sub-Conductor Surface Gradient	19 kV/cm
SLG Fault Current	23.1 kA
Fault clearing time	500 ms

Table 2
Environmental Conditions

Condition	Specified Value
Ambient Air Temperature: Minimum Maximum	 -50ºC 40ºC
Altitude	Less than 500 m
Environment type	Rural and agricultural
Terrain Type	Mainly flat and open with few trees or buildings, snow-covered during winter
Lightning Stroke Density	1.61/km^2/yr

4 DESIGN AND PERFORMANCE REQUIREMENTS

4.1 General Requirements

All Implosive Connectors shall be designed by the Contractor based on the parameters listed in these Technical Requirements.

All Implosive Connectors shall meet or exceed the electrical and mechanical performance requirements as per CAN/CSA-C57.

4.2 Functional Requirements

All Implosive Connectors shall be designed to perform the following functions:

(a) Provide the specified strength and function under operating and environmental conditions,
(b) Provide full electrical conductance, at least the same as the conductor of the corresponding length,
(c) Maintain temperature at or below the conductor temperature,
(d) Avoid damage to the conductor, and
(e) Provide corona free operation.

All Implosive Connectors shall be pre-mounted with an implosive charge engineered for each connector to provide a virtually void-free, uniformly smooth and straight connector assembly after compression.

4.3 Conductor Properties

All Implosive Connectors shall be designed for use with the conductor having the following properties;

Phase Conductor

Conductor Type:	Aluminum Conductor Steel Reinforced (ACSR)
Conductor Designation:	Bunting
Conductor Size:	1192.5 MCM
Aluminum Type:	1350-H19
Outside Diameter:	33.1 mm
Number of Strands:	45/7
Strand Diameter (Al):	4.14 mm
Strand Diameter (Steel):	2.76 mm
Outer Layer:	Right hand lay
Linear Density:	1.997 kg/m
Rated Tensile Strength (RTS):	142.3 kN

Ground Conductor

Conductor Type:	Alumoweld Steel Wire
Conductor Size:	7 No.7
Outside Diameter:	11 mm
Outer Layer:	Left hand lay
Linear Density:	0.491 kg/m
Rated Tensile Strength (RTS):	84.8 kN

4.4 Implosive Connector Class

Implosive Connectors shall be designed to the following classes, in accordance with CAN/CSA-C57.

Classification	Connector Type	Electrical Duty Class	Mechanical Duty Class
Full Tension	Deadend Terminal and Joint	A	1
Partial Tension	Jumper Terminal	A	2

4.5 Outer Tubular Sleeves

Design of outer tubular sleeves shall not permit slippage and damage to the conductor at the loads as specified in Table 2 of CAN/CSA-C57.

4.6 Aluminum Filler Tubes (where applicable)

Aluminum filler tubes shall be designed to create or produce a smooth outer surface allowing less surface irregularities after compression. Physical dimension shall conform to manufacturing specification.

4.7 Steel Core Sleeves

The inside diameter of steel core sleeves shall be coated with “grit” particles, coil or other “friction materials” that shall provide strengthened grip to hold the core of the conductor and prevent slippage to the conductor at loads specified in table 2 of CAN/CSA-C57.

4.8 Deadend Terminals

Design of deadend terminals shall provide for 360° rotation of the eye prior to final installation. The eye shall be secured in place by the implosive installation process.

Dead end connectors shall be supplied with an oval eye. The physical dimensions shall be in accordance with CAN/CSA-C83.

4.9 Implosive Charge

The implosive charge shall be initiated by the use of a detonator system. After implosion, it shall apply uniform, optimum compression throughout the length of the connector producing a straight, void-free and smooth connector.

The implosive charge shall be sealed to prevent water penetration into the implosive charge.

4.10 Terminal Pads

The physical dimensions of all terminal pads shall be in accordance with ANSI/NEMA CC 1.

All terminal pads shall have 15° angle design.

4.11 Connector Temperature Rise

The temperature of an Implosive Connector shall not exceed the temperature of the control conductor according to CAN/CSA-C57.

4.12 Corona Performance

All Implosive Connectors shall be designed to perform corona free operation at the maximum continuous operating voltage.

4.13 Construction and Maintenance Requirements

Implosive Joint Connectors shall be designed to pass through stringing blocks with no damage or deformation to the connector, and no damage to conductor strands. The splice shall not have sharp edges where the conductor will bend in relation to the sleeve as it passes through a stringing block.

The Contractor shall provide safe pulling limits for the safe passage of the connectors through the stringing blocks.

4.14 Drawings

The Proponent shall provide detailed design drawings of all Implosive Connectors with the following details:

(a) Identification of all part numbers,
(b) Part dimensions and weights,
(c) Material types used, and
(d) Marking details.
(e) Designer and date

All drawings shall be in SI (metric) system and only in English language.

5 MATERIALS AND MANUFACTURING

5.1 General

Only new manufactured materials shall be used.

5.2 Outer Aluminum Tubular Sleeves (ACSR only)

All implosive compression barrels shall be made of high strength Aluminum Alloy and shall be designed to ensure no fracture occurs during installation or later in application.

5.3 Outer Steel Tubular Sleeves (Ground Conductor only)

Steel material shall be hot dip galvanized conforming to the requirements of CAN/CSA-G164.

5.4 Steel Core Sleeves

Steel material shall be hot dip galvanized conforming to the requirements of CAN/CSA-G164.

5.5 Deadend Eyebolts

Deadend eyebolts shall be made from forged steel and hot dip galvanized in accordance with CAN/CSA-G164. Material strength shall conform to CAN/CSA-

C83 and shall have Level 1 energy absorption properties (20 Joules at -20°C) as specified by CAN/CSA-C83 after galvanizing.

5.6 Protective Material

Protective material shall be made of suitable material that vaporizes after implosion without flying debris.

Outer protective material shall protect the implosive charge from moisture and water penetration and keep it in tight configuration. It shall be made of suitable material that vaporizes after implosion without flying debris.

Inner protective material shall be made of suitable material and wrapped between the outer aluminum sleeve and implosive charge to ensure that outer surface of assembly is protected from damage and spiking during the implosion process.

6 TESTING REQUIREMENTS

6.1 General

The Contractor shall be responsible for all testing as required by these Technical Requirements.

All type tests, routine tests and sample tests shall be done in accordance with CSA C57 and CSA C83 standards unless otherwise specified by this Technical Specification.

All the required tests shall be made on the finished Implosive Connectors.

The Purchaser and/or designated representative may be required to do site visit and inspection to the manufacturing plant. Purchaser will require two weeks notice to make arrangements and inspection to take place at manufacturer's premises.

6.2 Classification of Tests

All Implosive Connectors shall be subjected to testing in accordance with Table 3 of these Technical Requirements.

Table 3
Test Requirements

Item	Test	Reference Clause	Full Tension Connector			Partial Tension Connector		
			Type	Sample	Routine	Type	Sample	Routine
1	Visual examination	IEC 61284 Clause 7	x	x	x	x	x	x
2	Dimensional and material verification	IEC 61284 Clause 8	x	x	x	x	x	x
3	Hot dip galvanizing	CSA G164 Clause 6	x	x		x		
4	Pull out Strength test	CAN/CSA-C57 Clause 4.4.1	x			x		
5	Electrical current cycling test (1)	CAN/CSA-C57 Clause 4.2	x			x		
6	Visual corona test (1)	Clause 6.9.1 of the Technical Requirements	x			x		
7	Short Time Overcurrent Test (2)	Clause 6.9.5 of the Technical Requirements	x					
8	RIV test (1)	Clause 6.9.2 of the Technical Requirements	x			x		
9	Impact energy absorption	Clause 6.9.3 of the Technical Requirements	x	x				
10	Weld cracks (1)	Clause 6.9.4 of the Technical Requirements	x	x				

Note (1): These tests are only required for phase conductor connectors.
(2): Short time overcurrent test is only required for ground conductor connectors.

6.3 Access and Notification

Contractor shall allow the Purchaser or his representative access to all tests. The contractor shall give notice to the Engineer of such testing a minimum of 30 days in advance.

6.4 Test Setups

The Implosive Connectors under tests shall be arranged and the loads shall be applied to simulate service loads as close as possible and in accordance with referenced clauses/standards.

6.5 Supply of Conductor and Insulators for Testing

The Purchaser will supply conductor sample for testing.

6.6 Type Tests

6.6.1 General

Type tests are intended to demonstrate conformance of electrical and mechanical characteristics of the proposed Implosive Connectors with all the requirements of these Technical Requirements. All Implosive Connectors shall be subject to type tests listed in Table 1.

All type tests shall be performed on three Implosive Connector samples except for:

a) Tensile load test shall be done on three sets, each including two terminal dead-ends and one joint.

b) Electrical current cycling test shall be done on three sets, each including four terminal dead-ends, four joints and four jumper terminal jumpers.

Type Test Reports shall be completed by a qualified third party laboratory which must be pre-approved by the Engineer. Type Test Reports shall be submitted electronically to the Engineer for approval.

The Purchaser shall not accept any material deliveries until the Type Test Report has been approved by the Engineer.

6.6.2 Validity of Existing Type Tests Reports

The Engineer may accept the existing type test reports offered by the Contractor in the Contractor’s Proposal, provided that:

(a) All the type tests were made of the same type of Implosive Connectors as required by the Technical Requirements;
(b) A complete set of tests were performed on the required number of Implosive Connectors as prescribed by the Technical Requirements;
(c) Testing was performed in accordance with all the requirements of the Technical Requirements;
(d) Testing was performed within the last ten (10) years;
(e) Testing was done on Implosive Connectors manufactured at the same facility; and
(f) The Contractor’s manufacturing process has not changed since the time of the type tests performed.

The Engineer shall advise the Contractor in writing as to whether the above criteria have been satisfied, in the Engineer’s sole discretion.

6.6.3 New Type Test Reports

Upon completion of all the required type tests, the Contractor will issue a Certified Type Test Report signed by a qualified professional. This report shall record full details of all tests completed to confirm full conformance with the Purchaser's Technical Requirements and it shall include:

(a) Scope of work,
(b) Identification of personnel witnessing testing,
(c) Test descriptions,
(d) Reference standards,
(e) Test setup details,
(f) Test procedure,
(g) Acceptance criteria, and
(h) Test results.

6.7 Sample Tests

6.7.1 General

All Implosive Connectors are subject to sample tests listed in Table 1 of these Technical Requirements. Samples shall be selected at random from the lot offered for acceptance.

All sample tests and inspections shall be made at the place of manufacture prior to shipment, in accordance with the Inspection and Test Plan.

All Sample Test Reports shall be issued by a qualified person and submitted electronically to the Engineer for approval.

The Contractor shall not ship any materials without a written approval by the Engineer.

6.7.2 Lot Size Definition

Production lots are defined as components batch processed at the same time, under identical conditions and using the same setup. In no rational basis for establishing a lot size can be determined, then a lot size shall be defined and marked as that material produced within an eight (8) hour shift.

6.7.3 Sampling and Acceptance Criteria

All implosive connectors shall be tested using a single sample plan for normal inspection, as defined by CSAC83 standard.

Sample size and acceptance numbers shall be:

(a) Sampling inspection by attributes: as per Table A1 of CSA C83 standard
(b) Sampling inspection by variables: as per Table B1 of CSA C83 standard

except for:

(a) For surface defects: 100% sampling,
(b) For energy absorption/toughness: the sample size shall be 1 sample per heat lot,
(c) For galvanizing: the samples size shall be 5 samples per galvanizing lot.

Alternate sampling plan and acceptance criteria may be acceptable subject to approval by the Engineer.

6.7.4 Classification of Defects

The following Acceptable Quality Levels shall be used:

Class B:
(a) dimensional and material verification
(b) energy absorption/toughness;
(c) weld cracks

Class D:
(a) visual examination
(b) hot dip galvanizing

Definitions of Acceptable Quality Levels shall be as per Table 3 of CSA C83 standard.

6.8 **Routine Tests**

The Contractor shall be responsible for all routine tests. Implosive connectors shall be subject to routine tests listed in Table 1 of the Technical Requirements.

6.9 **Individual Test Requirements**

6.9.1 Visual Corona Test

The test procedures and measurements shall be performed in accordance with CSA C83, Appendix E. The test shall be conducted three times, and the value for corona extinction considered for qualification shall be the arithmetic mean of the three voltage gradients.

The visual corona test shall be considered successful, if no visual corona is observed on any part of the tested assembly when the test voltage gradient on the conductor surface for the tested connector is less than and equal to the value specified in these Technical Requirements.

6.9.2 Radio Influence Voltage Test

The test procedure shall be in accordance with IEC 61284.

The measured RIV level shall not exceed the limits as specified in CSA C108.3.1 standard at the test voltage or the conductor surface voltage gradient as specified in the Technical Requirements.

6.9.3 Impact Energy Absorption Test

Charpy V-Notch impact tests shall be performed on specimens in accordance with the requirements of ASTM A370 and ASTM E23.

Ferrous materials shall all have Level 1 impact properties as specified in CSA C83 (minimum energy absorption of 20 Joules at -20 degrees Celsius for three Charpy V-Notch bars tested in accordance with ASTM A370).

6.9.4 Weld Crack Test

Welds shall be tested for cracks using the liquid penetrant testing method in accordance with ASTM E1471.

6.9.5 Short Time Overcurrent Test (Ground Conductor Connectors only)

The test procedure and requirement shall be in accordance with Clause 13.5.3.1of IEC standard 61284 with the exception of the pulse duration. Pulse duration to be used for the connectors of ground conductor shall be 0.5 second.

6.10 Submission of Test Reports

Upon completion of all testing as specified in the Technical Requirements, all test reports shall be submitted electronically to the Engineer to confirm that all requirements of the Technical Requirements have been met.

Test reports shall be sent to:

Chen Wang, P. Eng. – Transmission Line Engineer
Manitoba Hydro
Transmission & Civil Design Department
820 Taylor Avenue (4)
P.O. Box 7950
Winnipeg, Manitoba, Canada R3C 0J1
Email: cwang@hydro.mb.ca

6.11 Third Party Testing

The Purchaser reserves the right to select and test samples fabricated by the Contractor using a qualified third party and using the same tests as outlined in the Technical Requirements. If this tested lot fails any of the acceptance criteria set out in these Technical Requirements, then the lot will be refused and returned at the Contractor's expense. A replacement lot will be provided by the Contractor in accordance with all requirements of the Contract, at no additional expense or cost to the Purchaser.

7 QUALITY CONTROL

7.1 General

The Contractor shall comply with the quality assurance program requirements of ISO 9001 standard or its equivalent in the performance of the Work, the Contract, and the Contractor's obligations in respect of both. If the Contractor's proposed program is not based on ISO 9001 series of standards, the Contractor shall submit evidence, satisfactory to the Engineer that the proposed program conforms fully to the spirit and intent of ISO 9001.

The Engineer may, in his sole discretion, reject Work that is not produced under the Quality requirements specified in this Section.

The Contractor is responsible to identify in its Quality Plan the specific activities it will undertake to perform:

(a) Quality Assurance: The process of auditing the quality requirements and the results from Quality Control measurements to ensure quality standards are being met.

(b) Quality Control: The process of monitoring and recording results of Quality activities to assess performance and recommend necessary changes.

7.2 Quality Documentation

All quality documentation shall be in the English language. Where the original document is in a single language other than English, the Contractor is responsible to have the document translated into English without causing delays to the documentation process.

7.3 Access to Contractor's Facilities

The Purchaser reserves the right to audit the Contractor's Quality Management System program at any time during the Work.

The Purchaser or its representative shall be granted unescorted access to the Contractor's facilities and to the facilities of all of its Subcontractors, at any time during the Contractor's or Subcontractors' normal business hours to verify that the Contractor and its Subcontractors are satisfactorily carrying out the Work and that the Work complies with the requirements of this Section of the Technical Requirements. The Purchaser or its representative shall be allowed at any time and under any circumstance to take photographs of any portion of the Work he deems necessary.

While attending at the Contractor's facilities, the Purchaser or its representative will comply with the reasonable policies of the Contractor concerning confidentiality (and with respect to matters not related to the Work and the Contract) which have been disclosed in writing to the Purchaser prior to attendance and for which no objection has been made; provided further however that nothing in the Contract is altered or diminished by reason of any such policy or compliance with same. While attending at Contractor's facilities, the Purchaser or its representative will use best efforts to limit disruption of other activities at such facilities.

7.4 Tools and Equipment

All tools and equipment used to carry out inspection activities by the Contractor shall have been calibrated within the one (1) year proceeding of the date of inspection by accredited third party inspection company. Calibration records shall be provided to the Purchaser or its representative upon request. If it is discovered that tools and equipment are used for the Work that have not been calibrated within one (1) year of the inspection date, the inspections shall be repeated, at the sole risk of the Contractor, with tools and equipment that are properly calibrated.

7.5 Inspection and Test Plan

At least 30 days prior to commencing production, the Contractor shall submit the Inspection and Test Plan for approval by the Engineer. The ITP document shall identify in detail:

(a) Production process and associated test,
(b) Parameter to be controlled,
(c) Sampling and frequency,
(d) Acceptance criteria,
(e) Reference standard or document,
(f) Control equipment,
(g) Testing location,
(h) Person/position responsible for the test, and
(i) Quality Control record form.

The Engineer will determine the Purchaser's level of involvement in testing. This will be reflected in the ITP document.

7.6 Non-Conformance Reports

The Contractor shall provide the Purchaser or its representative, within 7 days of such request, information related to any present non-conformance reports regarding implosive connector quality and manufacturing, testing, shipping, internal and external QA audits, including corrective and preventative actions in accordance with CAN/CSA-ISO 9001.

8 MARKING, PACKAGING AND SHIPPING

8.1 General

The Contractor shall be responsible for ensuring that marking, packaging and shipping is done in accordance with:

(a) The Explosives Act (Canada), and
(b) Transportation of Dangerous Goods Regulations.

8.2 Marking

The following information shall be provided on the plastic label of each implosive connector:

(a) Manufacturer's name or Trademark
(b) Date of manufacturing (if not identifiable in the Serial/Part number)
(c) Range of conductor sizes/diameter
(d) Connector Type
(e) Serial/Part Number
(f) Arrows or line – to indicate location of detonator

Additionally, markings not limited to the following shall be stamped/marked on the outer sleeves of implosive connectors and shall be visible after detonation:

(a) Manufacturer's name or Trademark
(b) Date of manufacturing (if not identifiable in the Serial/Part number)
(c) Serial/Part Number
(d) Connector Type

The letters and numerals shall be distinct, durable, and conspicuous.

8.3 Packaging and Shipping

8.3.1 General

The Contractor shall prepare the Implosive Connectors for shipment in such manner as to protect them from dust and dirt, damages during transportation, handling and outdoor storage. The Contractor shall be responsible for and make good any and all damage resulting in loading and transportation.

The Contractor shall be responsible that all necessary Dangerous Goods Safety Markings are visible and in proper condition and conforms to Part IV of the Transportation of Dangerous Goods Regulations.

The maximum allowable net weight of each crate or box shall be less than 20 kg which allows one person to handle it.

8.3.2 Marking of Crates or Boxes

Each box shall be clearly marked with the following information:

(a) Project name specified on the Purchase Order,
(b) Purchase Order number,
(c) Contractor's name,
(d) Description of contents,
(e) Destination,
(f) Weight, in kilograms, and
(g) Date of manufacture.

All markings shall be legible and made of waterproof paint or stamped metal tag securely attached to the box. All identification marks shall appear on the side and on the top of each box.

8.3.3 Shipping Reports

The Contractor shall, within 24 hours of each shipment, provide Purchaser with the shipping report, which shall include:

(a) Project name specified on the Purchase Order,
(b) Purchase Order number,
(c) Items and quantities shipped,
(d) Net and gross mass of each box,
(e) Carrier,
(f) Bill of Lading number,
(g) Shipping date, and
(h) Expected delivery date.

The Contractor shall be responsible for tracking and expediting all shipments and for obtaining all required permits.

Manufacturer shall provide an action plan on handling quality issues after delivery, such as receiving-unloading, missing items, rejects and/or items of need for replacements.

END OF TECHNICAL REQUIREMENTS

TERMS AND CONDITIONS OF PAYMENT

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS FEBRUARY 2017
DRAFT 3

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS

REQUEST FOR PROPOSAL 040432

TERMS AND CONDITIONS OF PAYMENT

1 ITEMS OF THE WORK

Subject always to satisfactory performance of the Work by the Contractor in accordance with the Contract, the Purchaser shall pay the Contractor the cost of the Work and all services of the Contractor in connection therewith, in Canadian currency as follows:

1.1 Major Payment

An amount equal to 92.5% of the cost of the Work shall be paid 30 days after receipt of the Contractor's invoice following the completion of the Work.

1.2 Performance Holdback

The 7.5% Performance Holdback balance of the cost of the Work shall be paid 30 days after the date of acceptance of the Work, subject to the following:

If acceptance of the Work is delayed by the Purchaser beyond 90 days from the date of the completion of the Work, the Purchaser shall have the right to extend the time for payment of the said balance and shall pay the Contractor interest on said balance at the annual rate of interest equivalent to that charged to preferred borrowers by the Purchaser's bank ('prime lending rate') in Winnipeg, calculated from the 90th day after the date of the completion of the Work until the date of acceptance. If acceptance of the Work is delayed by reason of any defect in the Work or any portion thereof, or any failure to meet Request for Proposal 040432 or the requirements of the Contract, so that the Work or any portion thereof is rejected by the Purchaser, and if such defect or failure is attributable to the Contractor, then interest on said balance shall be payable by the Purchaser as aforesaid up to the date on which the Work or the portion thereof was rejected by the Purchaser, and thereafter no interest shall be payable.

Prior to payment of the balance of the cost of the Work to the Contractor as aforesaid, the Purchaser may require the Contractor to furnish the Purchaser with an Affidavit sworn by the Contractor in the form set out in Schedule 'A' (see SAMPLE ONLY) to these Terms and Conditions of Payment.

END OF TERMS AND CONDITIONS OF PAYMENT

Terms and Conditions of Payment Schedule 'A'

CANADA) I, ____
)
PROVINCE OF MANITOBA) of the ____________ of _______________ in the
)
TO WIT: 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__

Manitoba Hydro

FORM OF PROPOSAL

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

Important: Macro Security level to Medium

1. The first field to be completed in the Form of Proposal is your full legal company name. Once your proposal is complete and converted to pdf, your full legal company name will automatically appear inside the header of every page.

2 Continue preparing your proposal by completing the gray shaded fields on each page.

3. 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.

4. Certain fields which contain the drop-down selection feature will allow you to make a selection from a list. For checkboxes, click inside the applicable YES or NO box to make a selection. To deselect, click inside the YES or NO box you wish to deselect.

5. After you are satisfied with your electronic completion of the Form of Proposal, save the document and convert it to pdf.

6. Print and sign the signing page manually. Scan the signed page and insert it into the Form of Proposal pdf. Delete the unsigned page.

7. Certain fields have been limited to a maximum number of rows or characters that you can type. If the space provided is insufficient, you can use the document provided titled "Additional Form of Proposal.docx".

8. If the "Additional Form of Proposal.docx" document has been utilized, convert it to pdf.

9. Submit the Form of Proposal, Additional Form of Proposal (if used) and any other applicable documents that you wish to accompany your proposal.

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

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS

REQUEST FOR PROPOSAL 040432

FORM OF PROPOSAL 040432

COMPANY INFORMATION

This proposal is submitted by: ______________________________
(legal company name)
hereinafter called the "Proponent", a company duly incorporated under the laws of:

____

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

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

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

The Proponent's principal office dealing with this Form of Proposal is at:

____
(number, street)

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

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

THE WORK

ITEM	Description	Estimated Qty	Shipping Options	UNIT Price ($CAD)	EXTENDED Price ($CAD)
1	DEADEND for ACSR "BUNTING"	982	EXW LOADED		
			DDP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
			DAP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
2	JUMPER for ACSR "BUNTING"	982	EXW LOADED		
			DDP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
			DAP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
3	SPLICE for ACSR "BUNTING"	676	EXW LOADED		
			DDP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
			DAP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
4	DEADEND for ALUMOWELD 7#7	107	EXW LOADED		
			DDP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
			DAP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
5	JUMPER for ALUMOWELD 7#7	104	EXW LOADED		
			DDP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
			DAP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
6	SPLICE for ALUMOWELD 7#7	72	EXW LOADED		
			DDP: Gate 6, 59029 Hwy 207, Dugald Manitoba		
			DAP: Gate 6, 59029 Hwy 207, Dugald Manitoba		

MANUFACTURING INFORMATION

ITEM	Description	Manufacturing Plant	Delivery Lead Time
1	DEADEND for ACSR "BUNTING"		
2	JUMPER for ACSR "BUNTING"		
3	SPLICE for ACSR "BUNTING"		
4	DEADEND for ALUMOWELD 7#7		
5	JUMPER for ALUMOWELD 7#7		
6	SPLICE for ALUMOWELD 7#7		

COMMERCIAL COMPLIANCE

Below are proposed changes to the commercial terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

TECHNICAL COMPLIANCE

The Proponent's product offering fully conforms to all Technical Requirements stated within Manitoba Hydro Request for Proposal 040408:

YES ☐ NO ☐

If NO, below are proposed changes to the technical terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

TYPE TEST REPORT BY THIRD PARTY LABORATORY

.1 The Proponent submits with its proposal existing type test report that meets all necessary requirements:

YES ☐ NO ☐

Comments:

.2 If existing type test report is not available or fails to meet any requirement of Subsection 6.6 in Technical Requirements of this RFP, Proponent should identify the Third Party Laboratory that will perform type test outlined in the Technical Requirements.

Name and Address of the proposed Type Testing Facility:

NOTE: The Purchaser reserves the right to accept or reject the Proponent's listed Type Testing Facility.

PACKAGING METHOD

The Proponent shall provide a detailed packaging method that meets all necessary requirements:

Include packaging drawing for each item and net weight of each type of crate shall be labelled on the drawing.

Comments:

TRANSPORTATION OF DANGEROUS GOOD (TDG) CERTIFICATE

The Proponent is requested to provide a copy of their Transportation of Dangerous Good (TDG) Certificate

DELIVERY/LOADING DATE(S)

The Proponent offers to deliver or have the ITEMS of the Work loaded on the Purchaser's specified date:

YES ☐ NO ☐

If the above answer was NO or if the Proponent can deliver the Work earlier than the Purchaser's preferred date, the Proponent indicates below its earliest dates upon which the ITEMS of the Work could be delivered or loaded:

DELIVERED:
If the above answer was NO, the Proponent indicates below its earliest date(s) upon which the ITEMS of the Work could be completed:

ITEM 1	,	20
ITEM 2	,	20
ITEM 3	,	20

LOADED:
If the above answer was NO, the Proponent indicates below its earliest date(s) upon which the ITEMS of the Work could be completed:

ITEM 1	,	20
ITEM 2	,	20
ITEM 3	,	20

SHIPMENT/TRANSPORTATION DETAILS

Delivery of the Work

The Purchaser requires the Proponent to provide the following information regarding shipment/transportation of the Work:

The total shipment weight is ___________lb or ___________ kg.

The total shipment volume is __________ ft^3 or ___________m^3.

The shipment's dimensions are:
length ___________ ft x width ___________ ft x height ___________ ft, or
length ___________ m x width___________ m x height ___________ m.

The total shipment quantity is _________ (No. of cartons / No. of pallets, etc.)

The shipment will be transported via:

Road:
____________(qty) ___________ (length in ft) enclosed van(s), or
___________ (qty) ___________ (length in ft) flatdeck trailer(s).

OR
Rail:
___________ (qty) ___________ (length in ft) boxcar(s), or
__________ (qty) ___________ (length in ft) flatcar(s), or
___________ (qty) ___________ (length in ft) gondola car(s).

SHIPMENT/TRANSPORTATION DETAILS (CONTINUED)

Loading of the Work

The following is the location of the Proponent's shipping facility or factory where the ITEMS of the Work will be loaded, blocked, braced and secured for transportation by the Proponent or the Proponent's designated carrier:

Street Name and Number: ______________________________
City Province/State: ______________________________
Postal Code/Zip Code: ____________________

The estimated travel time from the Proponent's shipping facility or factory to the Purchaser's designated arrival destination is _____ day(s).

The Proponent intends to load the ITEMS of the Work in containers weighing:
___________(kg) approximately and measuring __________ (m) x ___________ (m) x __________ (m).

The Proponent indicates below any special equipment and requirements necessary for the transportation of the Work:

PRODUCTION SCHEDULE

The Proponent shall provide a detailed production schedule.

Include a GANTT chart, proposed schedule from ordering raw materials, manufacturing, shipping and delivery of products to final destination.

PLANT CAPACITY

.1 The Proponent identifies its total plant capacity by month and details what portion of the capacity has been allocated to other orders:

.2 The Proponent identifies its work arrangements:

Number of active shifts per day:

Number of working days per week:

Attach additional sheets if required.

PREVIOUS EXPERIENCE

The following is a list of work that the Proponent has previously performed which is similar to that described in Request for Proposal 040432.

Description	Date	Firm's Name, Contact's Name, Phone Number & E-mail Address

NOTE: The Purchaser reserves the right to contact the persons listed on this page of the Form of Proposal.

SUBCONTRACTORS

The following is a list of subcontractors, their addresses and the portions of the Work to be subcontracted:

Subcontractor	Address	Portion of the Work to be Subcontracted

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

MANITOBA CONTENT

The Proponent shall provide the estimated percentage of total proposed price that they consider to be Manitoba Content: ____________%

The Proponent shall provide a detailed breakdown of Manitoba Content that would be incorporated into the Work substantiating the above percentages (inputs originating from the Province of Manitoba such as labour, materials, transportation, etc):

NOTE: Upon request, the Contractor shall provide to Manitoba Hydro records substantiating the percentage of Manitoba Content.

a) Labour by Own Workforce

COMPONENT OF THE WORK	TYPE OF LABOUR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

b) Manitoba Subcontractors

TYPE OF WORK TO BE SUBCONTRACTED	NAME AND ADDRESS OF SUBCONTRACTOR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

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

Manitoba Business Involvement (continued)

c) Purchase of Goods from Manitoba Companies

TYPE OF GOODS	NAME AND ADDRESS OF SUPPLIER	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

d) Purchase of Equipment from Manitoba Companies

TYPE OF EQUIPMENT	NAME AND ADDRESS OF SUPPLIER	TOTAL VALUE OF PURCHASE PRICE $

e) Leased Equipment/Facility from Manitoba Companies

TYPE OF EQUIPMENT	OWNER	TOTAL VALUE OF LEASE $

Provide information regarding any lease agreements such as the following:

- Length of lease
- Lease payment
- Maintenance
- Residual value

Manitoba Business Involvement (continued)

f) Other Manitoba Content:

OTHER INPUTS	OWNER	TOTAL VALUE OF LEASE $

ALTERNATIVE METHODS, PROCEDURES, SCHEDULES, SEQUENCES OR ENVIRONMENTALLY PREFERABLE PRODUCTS/SERVICES

The following is a list of all of the Proponent's proposed alternative methods, procedures, schedules, sequences or environmentally preferable products/services that affect the Work:

EQUAL ARTICLES, MATERIALS OR EQUIPMENT

The following is a list of the equal articles, materials or equipment that the Proponent proposes to substitute for those specified:

Article, Material, or Equipment		Price Change $	
Specified	**Proposed**	**Increase**	**Decrease**

NOTE: Names of manufacturers of equals and catalogue numbers are stated, if applicable. All technical data and literature are appended to this proposal. No equal articles, materials, or equipment will be permitted unless listed above and approved by the Purchaser.

ALTERNATIVES

The following is a list of all the Proponent's proposed alternatives to the Work:

JOINT VENTURES

The extent and nature of Manitoba business participation in a joint venture is detailed below.

A Band Council Resolution authorizing the provision of the Form of Proposal on behalf of the First Nation Band is submitted with this proposal:

YES ☐ NO ☐

QUALITY ASSURANCE

The following are particulars of the quality assurance program that the Proponent proposes to apply to the Work:

PROPONENT'S TECHNICAL AND NON-TECHNICAL CONTACT PERSONS

All enquiries concerning the technical aspects of this proposal should be directed to:

(please print name and title of Proponent's Representative)
whose telephone number is: ( ) -
FAX number is: ( ) -
Internet e-mail address is: @ .
and World Wide Web is: http://www. .

All enquiries concerning the non-technical aspects of this proposal should be directed to:

(please print name and title of Proponent's Representative)
whose telephone number is: ( ) -
FAX number is: ( ) -
Internet e-mail address is: @ .
and World Wide Web is: http://www. .

SIGNING PAGE

The words used in this Proposal have the meanings ascribed to them in RFP 040432.

We/I the undersigned, having examined all of RFP 040432 together with all addenda issued prior to the Closing Date, and having attended all mandatory meetings and mandatory site visits, hereby submit this proposal with all necessary enclosures.

The Proponent agrees that RFP 040432, and any proposal submitted in respect of same, is not a legal offer. By signing below, the Proponent certifies that the information submitted herein is true and correct as of the date set out below to the best of the Proponent's knowledge, and that the Proponent agrees to the terms and conditions set out in the RFP.

______________________________ [Insert legal name(s) of Proponent]

Per ______________________________ Name ______________________________
Authorized signing officer Print Name

I have authority to bind the Proponent

Dated ___________________________ ________________________
Title

REQUEST FOR PROPOSAL 040378

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR

500kV AC TRANSMISSION LINES

DECEMBER 22, 2016

MANITOBA HYDRO DISCLAIMER

Manitoba Hydro does not represent or warrant that any electronic files provided hereunder are usable by the recipient, are error-free, or are free of viruses or other harmful or destructive properties. Such electronic files provided hereunder, and any content/part thereof, are provided on an “as is” basis, without warranty of any kind. The entire risk as to use of and/or reliance on such electronic files is assumed by the recipient.

Manitoba Hydro works in the Acrobat X1 Standard, Excel 2003-2007 and Word 2003-2007 environments. The recipient may not be able to view or utilize the full software features of Manitoba Hydro’s electronic files if the recipient has earlier versions of the aforementioned software.

NOTE: To open any supplied Word documents, your Macro Security level must be set to Medium.

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR - 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040378

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Appendix A: PROPOSAL CLARIFICATION FORM

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DEFINITIONS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR - 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040378

DEFINITIONS

“Confidential Information” means any and all information, regardless of form, format or medium, of or concerning or related to the Purchaser, the Work, etc. depending on situation, customer information, and Personal Information, which has or shall come into the possession or knowledge of the Contractor.

“Contract” means the entire agreement entered into between the Purchaser and the Contractor upon execution of the Cover Agreement for performance of the Work by the Contractor in accordance with the Contract Documents.

“Contract Documents” means the Cover Agreement, Definitions, General Conditions, the General Requirements, Purchaser’s Drawings, if any, the Technical Requirements, the Contract Forms listed in the Cover Agreement, all appendices and attachments to the foregoing documents, and amendments to any of them duly executed by both the Purchaser and the Contractor.

“Contractor” shall mean the party or parties named as such in the Contract and the legal personal representatives, successors and assigns of the Contractor.

“other contractor” or **“another contractor”** shall mean any person, firm or corporation employed by or having a contract directly or indirectly with the Purchaser otherwise than through the Contractor.

“DDP” shall mean “Delivered Duty Paid” per Incoterms 2010.

“EXW” shall mean “Ex works” per Incoterms 2010.

“Engineer” shall mean the engineer, engineers, or firm of consulting engineers, as the case may be, appointed in writing by the Purchaser to take charge of the Work, or a designated part (including the design) thereof, acting directly or through his or their properly authorized assistants or agents.

“Equipment” means all documents, designs, computer software, computer hardware, plant, materials, apparatus, tools, components, machinery, equipment, hardware, systems and other things required for the execution and completion of the Work and the remedying of any defects, or otherwise in respect of, and involving, Contractor’s performance of obligations under the Contract.

“Inspector” shall mean the person, firm or corporation authorized by the Purchaser to inspect the Work to be done and/or material to be furnished pursuant to the Contract acting directly or through his or their properly authorized assistants or agents.

“ID#” or “ITEM” shall mean a separate and designated part of the Work to be proposed, as defined in the Form of Proposal.

“Manitoba Business” is a business which is registered to do business in the Province of Manitoba, and the firm, or its principals, maintains their facilities, equipment and staff in Manitoba on a continuous basis.

“Personal Information” has the meaning given in The Freedom of Information and Protection of Privacy Act (Manitoba) and the Personal Information Protection and Electronic Documents Act (Canada).

“plant” shall mean all vehicles, transportation equipment, construction equipment, erection and installation equipment, falsework, forms, scaffolding, cofferdams, crushers, boilers, temporary storehouses and other temporary structures, lumber, timber, materials, power tools, machinery, appliances and apparatus which are brought on or constructed upon the site by the Contractor for the performance of the Work.

"Proponent" shall mean, as the context requires, any party or parties proposing on one or more of the various classes of work covered by the Instructions to Proponents, the General Requirements, the General Conditions, and the Technical Requirements.

"Purchaser" shall mean Manitoba Hydro, its successors and assigns.

"Site" shall mean the place or places where the Work is to be carried out for the Purchaser, and the immediate vicinity of such place or places.

"subcontractor" shall mean a person, firm or corporation having a contract with the Contractor for part of the Work, including without limitation the furnishing of labour, material, equipment or apparatus therefor.

"Superintendent" shall mean the duly appointed representative of the Contractor on duty at the site.

"tools" shall mean all small hand tools, other than power 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 or by any employee of the Contractor for the performance of the Work.

"Work" or "Services" shall mean all of the various classes of work to be done, executed and performed, whether temporary or permanent, and other equipment, apparatus, machinery and materials to be furnished and supplied by the Contractor pursuant to the Contract.

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.

END OF DEFINITIONS

INSTRUCTIONS TO PROPONENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR - 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040378

INSTRUCTIONS TO PROPONENTS

1 INVITATION

To be evaluated, a Proposal **must** be submitted not later than the Closing Date which is:

16:00:00 hours Manitoba local time
February 6, 2017 (the "Closing Date")

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

Proposals not submitted through MERX will not be accepted.

1.1 Delivery and Receipt of Submissions

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

(a) the timely delivery of any information or documentation, including, without limitation, the RFP by MERX, in connection with this RFP;
(b) the timely receipt of any proposals, revisions, amendments, notice of withdrawals, or any other information or documentation from any Proponent or potential Proponent, or;
(c) the working order, functioning or malfunctioning, of any electronic information system (including MERX).

2 PURPOSE

Issuing this RFP, Manitoba Hydro desires an experienced Contractor to enter into a Contract(s) for the design, test, manufacture, supply and delivery of overhead phase conductor for 500kV AC transmission lines.

Proponents are encouraged to review the balance of the RFP for additional information concerning Manitoba Hydro's anticipated commercial and technical needs in respect of any potential Contract.

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

By submitting a proposal, the Proponent agrees to the terms and conditions set out in this RFP.

3 GENERAL INTERPRETATION

Defined words and phrases used in this Request for Proposal have the meanings ascribed to them in the Definitions section or as expressly defined elsewhere in this Request for Proposal. Headings are used for convenience only, and they shall not affect the interpretation or meaning of the clauses, terms and conditions or the Request for Proposal or any resulting Contract.

4 ENQUIRIES

Enquiries concerning Request for Proposal 040378 including technical enquiries, should be in writing, using the Proposal Clarification Form, attached as Appendix A.

Enquiries should be submitted not less than **seven (7) calendar days** prior to the Closing Date. Enquiries received after that time may not be considered or answered.

Manitoba Hydro has the sole discretion to respond, or not, to an enquiry. Responses may be issued to the enquiring party only, or to any or all prospective Proponents.

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

5 PROPOSAL EVALUATION AND NEGOTIATION

5.1 General

Manitoba Hydro desires, through an evaluation and negotiation process, to determine if basis exists to award one (1) or more Contracts for performance of the Work described in this RFP.

Manitoba Hydro may select one (1) or more Proponent(s) for negotiation of a potential Contract.

Proposals submitted in respect to this RFP are for information and evaluation/negotiation/discussion purposes only.

5.2 Technical and Commercial Terms

The RFP describes the anticipated scope of work and anticipated technical and commercial needs of Manitoba Hydro. Manitoba Hydro is interested in receiving proposals that meet the technical and commercial needs outlined in this RFP.

With respect to technical needs, the Proponent may note in its proposal any technical exceptions which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative solution for addressing the matter in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

With respect to commercial needs, the Proponent may note in its proposal any commercial terms which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative wording for addressing the term(s) in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

5.3 Evaluation

Evaluation of proposals is expected to commence shortly after the Closing Date.

Manitoba Hydro reserves the right to complete or terminate evaluation of proposals at any time, or to extend the time of evaluation, without notifying Proponents.

Upon completion or termination of evaluation, Proponents may be notified that evaluation is complete.

5.4 Presentations

During evaluation of proposals, one (1) or more Proponents may be invited to attend at Manitoba Hydro's facilities in Winnipeg to make a presentation or participate in an interview concerning its proposal.

5.5 Amendments/ Further Information/Clarifications

During evaluation and negotiations, Manitoba Hydro reserves the right to request one (1) or more Proponents to:

(a) amend its proposal;
(b) provide additional, missing, and/or other information or documentation concerning its proposal; and
(c) clarify any matter(s) concerning its proposal.

In respect of any such matters, Manitoba Hydro shall have no duty or obligation to advise any other Proponent of any of the same, or to request them to vary their proposal as a result of any of the same.

5.6 Negotiation Process

Upon completion or termination of evaluation of proposals, Manitoba Hydro may select one (1) or more Proponents for negotiation of a Contract(s).

Manitoba Hydro will notify a Proponent if it has been selected for negotiations.

Manitoba Hydro reserves the right to terminate negotiations at any time.

Proponents are advised that Manitoba Hydro may conduct any negotiation through an intensive process. Such process may require a Proponent to make representative(s), who have sufficient decision-making authority, available for telephone, video-conference, and/or in person negotiating sessions.

5.7 Requirement for Contract

Until the execution of a Contract between Manitoba Hydro and a Proponent, there shall be no legal or other binding obligations created on the part of either party with respect to a Contract, the Work, or any matters related to the Work.

5.8 Manitoba Hydro Privilege/Discretion

Manitoba Hydro makes no representation or warranty that responding to this RFP will result in any negotiations or any Contract. Manitoba Hydro is under no obligation to evaluate any proposal, enter into any negotiations, or to award a Contract, with any Proponent or other person.

Manitoba Hydro reserves the right to cancel this RFP either before or after the Closing Date and regardless of whether or not any proposals have been received for any reason whatsoever.

Manitoba Hydro reserves the right to re-issue or tender all or any part of the work and services contemplated in this RFP at any time, including after the Closing Date, for any reason whatsoever.

Manitoba Hydro reserves the right to accept, waive or reject any non-compliance or irregularity, including without limitation, the right to accept, waive, or reject non-compliance or irregularity with respect to the requirements of the Instructions to Proponents and/or the submission requirements of this RFP.

Notwithstanding anything to the contrary in this RFP, Manitoba Hydro reserves the right to:

(a) negotiate any or all terms and conditions of a Contract with any one (1) or more Proponents, but not necessarily all Proponents, and to do so serially or concurrently and at any time;
(b) negotiate and enter into a Contract on terms and conditions different than those contained in the RFP and/or any Proposal;
(c) choose not to enter into negotiations with any one (1) or more Proponents;
(d) terminate negotiations with any one (1) or more Proponents at any time;
(e) choose not to award any Contract to any Proponent;
(f) terminate this procurement process at any time for any reason;
(g) choose to not offer the same or substantially the same or comparable terms and conditions of a proposed Contract to more than one (1) Proponent with which Manitoba Hydro may conduct negotiations; and
(h) enter into separate Contracts for different or identical portions of the Work, with any one (1) or more Proponents.

6 SCHEDULE OF RFP ACTIVITIES

The estimated schedule of activities concerning this RFP includes the following:

Description	Date
Closing Date for submission of proposals	As per Subsection 1.1 of these INSTRUCTIONS TO PROPONENTS
Evaluation of Proposals complete	March 10, 2017
Negotiations with Selected Proponent	March 24, 2017
Award of Contract	April 7, 2017

Manitoba Hydro may change the said schedule and dates and information without notice (including without notice to any actual or potential Proponent(s)) at any time including before and after the Closing Date of this RFP.

7 ADDENDA

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

8 FORM OF PROPOSAL

The Proponent is requested to use the Form of Proposal attached hereto. If any Form of Proposal page is found to have insufficient space, the Proponent is requested to attach a sheet or sheets immediately after such page.

The Proponent is encouraged to include in their proposal thorough and sufficient information concerning matters under consideration.

9 SIGNING OF PROPOSALS

A proposal submitted by:

(a) an individual shall be signed by the individual in the presence of a subscribing witness;
(b) a corporation shall be signed by the properly authorized signing officer or officers and the corporate seal affixed or by the properly authorized signing officer or officers in the presence of a subscribing witness or witnesses; or,
(c) a partnership or joint venture shall be signed by all partners or joint venturers in the presence of a subscribing witness or witnesses.

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. Each signature shall be accompanied by a printed name.

10 JOINT VENTURES/CONSORTIA

Proponents which are comprised of more than one legal entity, such as a joint venture or consortium of corporations, are to identify their duly appointed leader in the proposal.

Proponents are to execute the 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.

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 Contract awarded.

A copy of a written agreement binding the legal entities involved in each proposal shall be provided to Manitoba Hydro upon request. If no such writing exists at the time of request, it may be necessary for such entities to document their

arrangement to fulfill such requirement at any time, including after the time and date of closing for receipt of proposals and before or after an award of a Contract.

Where a Proponent is or includes a First Nation Band, the proposal shall be accompanied by a Band Council Resolution authorizing the provision of the proposal on behalf of the First Nation Band.

11 AMENDMENT OF PROPOSAL

A Proponent may amend its submitted Proposal on MERX at any time prior to the Closing Date. A Proponent may not amend its Proposal after the Closing Date except at the written request of Manitoba Hydro.

In order to advance toward a formal and binding contract during negotiations, Manitoba Hydro may issue a written request to the Preferred Proponent(s) for specific amendment(s) to its Proposal, and if the Proponent finds the request satisfactory, shall provide the requested amendment(s) via fax or letter.

All amendments must be signed by the person or persons having the authority to bind the Proponent.

Manitoba Hydro shall consider each Proponent's Proposal to be the Proponent's best position for entering into negotiations and for seeking award of a contract to perform the Work.

12 WITHDRAWAL OF PROPOSAL

At any time throughout the procurement process prior to execution of an agreement, a Proponent may revoke and withdraw a submitted Proposal by either removing the Proposal from MERX, if withdrawal is prior to the Closing Date, or by providing written notice to Manitoba Hydro via FAX or letter, if withdrawal is after the Closing Date.

Written notice of withdrawal of a Proposal must be duly signed by the authorized representative of the Proponent.

Manitoba Hydro is under no obligation to return withdrawn Proposals.

13 LANGUAGE

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

14 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 a proposal, satisfactory to Manitoba Hydro, that the Proponent has the ability, experience, capital and plant required to undertake and perform the Work successfully, and complete it within the time specified.

Manitoba Hydro may inspect any Plant and /or facilities that the Proponent proposes to use for doing the Work.

15 ESTIMATED QUANTITIES

Any quantities stated in the Request for Proposal or Form of Proposal are estimates only. Manitoba Hydro makes no guarantee with respect to any of same.

16 UNBALANCED PROPOSALS

Unbalanced unit prices or lump sum prices proposed may not be considered by Manitoba Hydro.

17 PROPONENT'S EXPENSES

The Proponent shall be responsible for all expenses concerning or related to the preparation of its proposal, including any subsequent discussions and/or negotiations.

18 PROPOSED PRICES

Proposed prices shall be stated in Canadian currency and shall include all customs duties, surcharges, insurance premiums, permit and licence fees, Workers Compensation and vacation pay assessments, and all other payroll benefits. Canadian Goods and Services Tax (GST) and Manitoba provincial retail sales tax (PST) shall be treated as specified in the Form of Proposal for each ITEM. All other applicable taxes shall be included and shall not be subject to any adjustment. No payment shall be made to the Contractor for sales tax (if any) which may be imposed by Canada or Manitoba in respect of the Contractor's plant, tools and any other items not included in the Work.

Prices in the accepted proposal, if any, shall be firm and not subject to adjustment for changes or unexpected contingencies of any kind whatsoever, including without restricting the generality of the foregoing, changes in wages, material costs, or taxes which may in future be imposed by lawful authority within or outside of Canada.

19 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 Business.

20 CORRUPT OR FRAUDULENT PRACTICES

Manitoba Hydro has the right at any time to reject any Proposal submitted by a Proponent or terminate negotiations with a Proponent if, in Manitoba Hydro's determination, the Proponent has engaged in any Corrupt, Fraudulent, Collusive, Coercive or Obstructive Practice or has breached any laws regarding corruption or fraud. For these purposes the following defined terms shall apply:

(a) **"Coercive Practice"** means impairing or harming, or threatening to impair or harm, directly or indirectly, persons or their property to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(b) **"Collusive Practice"** means an arrangement between two or more persons (including, without limitation, a Proponent and any other person) designed to achieve an improper purpose, including but not limited to the establishment of prices for the Work at artificial, non-competitive levels in the procurement process or in entering of the Contract.

(c) **"Corrupt Practice"** means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(d) **"Fraudulent Practice"** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, Manitoba Hydro, a Proponent, or any other person, to obtain a financial or other benefit or to avoid an obligation in the procurement process, or in the negotiation and signing of the Contract.

21 EVALUATION CRITERIA

In order to determine best value to Manitoba Hydro, proposals received will be evaluated using the following criteria (in no particular order of preference):

(a) Total evaluated cost (includes unit price, reel cost and reel policy, transportation cost, purchaser's inspection cost and type testing)
(b) Technical compliance of the proposal (absence of deviations from the Technical Requirements of this RFP)
(c) Commercial compliance (absence of deviations from the commercial terms and conditions of this RFP)
(d) Delivery date (includes production schedule and plant capacity)

All things being reasonably equal, the following additional criteria will be considered in the evaluation:

(a) Manitoba content

For the purposes of evaluation, Manitoba Hydro may take into account any or all of the information received from a Proponent under or pursuant to the RFP, Manitoba Hydro's knowledge of, and past experience with, the Proponent (including Proponent's performance on previous contracts with Manitoba Hydro, if any), and any information about the Proponent received from third parties and deemed reliable by Manitoba Hydro.

22 WAIVER

By submitting a proposal, the Proponent acknowledges Manitoba Hydro's rights under Request for Proposal 040378 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.

END OF INSTRUCTIONS TO PROPONENTS

GENERAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR - 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040378

GENERAL REQUIREMENTS

1 SCOPE OF THE WORK

The Work shall consist in all that is required for design, material procurement, manufacture and supply of 1192.5 MCM 45/7 Bunting ACSR/GA Conductor, including all supervision, labour, equipment, quality control, testing, packaging, shipping, delivery, Contractor's insurance and warranty, to meet requirements for the 500 kV AC Transmission Line.

Further requirements of the Work are provided in the Technical Requirements. The Work and any ITEM forming part of the Work shall also, in all respects, comply with the terms and conditions of the Contract.

2 WORK SCHEDULE

The Purchaser expects that all ITEMS of the Work will be delivered no later than **December 16, 2017**.

In carrying out the Work, the Contractor shall have reasonable latitude to organize the sequence of the Work, provided that the various stages of the Work are completed by the specified date(s) or the date(s) proposed by the Contractor and accepted by the Purchaser.

3 DELIVERY POINT(S)

If the Purchaser chooses delivery by the Contractor, the ITEMS of the Work shall be delivered to:

Manitoba Hydro Transmission Line Construction Material Yard
Gate 6, 59029, Hwy 207
Dugald, Manitoba R0E 0K0

4 DELIVERY OR LOADING OF THE WORK

4.1 Delivery of the Work

If the Purchaser chooses delivery of the Work by the Contractor, the Contractor shall prepare the Work for shipment in such a manner as to protect the Work from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation, loading, shipping, transporting, unloading, handling, or lifting. The Contractor shall be responsible for verifying the carrier's right-of-way clearances and weight limitations, if any, and for making all shipping arrangements.

4.2 Loading of the Work

If the Purchaser chooses to have the Work loaded, blocked, braced and secured by the Contractor at the Contractor's shipping facility or factory for transportation by the Purchaser or the Purchaser's designated carrier to the final destination, the Contractor shall prepare the Work for shipment in such a manner as to protect it from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation and loading.

5 FOREIGN NATIONALS WORKING IN CANADA

The following provisions apply to all workers employed by the Contractor or under the Contractor's control or for whom the Contractor is otherwise responsible under the Contract, who are NOT citizens of Canada or 'permanent residents' of Canada (as defined in the Immigration and Refugee Protection Act). Such persons are defined, collectively, in the Immigration and Refugee Protection Act as 'foreign nationals', which term is used below and has the same meaning.

The Contractor shall ensure that all workers who are foreign nationals and who perform services under the Contract in Canada are legally authorized to work in Canada. The Contractor shall obtain and maintain all necessary work permits, visas and documentation for such foreign nationals, and shall comply with all conditions imposed on the Contractor, as 'employer' of the foreign nationals, under the Immigration and Refugee Protection Act and regulations.

Before permitting any foreign nationals to perform services under the Contract in Canada, the Contractor shall, by notice in writing to the Engineer,

(a) list all such foreign nationals by name;

(b) certify that the said foreign nationals are legally authorized to perform services under the Contract in Canada; and

(c) provide copies of their respective work permits, and visas or other documentation if applicable.

Furthermore, the Contractor shall provide copies of work permit or visa renewals to the Engineer if applicable, so that at no time is any foreign national performing services under the Contract in Canada without the requisite legal authority.

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, R.S.M. 1987, c. W200.

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 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.

7 COMPLIANCE WITH STANDARDS

All materials, equipment and articles furnished by the Contractor shall comply with the applicable provisions of the standards of the Canadian Standards Association (CSA) or of the Canadian General Standards Board (CGSB) and where no such standards exist, materials, equipment and articles shall comply with the applicable provisions of the standard specifications of the American Society for Testing and Materials (ASTM).

END OF GENERAL REQUIREMENTS

GENERAL CONDITIONS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR REQUEST FOR PROPOSAL 040378

GENERAL CONDITIONS

1 INTENT

1.1 The Work

The Contractor shall fully and completely fulfill its obligations in respect of the Contract, and shall fully and completely perform the Work in every detail and within the timeframe(s) required, all in accordance with the Contract. The Contractor shall do or cause to be done and shall furnish any and everything necessary for such purposes all in accordance with the Contract.

The Contractor shall carry out the production, manufacture of all goods, products, materials and the Work, and the performance and execution of the Work:

(a) in accordance with the Contract;
(b) in the manner (if any) specified in the Contract;
(c) in a good and workmanlike manner;
(d) using new materials that are free of defects and are of the specified quality, if specified, otherwise of suitable quality as determined by the Engineer; and
(e) with properly equipped facilities and non-hazardous materials, except as otherwise specified in the Contract.

1.2 Application to Engineer

The Contractor shall apply to the Engineer for any explanation which the Contractor may require as to the meaning and intent of any provision in the Contract or in any document forming part thereof, and the Contractor shall be liable for any loss, damage or expense which the Purchaser may incur, suffer or be put to as a result of the Contractor's failure to obtain such explanation.

1.3 Interpretation

Defined words and phrases used in the Contract have the meanings ascribed to them in the Definitions forming a part of this Request for Proposal, or as expressly defined elsewhere in the Contract. Headings are used for convenience only and do not affect the interpretation or meaning of the Contract.

2 CORRUPTION AND FRAUD

The Contractor declares and undertakes in relation to the Contract that it:

(a) has not acted and will not act unfairly or dishonestly so as to cause loss to the Purchaser or deprive the Purchaser of its rights;

(b) has not offered, given, demanded or accepted any bribe or other improper benefit or advantage to any person and will not do so;

(c) has not provided false, inaccurate or misleading information to any person and will not do so;

(d) has not authorized, acquiesced or turned a blind eye to any form of corruption and will not do so;

(e) did not collaborate, directly or indirectly, with any person in competition for this or other contracts with the Purchaser during the procurement process;

(f) will not, in respect of any design services to be provided under the Contract, deliberately, knowingly, with willful blindness or recklessness, provide or approve a design which will provide an improper benefit or advantage to any person or which is in excess of the Purchaser's requirements and has not been fully disclosed and approved by the Purchaser;

(g) will not deliberately, knowingly or with willful blindness or recklessness, carry out, instruct, authorize, condone or be a party to provision of work, materials, equipment or services not of a quality and quantity required under the Contract; or

(h) will not conceal defective work, material, equipment or services.

3 AUTHORITY OF THE ENGINEER

3.1 No Authority to Amend Contract

The Engineer has no authority to amend the Contract.

3.2 Exercise of Authority

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:

(a) whenever carrying out duties or exercising authority, express 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.

3.3 Replacement

The Purchaser may, with notice to the Contractor, replace the Engineer.

3.4 Giving Effect

The Contractor and the Purchaser shall give effect to each determination of the Engineer unless and until revised pursuant to the ARBITRATION Section of the General Conditions.

4 CLARIFICATIONS AND CHANGES TO THE WORK

There will be four (4) mechanisms for clarifying 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	Contractor / Engineer	Clarification to the Work
Extra Work Order (EWO)	Purchaser	Approves change to the Work, related to the Contract Scope
Amending Agreement	Purchaser	Approves change to the Work, not related to the Contract Scope or Amends Terms of the Contract

Each of these mechanisms are described in this Section of the General Conditions.

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 or an Extra Work 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.

4.1 Clarifications to the Work

4.1.1 Work Instructions

Work Instructions are instructions and clarifications issued by the Engineer using the Work Instruction form set out in Appendix D: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 may be issued in response to a Request for Information from the Contractor or may be issued at the initiative of the Purchaser or Engineer.

Work Instructions are enforceable clarifications or refinements of the Contract, not amendments thereto.

Upon receipt of a Work Instruction, the Contractor shall promptly proceed with the Work as clarified therein.

The Contractor is not entitled to additional compensation or to changes in the time for performance of the Work as a result of the issuance of a Work Instruction.

4.1.2 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 D: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 28 days, the recipient will notify the requestor in writing.

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 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 28 days or notify the requestor of a required extension to the response period.

4.2 Changes to the Work

The Purchaser shall have the right, without notice to sureties on any bond, and without invalidating the Contract, 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, including additions, deductions, alterations and extras.

Such changes must in all cases be in writing signed by the Purchaser titled "Extra Work Order" and issued by the Engineer to the Contractor.

Upon receipt of a written Extra Work Order from the Engineer, the Contractor shall promptly proceed with the changes in the Work.

Adjustments to the Contract Price as a result of the changes directed by the Engineer in an Extra Work Order shall be determined in accordance with the PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK Section of these General Conditions.

4.2.1 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 D: Manitoba Hydro Forms for Clarification and Changes to the Work.

When initiated by the Engineer, the Proposal for Extra Work is a formal request for quotation for additional work required. The Contractor's responding quotation 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. The quoted price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

When initiated by the Contractor, the Proposal for Extra Work is a formal proposal for an alternate to the Work. The proposed price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

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 14 days, the requesting party shall be notified in writing.

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 14 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 quotation, 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. The Proposal for Extra Work may be accepted by the Purchaser providing written notice to the Contractor in the form of an Extra Work Order issued by the Engineer.

When the Contractor initiates a Proposal for Extra Work, the proposal shall be valid for a period of 14 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 issued by the Engineer.

4.2.2 Extra Work Orders

Extra Work Orders are formal approval of changes to the Work by the Purchaser where the change is related to or within the original Contract scope of the Work. The Purchaser through the Engineer may issue a written Extra Work Order using the Extra Work Order set out in Appendix D: Manitoba Hydro Forms for Clarification and Changes to the Work.

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 the Proposal for Extra Work Subsection of these General Conditions or the preceding sentence, if the Purchaser requires the Contractor to proceed with a change in the Work 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.

4.3 Contract Amendments

No amendment to any other terms or conditions of the Contract, other than those recognized to be made by Extra Work Order as provided in the Contract, shall be made unless first approved and authorized in writing by both the Purchaser and the Contractor. Such amendments shall be documented in an amending agreement signed by both parties.

5 PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK

The method for pricing and payment of all adjustments to the Contract Price due to changes to the Work by virtue of Extra Work Order pursuant to the CLARIFICATION AND CHANGES TO THE WORK Section of these General Conditions or pursuant to the CONTRACTOR CLAIMS Section of these General Conditions (hereinafter “Claims”), shall be as follows unless otherwise agreed to between the Purchaser and the Contractor.

5.1 Additions to the Work or Claims

5.1.1 Lump Sum

Where the Engineer has directed that an addition to the Work or Claim be dealt with by lump sum, the Contractor shall prepare and submit to the Engineer a detailed quoted lump sum cost of the requested addition or Claim. The quote shall not include any mark-up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The quoted lump sum cost shall include the following details as a minimum:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing cost
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

In respect of travel, airfare shall be limited to economy class, receipts shall be required.

(the “Quoted Cost”).

The Quoted Cost shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Quoted Cost was not accepted. Within the next 5 days, the Contractor will be entitled to submit a revised Quoted Cost.

Following such five (5) day period, the Engineer may either:

i) accept the latest Quoted Cost of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,

ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Quoted Cost of the addition or Claim as documented by issuance of an Extra Work Order;

5.2 Deductions from the Work

5.2.1 Credit for Deduction from the Work

Where a deduction from the Work is proposed by the Purchaser through issuance by the Engineer of a Proposal for Extra Work to the Contractor setting out such deduction, the Contractor shall prepare and submit to the Engineer a detailed quoted credit for the requested deduction. The quoted credit shall represent the cost to the Contractor to perform the Work to be deducted and shall not include any mark up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The Contractor shall submit a detailed breakdown of the proposed credit and at a minimum include the following:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing hours and rates for specific processes
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

(the "Deduction Credit")

The Deduction Credit shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Deduction Credit was not accepted. Within the next five (5) days, the Contractor will be entitled to submit a revised Deduction Credit.

Following such 5 day period, the Engineer may either:

i) accept the latest Deduction Credit of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,

ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Deduction Credit as documented by issuance of an Extra Work Order.

6 CONTRACTOR CLAIMS

6.1 Notice of Intent to Claim

If the Contractor determines it is entitled to additional costs to perform the Work 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 D: Manitoba Hydro Forms for Clarification and Changes to the Work 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 Contract Price or to any adjustment to the Contract Schedule, and the Purchaser shall be discharged from all liability in connection with the claim.

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.

6.2 Claim Documentation

Within 21 days after the Contractor has given written Notice of Intent to Claim in accordance with the Notice of Intent to Claim Section of these General Conditions, 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;
(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 request.

All subsequent communications with the Engineer respecting a claim or potential 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 of the General Conditions, each party shall take reasonable steps to mitigate its losses.

6.3 Determination of Claim

The Engineer shall proceed in accordance with this Section of the General Conditions to determine:

i) the extension (if any) of the time for completion of the Work in accordance with the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of these General Conditions; and,

ii) the adjustment (if any) to the Contract Price to which the Contractor is entitled to pursuant to the Contract.

Whenever a provision of the Contract provides that the Engineer shall proceed in accordance with this Subsection 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 Subsection, 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 a fair 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 extension of time or an adjustment to the Contract Price, or both, are warranted in the opinion of the Engineer, the Engineer shall document such changes in an Extra Work Order. 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 the ARBITRATION Section of these General Conditions.

For any claims made in accordance with this Section 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 the ARBITRATION Section of the General Conditions.

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 this Section of these General Conditions.

The Contractor shall not delay or hold up performance of the Work during resolution of a claim pursuant to this Section or originating pursuant to the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of the General Conditions or during referral of any such claim to arbitration as permitted above.

7 REQUEST FOR EXTENSION OF TIME

The Contractor shall be entitled, subject to the CONTRACTOR CLAIMS Section of the General Conditions, to an extension of time for completion of the Work if completion of the whole of the Work is or will be delayed by any of the following causes:

(a) legal strikes or walkouts;
(b) any peril insured against pursuant to the INSURANCE Section of the General Conditions;
(c) unpreventable accident;
(d) terrorism, war or delay caused by war;
(e) vandalism or malicious mischief not reasonably preventable by the Contractor;
(f) riot or civil commotion;
(g) acts of God;
(h) lawful orders of civil or military authorities; or
(i) a cause of delay giving an entitlement to extension of time 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 Subsection 6.1 Notice of Intent to Claim of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c), (d), (e), (f), (g), (h), and (i) above resulted in a delay to the completion of the Work; and,

ii) 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.

Other than as stated in this section and the PURCHASER CAUSED DELAY Section of the General Conditions, 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.

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.

8 PURCHASER CAUSED DELAY

If the Contractor suffers delay and/or incurs additional costs in relation to the Work as a result of:

(a) an Extra Work Order issued by the Engineer without the agreement or in absence of the agreement of the Contractor;
(b) negligence or default on the part of the Purchaser;
(c) negligence or default on the part of another contractor for whom the Purchaser is responsible; or
(d) deviation from the Contract or temporary suspension of the Work by direction of the Engineer;

then the Contractor shall give notice to the Engineer in accordance with the Notice of Intent to Claim Subsection of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c) and (d), 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;
ii) 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,
iii) the resulting adjustment, if any, to the Contract Price for the substantiated amount of resulting additional costs to the Contractor.

9 SCHEDULE OF THE WORK

The Contractor shall submit to the Engineer within 20 working days of the effective date of the Contract, a time chart or schedule containing all or such part of the following information as the Engineer requires:

(a) the scheduled date of completion of design and submission of working drawings to the Engineer for approval;
(b) the scheduled date of start and completion of type test
(c) the scheduled date of completion of all orders for material required for the Work;
(d) the scheduled date of completion of manufacture, fabrication and/or assembly of the Work;
(e) the scheduled date of completion of delivery of the Work (and where applicable, unit sections thereof) to the site; and
(f) such other information as is requested in writing by the Engineer.

The Contractor shall also submit reports on the progress of the Work to the Engineer containing such detailed information as the Engineer from time to time requires on the design, material, manufacture, fabrication, assembly, shipment and delivery of the Work. The Contractor shall grant authorized representatives of the Purchaser and Inspector access to the Contractor's factory and to the factory or factories of all subcontractors, during the Contractor's or subcontractor's normal business hours, to enable such representatives to ascertain the state of the Work and the progress being made thereon by the Contractor or subcontractor.

10 LANGUAGE, DIMENSIONS AND WEIGHTS

All communication, including without limitation all notices, documents, notes on drawings, and submissions, required or permitted under the Contract, shall be in English.

Any Work shall be executed in the SI (Metric) System of Units except for bolts and nuts. Dimensions shall be shown in metres and millimetres and weights shall be shown in kilograms and metric tonnes.

11 SUBCONTRACTS

The Contractor shall not, without the prior approval in writing of the Purchaser, assign the Contract, nor make a subcontract with any person, firm or corporation for the execution of any portion of the Work, other than for materials or for any part of the Work for which the manufacturer or supplier is named in the Contract. If the Contractor wishes to sublet any part of the Work, the Contractor shall first submit to the Purchaser for approval, a description of the part of the Work which the Contractor wishes to sublet and the name or names of the subcontractor or subcontractors it wishes to employ. Any approval given by the Purchaser as provided for in the immediate preceding sentence shall not relieve the Contractor from any obligation or liability for the full and complete performance of the Work, all in accordance with the Contract.

If the Purchaser gives its approval thereto in writing, and the Contractor enters into one or more subcontracts, 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.

All work done by a subcontractor shall, for the purposes of the Contract, be deemed to be done by the Contractor and payment therefore 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 therefore. 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.

If the Purchaser so requests, the Contractor shall furnish the Purchaser with duplicate copies of all orders placed by the Contractor with subcontractors.

12 COOPERATION BETWEEN CONTRACTORS

The Contractor shall cooperate with all other contractors who may be performing Work on behalf of the Purchaser, and with the workers who may be employed by the Purchaser on any work at/in the vicinity of the Site. 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 materials and equipment of the Purchaser or of other contractors.

13 INSURANCE

The Contractor shall provide, maintain and pay for the insurance coverage listed below. The Contractor shall supply the Purchaser with a certified copy of the required policy of insurance and all renewals thereof. A Certificate of Insurance may be submitted in place of the policy provided that all terms and conditions of required coverage are specified therein. All documentation must be submitted to the Purchaser prior to the commencement of the Work or delivery of goods or services.

The policy shall be endorsed to provide the Purchaser with not less than 30 days' written notice in advance of cancellation, change or amendment restricting coverage, and to show the Purchaser as an Additional Insured.

The Contractor shall be responsible for any deductible amounts under the policy except where such amounts may be excluded from the Contractor's responsibility. Should a loss be sustained, the Contractor shall act on behalf of both the Purchaser and the Contractor for the purpose of adjusting the amount of loss with the insurance companies.

13.1 General Liability Insurance

General Liability Insurance, shall provide limits of not less than $2 000 000 (CAD) inclusive, per occurrence, for bodily injury, death, and damage to property including loss of use thereof.

The General Liability Insurance shall include insurance coverage for the following:

(a) Premises Property and Operations
(b) Products and Completed Operations
(c) Blanket Contractual Liability
(d) Cross Liability
(e) Non-owned Automobile Liability
(f) Occurrence Property Damage
(g) The Purchaser named as Additional Insured

14 IMPORTS

The Contractor shall be the importer of all non-Canadian goods and services.

15 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 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.

16 MATERIALS AND LABOUR

Unless otherwise specified in the contract, the Contractor shall furnish all material and shall perform all labour necessary for the due and proper design, manufacture, fabrication, completion and delivery of the Work.

All work done and materials supplied pursuant to the contract shall be of specified quality, if specified, otherwise of suitable quality as determined by the Engineer.

17 INVOICES

The invoices to be submitted by the Contractor shall be satisfactory to the Purchaser in both form and content. The Contractor shall also provide supporting documents and receipts if requested by the Purchaser.

18 RECORDS

The Contractor shall:

(a) keep full and detailed records, books, accounts, correspondence, instructions, drawings, receipts, vouchers, memoranda, and records of labour force, plant, tools, equipment, hours worked, rates required to properly appraise the progress of the Work, (herein “records”), necessary for the proper administration of the Contract and the Work.

(b) provide the Engineer and/or the Purchaser with copies of any records when requested, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(c) provide the Engineer and/or the Purchaser with reasonable access to any premises and to inspect and/or audit records, and permit copies to be made of same, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(d) preserve records for a period of not less than three (3) years from the date of the Completion Certificate.

19 CONFLICTS

For the entire duration of the Contract, the Contractor and its agents shall not provide equipment or services to any other person(s) in a manner which conflicts with the Contract.

20 CONFIDENTIALITY

The Contractor shall keep the Confidential Information confidential, using no less a standard than measures the Contractor uses to keep its own highly confidential information secret, but in any event not less than a reasonable standard of care.

Confidential Information may only be used by the Contractor for providing Services to the Purchaser and for no other purpose whatsoever.

The Contractor shall not, without the prior written consent of the Purchaser, disclose or otherwise make available any Confidential Information to any other Person, except to such directors, officers, and employees of the Contractor who have a need to access Confidential Information to perform their obligations to the Contractor for Hydro. The Contractor shall be responsible for any breach of the terms of this Section by it or any such Person.

The Contractor shall deliver Confidential Information to the Purchaser immediately on demand from the Purchaser and, on demand from Hydro, certify in writing to Hydro within ten (10) days of such demand that Confidential Information has been erased or destroyed.

The Contractor acknowledges that any failure to comply with the provisions of this Section hereof, shall cause irreparable harm to Hydro which cannot be adequately compensated for in damages, and accordingly acknowledges that Hydro shall be entitled, in addition to any other remedies available to it, interlocutory and permanent injunction relief to restrain any anticipated, present, or continuing breach of this Contract.

The Contractor's obligations pursuant to this Section hereof shall continue without limitation of time.

The Contractor shall

(a) have in place and utilize systems, media, policies, and procedures, for the storage of, security for, access to, handling of, transfer of, and destruction of, Personal Information that would satisfy the requirements of: (i) The Freedom of Information and Protection of Privacy Act (Manitoba) as if that Act applies to Contractor; and (ii) the Personal Information Protection and Electronic Documents Act (Canada) requirements for protection of Personal Information; and conform to ISO 27000;

(b) secure Personal Information against unauthorized and accidental access, disclosure or attack.

21 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 the type/sample/routine 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, at the Contractor's expense, 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 the USE OF FAULTY OR DEFECTIVE WORK Section of the General Conditions.

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. The Contractor shall be liable for all 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 invoice therefore certified correct by the Purchaser. The Purchaser may, at the Purchaser's option, apply moneys due or to become due from the Purchaser to the Contractor in or towards payment of such costs, charges and expenses, in which event the Contractor shall remain liable for any deficiency.

22 USE OF FAULTY OR DEFECTIVE WORK

Until all faulty or defective work has been made good or altered as provided by the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions, the Purchaser shall have the right to use any such faulty or defective work at the Contractor's sole risk, and without thereby in any way affecting the Purchaser's rights under the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions 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.

23 CONTRACTOR'S LIABILITY

23.1 The Work

Unless otherwise specifically provided in the Contract, the Work shall be and remain at the risk of the Contractor and the Contractor shall make good loss thereof or damage thereto occurring between the effective date of the Contract and the date of the COMPLETION CERTIFICATE issued in respect thereof, or the date of final payment, whichever shall first occur.

23.2 Labour and Materials

The Contractor 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.

23.3 Injury to Persons or Property

If, at any time after the effective date of the Contract and before the date of the COMPLETION CERTIFICATE, or if at any time thereafter while the Contractor, its officers, servants, agents, employees or subcontractors are on the site for the purpose of making good any breakage, defect or failure in the Work pursuant to the WARRANTY Section of the General Conditions, there shall occur any injury (including loss of life), loss or damage to any person or property, other than property forming part of the Work, caused by or resulting from defective plant, material, workmanship, fabrication, or construction or by anything done, or omitted to be done, or permitted to be done by the Contractor, its officers, servants, agents, employees or subcontractors (but not otherwise), then the Contractor shall 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 by any person, firm or corporation for, or by reason, or on account of such injury, loss or damage, or anything relating thereto.

24 INTELLECTUAL PROPERTY

Drawings, reports, manuals, documents, and other and/or similar materials (herein "Drawings") produced/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 Drawings shall remain with the Contractor. The Contractor shall grant the Purchaser a perpetual, royalty free, non-transferable (save and except transferable to the Purchaser's affiliates or transferable to any entity created after the effective date of the Contract and to which the Purchaser assets are assigned or otherwise transferred) limited licence to use, copy, and to allow third parties to use, the Drawings and all proprietary information in the Drawings as may be required for the purpose of proposing, installing, operating, repairing, maintaining, modifying, replacing and/or upgrading the Work, or any part thereof.

25 PAYMENTS BY THE CONTRACTOR

The Contractor shall promptly pay all assessments, premiums, levies, taxes, permit and licence fees and shall promptly pay for all materials, labour, and services obtained or required by the Contractor in the execution of the Contract. If the Contractor fails to pay the same, or unduly delays payment, the Purchaser may, at the Purchaser's option, make such payment or payments for and on behalf of the Contractor, and thereafter the Contractor shall on demand, pay the Purchaser an amount equal to the aggregate of all the sums so paid by the Purchaser, plus interest on the sums so paid at an interest rate equal to the Prime Rate of interest charged by the Purchaser's bank plus 3% per annum calculated from the date of payment by the Purchaser to the date when moneys are next due and payable by the Purchaser to the Contractor under the Contract, plus the sum of $10.00 (CAD) as a service charge in respect of each cheque issued by the Purchaser for or on behalf of the Contractor pursuant to this Section of the General Conditions, or the Purchaser may, at its option, deduct the aforesaid sums, interest and service charge from any moneys due or to become due to the Contractor from the Purchaser, provided that no payment by the Purchaser as aforesaid shall be held to relieve the Contractor from the Contractor's liabilities and obligations under the Contract.

The Contractor shall keep a record of the pro rata share of accrued interest on holdbacks due all subcontractors.

26 WARRANTY

If, within 24 months from the date when the Work has been accepted by the Purchaser, the Work or any part thereof becomes broken or defective or fails due to faulty or improper design, material, workmanship, manufacture, fabrication, shipment or delivery, or fails to meet the requirements of the contract, then the Contractor, upon notification in writing from the Purchaser, shall forthwith make good every such breakage, defect or failure without cost (including without limitation, transportation costs to and from the place where the Work was delivered) to the Purchaser.

If, after such notification, 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 all costs, charges and expenses incurred by the Purchaser in connection therewith and shall forthwith pay to the Purchaser an amount equal to such costs, charges and expenses upon receipt of invoices therefore certified correct by the Purchaser.

The Contractor’s liability under this Section of the General Conditions shall be in lieu of any warranty or condition implied by law as to the quality, design or fitness of the Work for any particular purpose, and save as in this Section of the General Conditions expressed the Contractor shall not be liable for defects in any work after the Work has been taken over by the Purchaser or for any injury or damage resulting from any such defects.

Provided the Contractor is not otherwise in default under the terms of the contract, and subject to the provisions of the CONTRACTOR’S LIABILITY and RESPONSIBILITY AS TO PATENTS Sections of the General Conditions, the Contractor’s liability in respect of the Work, whether in contract, tort or otherwise, shall cease upon the fulfilment by the Contractor of the Contractor’s obligations under this Section of the General Conditions; provided further that any part of the Work made good under this Section of the General Conditions shall be subject to all provisions of this Section of the General Conditions for a further period of 24 months from the date when the same has been made good as aforesaid.

Where more than one unit section of equipment is included in the Work, the said period of 24 months shall be deemed to commence when each unit section of the Work has been taken over by the Purchaser.

27 INSPECTION AND TESTING

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 or Inspector. Any special tests which the Purchaser requires are set forth in Request for Proposal 040378. The Contractor shall co-operate with the Engineer or Inspector and shall make available every facility which the Contractor possesses for inspecting and testing.

All work, materials and equipment condemned by the Engineer or Inspector shall be removed and rebuilt or replaced in accordance with the Contract at the Contractor’s expense 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 work shall be promptly repaired and made good at the Contractor’s own proper cost and expense.

If the Purchaser 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, proper operation 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 the USE OF FAULTY OR DEFECTIVE WORK, CONTRACTOR'S LIABILITY, CONTRACTOR'S DEFAULT, TERMINATION FOR BREACH OF CONTRACT, WARRANTY and INTERPRETATION OF THE CONTRACT Sections of the General Conditions.

28 COMPLETION CERTIFICATE

Subject to the provisions of the WARRANTY Section of the General Conditions, 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, the Purchaser will issue a COMPLETION CERTIFICATE (see SAMPLE ONLY COMPLETION CERTIFICATE included as Appendix E) to the Contractor, and from and after the date of said Certificate, the Purchaser shall be deemed to have accepted and taken over the Work, or the unit section thereof, as the case may be.

29 CONTRACTOR'S DEFAULT

If the Contractor:

(a) abandons the Work;

(b) fails to perform the Work in accordance with the terms and provisions specified in the Contract;

(c) fails to perform the Work within the time or times specified in the Contract;

(d) becomes bankrupt or insolvent, or makes an assignment for the general benefits of creditors;

(e) permits any execution to be levied on the Contractor's real or personal property or on any portion of the Work;

(f) assigns or sublets the Contract without the consent in writing of the Purchaser;

(g) loses control of the Work for any cause whatsoever, except by act of God, lawful orders of civil or military authorities, or the public enemy;

(h) refuses or neglects to follow the instructions of the Purchaser;

(i) fails to meet the Purchaser's requirements for material, plant, methods and/or labour within a reasonable time;

(j) refuses or neglects to use measures to protect the Work from damage;

(k) is guilty of carelessness or incompetence in the execution of the Work;

(l) delays the Work or any part thereof unnecessarily or unreasonably; or

(m) is in default of any other of its covenants or obligations in, or arising from, the Contract;

then the Purchaser may, at its option, and without prejudice to any other rights or remedies:

i) at the Contractor's expense, 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; and/or

ii) at the Contractor's risk and expense, remove unsuitable or inefficient material, plant and tools from the site; and/or

iii) at the Contractor's expense, take over and carry on the Work to the extent necessary to avoid loss or waste or damage to the Work already performed; and/or

iv) give notice of intention to terminate the Contract as provided in the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions.

30 TERMINATION FOR BREACH OF CONTRACT

If the Contractor makes default in any manner set forth in the CONTRACTOR'S DEFAULT Section paragraph (b), (c), (h), (i), (j), (k), (l), or (m) of the General Conditions, the Purchaser may give written notice to the Contractor of intention to terminate the Contract, stating the reasons therefore. If the Contractor does not remedy or take steps to remedy the default to the satisfaction of 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 the CONTRACTOR'S DEFAULT Section paragraph (a), (d), (e), (f) or (g) of the General Conditions, 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 thereafter. The Purchaser may, at its 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 may think fit, for the account and at the expense of the Contractor, and the Contractor shall be liable to the Purchaser for any excess cost occasioned the Purchaser.

At any time after the Purchaser has terminated the Contract, the Purchaser, with such assistance 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's material, plant, and tools at the site may be utilized by the Purchaser, without payment, for the purpose of completing the Work, and may be sold by the Purchaser by private sale or by public auction, either for cash or credit, and upon such terms and conditions as the Purchaser deems most advantageous, but without the Purchaser being liable for loss which may be occasioned thereby. The proceeds of such sale shall be applied in and towards the satisfaction of any money due or to become due to the Purchaser from the Contractor under the Contract.

Upon any termination of the Contract as provided herein, 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. 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 or due completion 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 moneys due or to become due to the Contractor. 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.

31 TERMINATION FOR CONVENIENCE

Notwithstanding the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions, the Purchaser may terminate the Contract (for whatever reason the Purchaser deems fit and at any time during the Work) on 30 days' written notice. The Purchaser shall pay for fees and expenses incurred to the date of the termination.

Without restricting its other remedies, the Purchaser may immediately terminate the Contract in writing if the equipment or services are unsatisfactory, inadequate, or improperly performed, the Contractor fails to comply with the Contract, or the Contractor becomes bankrupt or insolvent.

32 RESPONSIBILITY AS TO PATENTS

The Contractor shall pay all royalties payable under or in respect of, and shall fully 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 of, any and all letters patent, registered design, trade mark or copyright of any apparatus or component part thereof forming part of or used in or 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 this proposing document, but such indemnity shall not cover any use of the Work otherwise than for the purpose indicated by or reasonably to be inferred from this proposing document.

In the event of any claim being made or action brought against the Purchaser arising out of the matters referred to in this Section of the General Conditions, the Contractor shall be promptly notified thereof and may at its own expense conduct 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 conduct by the Contractor of such negotiations or litigation shall be conditional upon the Contractor having first given to the Purchaser such reasonable security as shall from time to time be required by the Purchaser to cover the amount ascertained, or agreed, or estimated, as the case may be, of any compensation, damages, expenses, and costs for which the Purchaser may become liable in respect of such infringement or alleged infringement as aforesaid. The Purchaser shall, at the request of the Contractor, afford all available 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, replace such work with a non-infringing work or modify it so that it becomes non-infringing or remove the said enjoined work and refund the sums paid therefor.

33 OWNERSHIP OF EQUIPMENT AND SUPPLIES

Any equipment and supplies provided by Manitoba Hydro to the Contractor for use pursuant to the Contract shall remain the property of Manitoba Hydro and shall be returned to Manitoba Hydro upon request.

34 ENUREMENT

The Contract shall enure and be binding upon the parties and their executors, administrators, heirs, successors and permitted assigns.

35 ASSIGNMENT OF RIGHTS AND OBLIGATIONS

The Contractor shall not assign any of its rights or obligations arising under the contract without the written consent of the Purchaser, which consent may be arbitrarily withheld.

36 SURVIVAL OF TERMS

Sections RECORDS, CONFIDENTIALITY, CONTRACTOR'S LIABILITY, ENUREMENT, INTELLECTUAL PROPERTY, OWNERSHIP OF EQUIPMENT AND SUPPLIES of the General Conditions shall survive the termination or expiration of the Contract.

37 INTERPRETATION OF THE CONTRACT

The Purchaser's decision shall govern 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 the Purchaser shall be the sole judge of the quality, quantity, suitability and efficiency of labour, workmanship, materials, plant, apparatus, equipment, appliances and methods used, furnished or supplied by the Contractor pursuant to the Contract.

The Contract shall be interpreted according to the laws of the Province of Manitoba, Canada.

38 OBSERVANCE OF LAWS AND REGULATIONS

Until the Work shall have been fully completed and accepted by the Purchaser, the Contractor shall be liable for the due and proper observance, both by itself, and by its servants, agents, employees and subcontractors, of all statutes, by-laws, rules and regulations in any way affecting or relating to the Work, which are lawfully imposed by any federal, provincial or municipal authority.

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 statutes, by-laws, rules and regulations by the Contractor, its servants, agents, employees and subcontractors.

39 APPLICABLE LAWS

The Contract shall be governed by the laws of the Province of Manitoba, Canada.

40 NOTICES

Every notice or communication required or permitted to be given or served pursuant to the Contract shall be in writing, and shall be delivered personally or by fax:

To the Purchaser:
TBD

To the Contractor:
TBD

To the Engineer:
TBD

In addition to forgoing, the Purchaser may effectually give notice to the Contractor:

(a) by giving same on the Superintendent, whether personally, or by fax to the Superintendent's designated Manitoba office; or

(b) by giving same to Contractors address and contact particulars included in the Contract.

Notice given or served by personal service shall be deemed effectually given and received upon such personal service, and notice given or served by fax shall be deemed effectually given and received on the first (1st) calendar day after the day of transmission.

The Contractor acknowledges and agrees that the Engineer is an employee of the Purchaser.

41 ARBITRATION

41.1 Notice of Dissatisfaction Concerning Engineer Determinations

A party shall be conclusively deemed to have accepted a determination by the Engineer issued under any provision of the Contract, 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 seven (7) 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.

41.2 Amicable Settlement of Disputes

The Purchaser and the Contractor shall make all reasonable efforts to resolve any 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 Engineer and Contractor's representative fail to resolve the dispute, 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 a Vice President for the Purchaser and the equivalent senior executive of the Contractor.

41.3 Final and Binding Arbitration

If the dispute has not been resolved within a reasonable time, 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, together with a concise statement of the matters in dispute.

41.4 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.

41.5 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.

41.6 Venue

Arbitration proceedings shall be conducted at Winnipeg, Manitoba.

41.7 Work to Continue

The Contractor shall not suspend, delay or interfere with 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 above, nor during arbitration proceedings.

END OF GENERAL CONDITIONS

TECHNICAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR - 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040378

TECHNICAL REQUIREMENTS

1 DESCRIPTION OF THE WORK

Design, material procurement, manufacture, supervision, labour, equipment, quality control, testing, packaging, shipping, delivery, Contractor's insurance and warranty of 1192.5 MCM 45/7 Bunting ACSR/GA Conductor for 500 kV AC Transmission Line is required.

2 REFERENCE STANDARDS

The latest revisions of the following standards, current at the time and the date of the execution of the Contract, shall apply.

American Society for Testing and Materials (ASTM):

ASTM B232	Standard Specification for Concentric-Lay-Stranded Aluminum Conductors, Coated steel Reinforced (ACSR)
ASTM B230	Specification for Aluminum 1350-H19 Wire for Electrical Purposes
ASTM B263	Standard Test Method for Determination of Cross-Sectional Area of Stranded Conductors
ASTM B498	Specification for Zinc-Coated (Galvanized) Steel Core Wire for Use in Overhead Electrical Conductors
ASTM B500	Specification for Zinc-Coated (Galvanized) Steel Core Wire for Use in Overhead Electrical Conductors

Canadian Standards Association (CSA):

CAN/CSA-C61089	Round wire concentric lay overhead electrical stranded conductors

International Electrotechnical Commission (IEC):

IEC 61395	Overhead electrical conductors – Creep test procedures for stranded conductors

International Organization for Standardization (ISO):

ISO 9001	Quality Management Systems –Requirements

In case of conflict between the Technical Requirements and the referenced standards, the requirements of the Technical Requirements shall take precedence.

3 SYSTEM PARAMETERS

3.1 Operating System Parameters

The conductors shall be suitable for reliable operations under the specified environmental conditions as shown in Table 1.

Table 1
Environmental Conditions

Condition	Specified Value
Ambient Air Temperature: Minimum Maximum	 -50°C -40°C
Maximum Continuous Operating Temperature:	100°C
Altitude	Less than 500m
Environment Type	Rural and agricultural
Terrain Type	Mainly flat and open with few trees or buildings; snow-covered during winter

3.2 Conductor Characteristics

Conductor Type:	Aluminum Conductor Steel Reinforced (ACSR/GA)
Conductor Designation:	Bunting
Conductor Size:	1192.5 MCM
Aluminum Type:	1350-H19
Outside Diameter:	1.302 inch

Stranding Design:	45/7
Strand Diameter (Al):	0.1628 inch
Strand Diameter (Steel):	0.1085 inch
Outer Layer:	Right hand lay
Linear Density:	1342 lb/1000 ft
Type of Coated Steel Wire:	Class A Zinc Coated Steel Wire
Rated Tensile Strength (RTS):	32 kips
Bundle Configuration:	Triple – see Figure 1

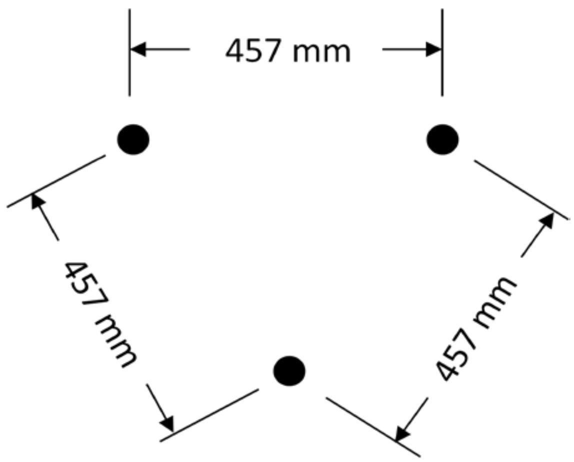

Figure 1 - Conductor Symmetric Bundle Configuration

4 CONDUCTOR CHARACTERISTICS

4.1 Material

The complete conductor shall be made up of aluminum and steel wires possessing, before stranding, the electrical and mechanical characteristics and dimensions specified in ASTM B232, ASTM B230 and ASTM B498.

All materials shall be new and be of the top quality for their respective kinds. These materials shall have proven records operating in similar service conditions. Liberal factors of safety shall be allowed.

4.2 Conductor Stress-Strain and Creep Data for PLS-CADD Coefficient

The PLS-CADD cable file shall be provided by the Contractor at time of bid. The conductor information shall include the Contractor’s own stress-strain and creep test data for the specified conductor.

5 MATERIALS AND MANUFACTURING

5.1 General

Materials and workmanship incorporated into the manufacturing of the conductor shall be in full compliance with the latest engineering practice. Workmanship of all parts shall be of the highest quality.

The surface of the conductor shall be free of all imperfections, including nicks, indentations and excessive lubricant.

5.2 Stranding

Before stranding, the steel core or the partially stranded conductor, and the strands to be added, shall be kept inside the Contractor's factory long enough to ensure that the steel core or partially stranded conductor, and the strands to be added, are at the same temperature as will be maintained throughout the stranding process.

The steel core shall be formed so that the original lay and diameter of the steel core can be restored easily by twisting the core wires together by hand when the conductor is cut and the aluminum strands are removed. This is to permit easy installation of the steel compression sleeve.

A uniform tension shall be maintained on all bobbins to prevent loose stranding. The conductor shall be stranded in one pass if possible. If this cannot be done, the conductor shall be stranded in a maximum of two passes.

The direction of lay of the external layer shall be “right-hand”.

5.3 Joints

No joints or splices of any kind shall be used during stranding.

5.4 Lay Factors

The aluminum wires and the zinc-coated steel wires shall have lay factors within the limits specified in ASTM B232 Table 5 and ASTM B500 Clause 7.

5.5 Conductor Length

The Purchaser’s preferred conductor length is 3,200 metres per reel. Other reel lengths, such as those recommended by the manufacturer, may be approved at the discretion of the Purchaser’s Technical Representative.

Reel lengths may vary with a tolerance of ±5%. Also, up to 5% of the total order weight may be furnished in random lengths provided no piece is less than 50% of the standard conductor length.

6 TESTING REQUIREMENTS

The Contractor shall be responsible for all testing costs as set out in the Technical Requirements and these testing costs are deemed included in the Contract Price.

6.1 Classification of Tests

The conductor shall be subjected to testing in accordance with Table 2 of the Technical Requirements.

Table 2
Test Requirements

Item	Test	Reference Clause	Insulator String Assemblies		
			Type	Sample	Routine
The Complete Conductor					
1	Tensile Test	ASTM B232 Clause 15.4	x		
2	Stress-Strain Test	CSA C61089 Annex B	x		
3	Creep Test	IEC Standard 61395 and Clause 6.61 of the Technical Requirements	x		
4	Cross-sectional Area	ASTM B263	x	x	x
5	Conductor Diameter	ASTM B232 Clause 9.8	x	x	x
6	Linear Density	ASTM B232 Clause 11	x	x	x
7	Lay Ratio and Direction of Lay	ASTM B232 Clause 8	x	x	x
Aluminum Wire					
8	Wire Diameter	ASTM B230 Clause 14.1	x	x	x
9	Tensile Strength and Elongation	ASTM B230 Clause 14.3	x	x	
10	Electrical Resistivity	ASTM B230 Clause 14.4	x		
11	Bending Test	ASTM B230 Clause 8	x	x	

Item	Test	Reference Clause	Insulator String Assemblies		
			Type	Sample	Routine
Zinc-Coated Steel Wire					
12	Wire Diameter	ASTM B498 Clause 14	x	x	x
13	Tensile Strength and Elongation	ASTM B498 Clause 8	x	x	
14	Warp Test	ASTM B498 Clause 9	x	x	
15	Coating Test	ASTM B498 Clause 10	x	x	
16	Adherence of Coating	ASTM B498 Clause 11	x	x	

6.2 Access and Notification

The Contractor shall allow the Purchaser or its representative access to all tests for the Work as set out in the Technical Requirements. The Contractor shall give notice to the Engineer of such testing a minimum of 30 days in advance.

6.3 Type Tests

6.3.1 General

Type tests are intended to demonstrate conformance of electrical and mechanical characteristics of the proposed conductor with all the requirements of the Technical Requirements. The conductor shall be subject to type tests listed in Table 2 of the Technical Requirements.

Type Test Reports shall be completed by a qualified third party laboratory which must be pre-approved by the Engineer. Type Test Reports shall be submitted electronically to the Engineer for approval.

The Purchaser shall not accept any material deliveries until the Type Test Report has been approved by the Engineer.

6.3.2 Existing Type Tests

The Engineer may accept the existing type test reports offered by the Contractor in the Contractor's Proposal, provided that:

(a) All the type tests were made of the same type of conductor as required by the Technical Requirements;

(b) Testing was performed in accordance with all the requirements of the Technical Requirements;
(c) Testing was performed within the last ten (10) years;
(d) Testing was done on conductor manufactured at the same facility; and
(e) The Contractor's manufacturing process has not changed since the time of the type tests performed.

The Engineer shall advise the Contractor in writing as to whether the above criteria have been satisfied, in the Engineer's sole discretion.

6.4 Sample Tests

6.4.1 General

The conductor is subject to sample tests listed in Table 2 of the Technical Requirements. Samples shall be selected at random from the lot offered for acceptance.

All sample tests and inspections shall be made at the place of manufacture prior to shipment, in accordance with the Inspection and Test Plan.

All Sample Test Reports shall be issued by a qualified person and submitted electronically to the Engineer for approval.

The Contractor shall not ship any materials without a written approval by the Engineer.

6.4.2 Chemical Analysis Reports

The Contractor shall provide the Engineer with test results from a chemical analysis performed by a test laboratory acceptable to both the Engineer and the Contractor.

6.5 Routine Tests

The Contractor shall be responsible for all routine tests. The conductor shall be subject to routine tests listed in Table 2 of the Technical Requirements.

6.6 Individual Test Requirements

6.6.1 Creep Test

Creep test of the overhead conductor shall be in accordance with IEC 61395 standard.

The following testing parameters shall be used:

(a) Temperature of the test shall be 20˚C
(b) Test load shall be equal to 20% of the rated tensile strength

6.7 Acceptance Criteria for Sample Test

Failure of a test specimen to comply with any one of the requirements of these Technical Specifications shall constitute grounds for rejection of the lot represented by the specimen. If any lot is so rejected, the Contractor shall have the right to test, only once, every individual reel or coil of wire in the lot and submit those individual reels or coils that meet the requirements for acceptance.

6.8 Submission of Test Reports

Upon completion of all testing as specified in the Technical Requirements, all test reports shall be submitted electronically to the Engineer to confirm that all requirements of the Technical Requirements have been met.

Test reports shall be sent to:

Chen Wang, P. Eng. – Transmission Line Design Engineer
Manitoba Hydro
Transmission & Civil Design Department
820 Taylor Avenue (4)
Winnipeg, Manitoba, Canada R3M 3T1
Email: cwang@hydro.mb.ca

6.9 Third Party Testing

The Purchaser reserves the right to select and test samples from conductor lots fabricated by the Contractor using a qualified third party using the same tests as outlined in the Technical Requirements. If this tested lot fails any of the acceptance criteria set out in the Technical Requirements, then the lot will be refused and returned at the Contractor's expense. A replacement lot will be provided by the Contractor in accordance with all requirements of the Contract, at no additional expense or cost to the Purchaser.

7 QUALITY ASSURANCE

7.1 General

The Contractor shall comply with the quality assurance program requirements of ISO 9001 standard or its equivalent in the performance of the Work, the Contract, and the Contractor's obligations in respect of both. If the Contractor's proposed program is not based on ISO 9001 series of standards, the Contractor shall submit evidence, satisfactory to the Engineer that the proposed program conforms fully to the spirit and intent of ISO 9001.

The Engineer may, in his sole discretion, reject Work that is not produced under the Quality requirements specified in this Section.

The Contractor is responsible to identify in its Quality Plan the specific activities it will undertake to perform:

(a) Quality Assurance: The process of auditing the quality requirements and the results from Quality Control measurements to ensure quality standards are being met.

(b) Quality Control: The process of monitoring and recording results of Quality activities to assess performance and recommend necessary changes.

7.2 Quality Documentation

All quality documentation shall be in the English language. Where the original document is in a language other than English, the Contractor is responsible to have the document translated into English without causing delays to the documentation process.

7.3 Access to Contractor's Facilities

The Purchaser reserves the right to audit the Contractor's Quality Management System program at any time during the Work.

The Purchaser or its representative shall be granted unescorted access to the Contractor's facilities and to the facilities of all of its Subcontractors, at any time during the Contractor's or Subcontractors' normal business hours to verify that the Contractor and its Subcontractors are satisfactorily carrying out the Work and that the Work complies with the requirements of this Section of the Technical Requirements. The Purchaser or its representative shall be allowed at any time and under any circumstance to take photographs of any portion of the Work he deems necessary.

While attending at the Contractor's facilities, the Purchaser or its representative will comply with the reasonable policies of the Contractor concerning confidentiality (and with respect to matters not related to the Work and the Contract) which have been disclosed in writing to the Purchaser prior to attendance and for which no objection has been made; provided further however that nothing in the Contract is altered or diminished by reason of any such policy or compliance with same. While attending at Contractor's facilities, the

Purchaser or its representative will use best efforts to limit disruption of other activities at such facilities.

7.4 Tools and Equipment

All tools and equipment used to carry out inspection activities by the Contractor shall have been calibrated within the one (1) year proceeding of the date of inspection by accredited third party inspection company. Calibration records shall be provided to the Purchaser or its representative upon request. If it is discovered that tools and equipment that were used for the Work have not been calibrated within one (1) year of the inspection date, the inspections shall be repeated, at the sole risk of the Contractor, with tools and equipment that are properly calibrated.

7.5 Inspection and Test Plan

At least 30 days prior to commencing production, the Contractor shall submit the Inspection and Test Plan for approval by the Engineer. The ITP document shall identify in detail:

(a) Production process and associated test,
(b) Parameter to be controlled,
(c) Sampling and frequency,
(d) Acceptance criteria,
(e) Reference standard or document,
(f) Control equipment,
(g) Testing location,
(h) Person/position responsible for the test, and
(i) Quality control record form.

The Engineer will determine the Purchaser's level of involvement in testing. This will be reflected in the ITP document.

7.6 Non-Conformance Reports

The Contractor shall provide the Purchaser or its representative, within 7 days of such request, information related to any present non-conformance reports regarding conductor hardware assembly quality and manufacturing, testing, shipping, internal and external QA audits, including corrective and preventative actions in accordance with CAN/CSA-ISO 9001.

8 MARKING, PACKAGING AND SHIPPING

8.1 Packaging

The conductor shall be supplied on returnable metal reels suitable for tension stringing and capable of withstanding the normal handling encountered during transportation and installation. A drawing of the reel and associated dimensions including weight, bore size, description of lagging, or hardboard wrapping, and a description of the protective material to be used to protect the conductor, shall accompany the proposal.

Prior to the installation of the completed conductor on reels, the inner conductor end shall be prepared as per the following:

(a) The steel core shall protrude from the end of the completed conductor in sufficient length to enable it to be securely attached to the grounding screw on the inside of the reel.

(b) The complete conductor end shall be wrapped with tape to maintain the concentric shape of the conductor.

(c) The prepared conductor end shall then be firmly secured in the cable pocket of the reel by means of a U-bolt, or a method approved by the Purchaser. The U-bolt must be installed over a bare section of the completed conductor, not over the taped section.

(d) The steel core protruding from the end of the completed conductor shall be securely attached to the grounding screw of the reel.

(e) The conductor adjacent to the metal reel and hardboard wrapping shall be adequately protected to prevent the conductor from being scraped, chafed or nicked. A suitable protective material shall be wrapped around the outer layer of the conductor to prevent grit or dirt from coming in contact with the conductor.

8.2 Marking of Reels

The reels of completed conductor shall be arranged and shipped in groups of three reels. The difference in length between each of reels in the group shall not be more than 10 m. The groups of reels shall be marked in a way that is readily distinguishable.

For three reel groups (e.g. 1A, 1B, 1C, 2A, 2B, 2C, etc.)

A metal tag shall be securely attached to the side of each reel showing the following information:

(a) Project Name specified on the Purchase Order
(b) Purchase Order number
(c) Contractor's Name
(d) Size and Type of Conductor
(e) Length of Conductor on the Reel (metres)
(f) Tare Weight of the Reel (kilograms)
(g) Weight of Conductor on the Reel (kilograms)
(h) Gross Shipping Weight of the Reel (kilograms)
(i) Shipping Dimensions of the Reel (millimetres)
(j) Reel Production Number
(k) Date of Conductor Manufacture
(l) Reel Grouping Identification

Reel grouping identification shall be clearly marked on the reel and the conductor wrapping material.

8.3 Shipping and Delivering

The Contractor shall prepare the conductor for shipment in such manner as to protect them from dust and dirt, damages during transportation, handling and outdoor storage.

The Contractor shall be responsible for and make good any and all damage resulting in loading and transportation.

The Contractor shall be responsible for tracking and expediting all shipments and for obtaining all required permits.

The Contractor shall deliver all shipments on an open flatbed trucks for offloading using a forklift.

Deliveries using sea containers will not be accepted.

8.4 Shipping Notice

The Contractor shall, within 24 hours of each shipment, provide Purchaser with the shipping report, which shall include:

(a) Project name specified on the Purchase Order
(b) Purchase Order number
(c) Items and quantities shipped
(d) Carrier
(e) Bill of Lading number
(f) Shipping date
(g) Expected delivery date

to:
Material Expeditor
Transmission & Civil Design Department
Manitoba Hydro
820 Taylor Ave (4)
Winnipeg, Manitoba R3M 3T1

END OF TECHNICAL REQUIREMENTS

Manitoba Hydro

TERMS AND CONDITIONS OF PAYMENT

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR - 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040378

TERMS AND CONDITIONS OF PAYMENT

1 TERMS OF PAYMENT

Subject always to satisfactory performance of the Work by the Contractor in accordance with the Contract, the Purchaser shall pay the Contractor the cost of the Work and all services of the Contractor in connection therewith, in Canadian currency as follows.

1.1 Payments

The Contractor shall submit invoices to the Purchaser for ITEMs delivered.

Contractor invoices will be paid as follows:

(a) An amount equal to 92.5% of the cost of an ITEM shall be paid thirty (30) days from date of receipt of the Contractor's invoice, following the complete delivery, and acceptance of, the ITEM.

(b) An amount equal to 7.5% of the cost of each ITEM shall be retained, and shall be paid thirty (30) days after the unconditional attainment of the following:

i) a Completion Certificate has been issued in respect of the ITEM;
ii) all deficiencies/defects in respect of the ITEM have been repaired/replaced; and
iii) the Purchaser has received from the Contractor complete documentation in respect of the ITEM, including all drawings and test reports.

If acceptance of the Work is delayed by the Purchaser beyond 90 days from the date of the completion of the Work, the Purchaser shall have the right to extend the time for payment of the said balance and shall pay the Contractor interest on said balance at the annual rate of interest equivalent to that charged to preferred borrowers by the Purchaser's bank ('prime lending rate') in Winnipeg, calculated from the 90th day after the date of the completion of the Work until the date of acceptance. If acceptance of the Work is delayed by reason of any defect in the Work or any portion thereof, or any failure to meet Request for Proposal 040378 or the requirements of the Contract, so that the Work or any portion thereof is rejected by the Purchaser, and if such defect or failure is attributable to the Contractor, then interest on said balance shall be payable by the Purchaser as aforesaid up to the date on which the Work or the portion thereof was rejected by the Purchaser, and thereafter no interest shall be payable.

END OF TERMS AND CONDITIONS OF PAYMENT

Terms and Conditions of Payment Schedule 'A'

CANADA	)	I, ______________________
	)	
PROVINCE OF MANITOBA	)	of the __________ of ____________ in the
	)	
TO WIT:		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__

Manitoba Hydro

FORM OF PROPOSAL

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

Important: Macro Security level to Medium

1. The first field to be completed in the Form of Proposal is your full legal company name. Once your proposal is complete and converted to pdf, your full legal company name will automatically appear inside the header of every page.

2 Continue preparing your proposal by completing the gray shaded fields on each page.

3. 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.

4. Certain fields which contain the drop-down selection feature will allow you to make a selection from a list. For checkboxes, click inside the applicable YES or NO box to make a selection. To deselect, click inside the YES or NO box you wish to deselect.

5. After you are satisfied with your electronic completion of the Form of Proposal, save the document and convert it to pdf.

6. Print and sign the signing page manually. Scan the signed page and insert it into the Form of Proposal pdf. Delete the unsigned page.

7. Certain fields have been limited to a maximum number of rows or characters that you can type. If the space provided is insufficient, you can use the document provided titled “Additional Form of Proposal.docx”.

8. If the “Additional Form of Proposal.docx” document has been utilized, convert it to pdf.

9. Submit the Form of Proposal, Additional Form of Proposal (if used) and any other applicable documents that you wish to accompany your proposal.

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

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC OVERHEAD PHASE CONDUCTOR - 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040378

FORM OF PROPOSAL 040378

COMPANY INFORMATION

This proposal is submitted by: ______________________________
(legal company name)
hereinafter called the "Proponent", a company duly incorporated under the laws of:

____

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

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

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

The Proponent's principal office dealing with this Form of Proposal is at:

____
(number, street)

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

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

Manitoba Hydro RFP 040378 Form of Proposal - 2

Printed: ______________

THE WORK

For the supply of the Work as required for design, material procurement, manufacture and supply of 1192.5 MCM 45/7 Bunting ACSR/GA Conductor, including all supervision, labour, equipment, quality control, testing, packaging, shipping, delivery, Contractor's insurance and warranty, to meet requirements for the 500 kV AC Transmission Line, all in accordance with Manitoba Hydro Request for Proposal 040378, the following prices.

(GST) and Manitoba provincial retail sales tax (PST) are not included in the proposed prices. GST and PST shall be shown as "extra" on each invoice. All other applicable taxes shall be included.

Description [Manitoba Hydro Reference (CIIC) Code: 04-29-14]	**PRICING ITEM**	**Shipment Options**	**PRICE PER METRE $CAD**	**EXTENDED PRICE (2,022,400 metres)**
1192.5 MCM 45/7 Bunting ACSR/GA Conductor Estimated Total Requirement*: 2,022,400 metres	1	**EWX LOADED**:		
	2	**DDP**: Gate 6, 59029, Hwy 207 Dugald, Manitoba R0E 0K0		
	3	**DAP**: Gate 6, 59029, Hwy 207 Dugald, Manitoba R0E 0K0		

*Quantities are not guaranteed and the Purchaser shall not be obligated to purchase stated quantities. Quantities are subject to change.

Third Party Type Testing Costs of $_____ CAD Lump Sum are factored into the above unit prices.

Proposed prices for ITEMS 1 to 3 are based on:

Aluminum Base Price: $_______/100 kg (CAD)

Month of the Aluminum Base Price: _________, 2016 OR _______, 2017

Aluminum Base Price Index Source: _________

Aluminum weight (kg/km): _________

NON-RESIDENT IMPORTER TO CANADA

.1 Are you a non-resident importer to Canada?

YES ☐ NO ☐

.2 Do you have a GST number?

YES ☐ NO ☐

.3 If you answered YES to the above, please provide your GST (Canadian Goods and Services Tax) number:

PROPONENT'S CANADIAN CUSTOMS BROKER

Following is the name of the Proponent's Canadian customs broker, as well as the name, address, telephone number and e-mail address of internal contact persons representing the customs broker:

Name of Customs Broker	Address	Contact Name & Title	Contact Phone	Contact E-mail

REEL DESIGN AND POLICY

.1 As noted in the Technical Requirements, the Purchaser's preferred conductor length is 3,200 metres per reel. The Proponent attaches a drawing of its proposed reel and associated dimensions including weight, bore size, description of lagging, or hardboard wrapping, and a description of the protective material to be used to protect the conductor:

YES ☐ NO ☐

Comments:

.2 The Proponent's proposed deposit schedule and reel return policy are submitted with its proposal

YES ☐ NO ☐

If NO, explain:

.3 The Proponent's proposed deposit schedule and reel return policy include the following proposed pricing and options:

Reel deferral charges (cost if reel not returned within: _____ [name time period], commencing three (3) years after delivery of each respective reel). **No charges shall apply for the three year interim following delivery:**

$ _____ (CAD) per reel

Refundable reel deposit charges (upfront cost to be reimbursed by supplier when empty reels are returned): $ _____ (CAD) per reel

Non-returnable reel: $ _____ (CAD) cost per reel

Damage policy:

REEL RETURN FACILITATION AND TRACKING

The Proponent indicates in detail below how it proposes to facilitate and track the reels associated with (any) contract.

For example:
- Metal tag
- Bluetooth
- RFID
- Real time GPS Tracker

TYPE TEST REPORT BY THIRD PARTY LABORATORY

.1 The Proponent submits with its proposal existing type test report that meets all requirements of Section 6.3.2 in Technical Requirements of this RFP:

YES ☐ NO ☐

Comments:

.2 If existing type test report is not available or fails to meet any requirement of Section 6.3.2 in Technical Requirements of this RFP, Proponent should identify the Third Party Laboratory that will perform type test outlined in the Technical Requirements.

Name and Address of the proposed Type Testing Facility:

NOTE: The Purchaser reserves the right to accept or reject the Proponent's listed Type Testing Facility.

COMMERCIAL COMPLIANCE

Below are proposed changes to the commercial terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

TECHNICAL COMPLIANCE

The Proponent's product offering fully conforms with all Technical Requirements stated within Request for Proposal 040378:

YES ☐ NO ☐

Below are proposed changes to the technical terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

LEAD TIMES AND PRODUCTION SCHEDULE

The Proponent indicates below its required lead times for the design, material procurement, manufacture and supply of the required phase conductor.

	Activity (e.g., design, material procurement, manufacture, type testing, required loading / delivery lead times)	Anticipated Date / Duration
.1		
.2		
.3		
.4		
.5		
.6		
.7		
.8		
.9		
.10		
.11		
.12		
.13		
.14		
.15		

Include a GANTT chart, identifying proposed schedule for ordering of raw materials, manufacturing, shipping and delivery of products to final destination. Attach additional sheets, as required.

DELIVERY DATE

With reference to the WORK SCHEDULE section of the General Requirements, the Proponent offers to deliver ITEM 1 of the Work on the following date(s):

DELIVERED:

, 2017

SHIPMENT/TRANSPORTATION DETAILS

Delivery of the Work

The Purchaser requires the Proponent to provide the following information regarding shipment/transportation of ITEM 1 of the Work:

The total shipment weight is ___________lb or ___________ kg.

The total shipment volume is __________ ft^3 or ___________m^3.

The shipment's dimensions are:
length ___________ ft x width ___________ ft x height ___________ ft, or
length ___________ m x width___________ m x height ___________ m.

The total shipment quantity is _________ (No. of reels, etc.)

The shipment will be transported via:

Road:
____________(qty) ___________ (length in ft) enclosed van(s), or
___________ (qty) ___________ (length in ft) flatdeck trailer(s).

OR
Rail:
__________ (qty) ___________ (length in ft) boxcar(s), or
__________ (qty) ___________ (length in ft) flatcar(s), or
___________ (qty) ___________ (length in ft) gondola car(s).

SHIPMENT/TRANSPORTATION DETAILS (CONTINUED)

Loading of the Work

The following is the location of the Proponent's shipping facility or factory where the ITEMS of the Work will be loaded, blocked, braced and secured for transportation by the Proponent or the Proponent's designated carrier:

Street Name and Number: ____
City Province/State: ____
Postal Code/Zip Code: ____________________

The estimated travel time from the Proponent's shipping facility or factory to the Purchaser's designated arrival destination is _____ day(s).

The Proponent intends to load the ITEMS of the Work in containers weighing:
___________(kg) approximately and measuring __________ (m) x ___________ (m) x __________ (m).

The Proponent indicates below any special equipment and requirements necessary for the transportation of the Work:

PLANT CAPACITY AND ACCESSIBILITY FOR INSPECTIONS

The Proponent identifies year 2017 availability of its plant resources for the design, manufacture, testing and supply of **2,022,400 metres** of 1192.5 MCM 45/7 Bunting ACSR/GA Conductor to Manitoba Hydro. The Proponent identifies calendar durations already allocated to, or anticipated to be allocated to, other customer orders.

.1 Description of monthly output capabilities at Maximum Plant Capacity (i.e., 100%): .

.2 Number of active shifts per day: . Number of working days per week: .

	Percentage of Plant Resources Available		
Year 2017	Percent of resources available for filling the phase conductor requirements of RFP 040378	Percent of resources allocated to other customer orders	Is the plant accessible for inspection(s) by Manitoba Hydro appointed personnel?
January	%	%	YES ☐ NO ☐
February	%	%	YES ☐ NO ☐
March	%	%	YES ☐ NO ☐
April	%	%	YES ☐ NO ☐
May	%	%	YES ☐ NO ☐
June	%	%	YES ☐ NO ☐
July	%	%	YES ☐ NO ☐
August	%	%	YES ☐ NO ☐
September	%	%	YES ☐ NO ☐
October	%	%	YES ☐ NO ☐
November	%	%	YES ☐ NO ☐
December	%	%	YES ☐ NO ☐

MANITOBA CONTENT

The Proponent shall provide the estimated percentage of total proposed price that it considers to be Manitoba Content: ___________%

The Proponent shall provide a detailed breakdown of Manitoba Content that would be incorporated into the Work substantiating the above percentages (inputs originating from the Province of Manitoba such as labour, materials, transportation, etc):

NOTE: **Upon request, the Contractor shall provide to Manitoba Hydro records substantiating the percentage of Manitoba Content.**

a) Labour by Own Workforce

COMPONENT OF THE WORK	TYPE OF LABOUR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

b) Manitoba Subcontractors

TYPE OF WORK TO BE SUBCONTRACTED	NAME AND ADDRESS OF SUBCONTRACTOR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

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

MANITOBA CONTENT (CONT'D – 1)

c) Purchase of Goods from Manitoba Companies

TYPE OF GOODS	NAME AND ADDRESS OF SUPPLIER	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

d) Purchase of Equipment from Manitoba Companies

TYPE OF EQUIPMENT	NAME AND ADDRESS OF SUPPLIER	TOTAL VALUE OF PURCHASE PRICE $

e) Leased Equipment/Facility from Manitoba Companies

TYPE OF EQUIPMENT	OWNER	TOTAL VALUE OF LEASE $

Provide information regarding any lease agreements such as the following:

- Length of lease
- Lease payment
- Maintenance
- Residual value

MANITOBA CONTENT (CONT'D – 2)

f) Other Manitoba Content:

OTHER INPUTS	OWNER	TOTAL VALUE OF LEASE $

ALTERNATIVE METHODS, PROCEDURES, SCHEDULES, SEQUENCES OR ENVIRONMENTALLY PREFERABLE PRODUCTS/SERVICES

The following is a list of all of the Proponent's proposed alternative methods, procedures, schedules, sequences or environmentally preferable products/services that affect the Work:

EQUAL ARTICLES, MATERIALS OR EQUIPMENT

The following is a list of the equal articles, materials or equipment that the Proponent proposes to substitute for those specified:

Article, Material, or Equipment		Price Change $	
Specified	**Proposed**	**Increase**	**Decrease**

NOTE: Names of manufacturers of equals and catalogue numbers are stated, if applicable. All technical data and literature are appended to this proposal. No equal articles, materials, or equipment will be permitted unless listed above and approved by the Purchaser.

JOINT VENTURES

The extent and nature of Manitoba business participation in a joint venture is detailed below.

A Band Council Resolution authorizing the provision of the Form of Proposal on behalf of the First Nation Band is submitted with this proposal:

YES ☐ NO ☐

PROPONENT'S TECHNICAL AND NON-TECHNICAL CONTACT PERSONS

All enquiries concerning the technical aspects of this proposal should be directed to:

____

(please print name and title of Proponent's Representative)

whose telephone number is: ( ) -

FAX number is: ( ) -

Internet e-mail address is: @ .

and World Wide Web is: http://www. .

All enquiries concerning the non-technical aspects of this proposal should be directed to:

____

(please print name and title of Proponent's Representative)

whose telephone number is: ( ) -

FAX number is: ( ) -

Internet e-mail address is: @ .

and World Wide Web is: http://www. .

SIGNING PAGE

The words used in this Proposal have the meanings ascribed to them in RFP 040378.

We/I the undersigned, having examined all of RFP 040378 together with all addenda issued prior to the Closing Date, and having attended all mandatory meetings and mandatory site visits, hereby submit this proposal with all necessary enclosures.

The Proponent agrees that RFP 040378, and any proposal submitted in respect of same, is not a legal offer. By signing below, the Proponent certifies that the information submitted herein is true and correct as of the date set out below to the best of the Proponent's knowledge, and that the Proponent agrees to the terms and conditions set out in the RFP.

______________________________ [Insert legal name(s) of Proponent]

Per ______________________________ Name ______________________________

Authorized signing officer Print Name

I have authority to bind the Proponent

Dated __________________________ _______________________

Title

REQUEST FOR PROPOSAL 040565

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES

500kV AC TRANSMISSION LINES

MAY 4, 2017

MANITOBA HYDRO DISCLAIMER

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Manitoba Hydro works in the Acrobat X1 Standard, Excel 2003-2007 and Word 2003-2007 environments. The recipient may not be able to view or utilize the full software features of Manitoba Hydro's electronic files if the recipient has earlier versions of the aforementioned software.

NOTE: To open any supplied Word documents, your Macro Security level must be set to Medium.

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040565

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DEFINITIONS

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES	MAY 2017

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040565

DEFINITIONS

"Confidential Information" means any and all information, regardless of form, format or medium, of or concerning or related to the Purchaser, the Work, etc. depending on situation, customer information, and Personal Information, which has or shall come into the possession or knowledge of the Contractor.

"Contract" means the entire agreement entered into between the Purchaser and the Contractor upon execution of the Cover Agreement for performance of the Work by the Contractor in accordance with the Contract Documents.

"Contract Documents" means the Cover Agreement, Definitions, General Conditions, the General Requirements, Purchaser's Drawings, if any, the Technical Requirements, the Contract Forms listed in the Cover Agreement, all appendices and attachments to the foregoing documents, and amendments to any of them duly executed by both the Purchaser and the Contractor.

"Contractor" shall mean the party or parties named as such in the Contract and the legal personal representatives, successors and assigns of the Contractor.

"other contractor" or **"another contractor"** shall mean any person, firm or corporation employed by or having a contract directly or indirectly with the Purchaser otherwise than through the Contractor.

"DAP" shall mean "Delivered at Place" per Incoterms 2010.

"DDP" shall mean "Delivered Duty Paid" per Incoterms 2010.

"Engineer" shall mean the engineer, engineers, or firm of consulting engineers, as the case may be, appointed in writing by the Purchaser to take charge of the Work, or a designated part (including the design) thereof, acting directly or through his or their properly authorized assistants or agents.

"Equipment" means all documents, designs, computer software, computer hardware, plant, materials, apparatus, tools, components, machinery, equipment, hardware, systems and other things required for the execution and completion of the Work and the remedying of any defects, or otherwise in respect of, and involving, Contractor's performance of obligations under the Contract.

"EXW" shall mean "Ex Works" per Incoterms 2010.

"Inspector" shall mean the person, firm or corporation authorized by the Purchaser to inspect the Work to be done and/or material to be furnished pursuant to the Contract acting directly or through his or their properly authorized assistants or agents.

"ID#" or "ITEM" shall mean a separate and designated part of the Work to be proposed, as defined in the Form of Proposal.

"Manitoba Business" is a business which is registered to do business in the Province of Manitoba, and the firm, or its principals, maintains their facilities, equipment and staff in Manitoba on a continuous basis.

"Personal Information" has the meaning given in The Freedom of Information and Protection of Privacy Act (Manitoba) and the Personal Information Protection and Electronic Documents Act (Canada).

"plant" shall mean all vehicles, transportation equipment, construction equipment, erection and installation equipment, falsework, forms, scaffolding, cofferdams, crushers, boilers, temporary storehouses and other temporary structures, lumber, timber, materials, power tools, machinery, appliances and apparatus which are brought on or constructed upon the site by the Contractor for the performance of the Work.

"Proponent" shall mean, as the context requires, any party or parties proposing on one or more of the various classes of work covered by the Instructions to Proponents, the General Requirements, the General Conditions, and the Technical Requirements.

"Purchaser" shall mean Manitoba Hydro, its successors and assigns.

"Site" shall mean the place or places where the Work is to be carried out for the Purchaser, and the immediate vicinity of such place or places.

"subcontractor" shall mean a person, firm or corporation having a contract with the Contractor for part of the Work, including without limitation the furnishing of labour, material, equipment or apparatus therefor.

"Superintendent" shall mean the duly appointed representative of the Contractor on duty at the site.

"tools" shall mean all small hand tools, other than power 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 or by any employee of the Contractor for the performance of the Work.

"Work" or "Services" shall mean all of the various classes of work to be done, executed and performed, whether temporary or permanent, and other equipment, apparatus, machinery and materials to be furnished and supplied by the Contractor pursuant to the Contract.

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.

END OF DEFINITIONS

INSTRUCTIONS TO PROPONENTS

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES	MAY 2017

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040565

INSTRUCTIONS TO PROPONENTS

1 INVITATION

To be evaluated, a Proposal **must** be submitted not later than the Closing Date which is:

16:00:00 hours Manitoba local time
May 24, 2017 (the "Closing Date")

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

Proposals not submitted through MERX will not be accepted.

1.1 Delivery and Receipt of Submissions

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

(a) the timely delivery of any information or documentation, including, without limitation, the RFP by MERX, in connection with this RFP;
(b) the timely receipt of any proposals, revisions, amendments, notice of withdrawals, or any other information or documentation from any Proponent or potential Proponent, or;
(c) the working order, functioning or malfunctioning, of any electronic information system (including MERX).

2 PURPOSE

Issuing this RFP, Manitoba Hydro desires an experienced Contractor to enter into a Contract(s) for the design, test, manufacture, supply and delivery of spacer-damper assemblies for 500kV AC transmission lines.

Proponents are encouraged to review the balance of the RFP for additional information concerning Manitoba Hydro's anticipated commercial and technical needs in respect of any potential Contract.

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

By submitting a proposal, the Proponent agrees to the terms and conditions set out in this RFP.

3 GENERAL INTERPRETATION

Defined words and phrases used in this Request for Proposal have the meanings ascribed to them in the Definitions section or as expressly defined elsewhere in this Request for Proposal. Headings are used for convenience only, and they shall not affect the interpretation or meaning of the clauses, terms and conditions or the Request for Proposal or any resulting Contract.

4 ENQUIRIES

Enquiries concerning Request for Proposal 040565 should be in writing, using the Proposal Clarification Form, attached as Appendix A.

Enquiries should be submitted not less than **seven (7) calendar days** prior to the Closing Date. Enquiries received after that time may not be considered or answered.

Manitoba Hydro has the sole discretion to respond, or not, to an enquiry. Responses may be issued to the enquiring party only, or to any or all prospective Proponents.

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

5 PROPOSAL EVALUATION AND NEGOTIATION

5.1 General

Manitoba Hydro desires, through an evaluation and negotiation process, to determine if basis exists to award one (1) or more Contracts for performance of the Work described in this RFP.

Manitoba Hydro may select one (1) or more Proponent(s) for negotiation of a potential Contract.

Proposals submitted in respect to this RFP are for information and evaluation/negotiation/discussion purposes only.

5.2 Technical and Commercial Terms

The RFP describes the anticipated scope of work and anticipated technical and commercial needs of Manitoba Hydro. Manitoba Hydro is interested in receiving proposals that meet the technical and commercial needs outlined in this RFP.

With respect to technical needs, the Proponent may note in its proposal any technical exceptions which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative solution for addressing the matter in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

With respect to commercial needs, the Proponent may note in its proposal any commercial terms which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative wording for addressing the term(s) in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

5.3 Evaluation

Evaluation of proposals is expected to commence shortly after the Closing Date.

Manitoba Hydro reserves the right to complete or terminate evaluation of proposals at any time, or to extend the time of evaluation, without notifying Proponents.

Upon completion or termination of evaluation, Proponents may be notified that evaluation is complete.

5.4 Presentations

During evaluation of proposals, one (1) or more Proponents may be invited to attend at Manitoba Hydro's facilities in Winnipeg to make a presentation or participate in an interview concerning its proposal.

5.5 Amendments/ Further Information/Clarifications

During evaluation and negotiations, Manitoba Hydro reserves the right to request one (1) or more Proponents to:

(a) amend its proposal;

(b) provide additional, missing, and/or other information or documentation concerning its proposal; and
(c) clarify any matter(s) concerning its proposal.

In respect of any such matters, Manitoba Hydro shall have no duty or obligation to advise any other Proponent of any of the same, or to request them to vary their proposal as a result of any of the same.

5.6 Negotiation Process

Upon completion or termination of evaluation of proposals, Manitoba Hydro may select one (1) or more Proponents for negotiation of a Contract(s).

Manitoba Hydro will notify a Proponent if it has been selected for negotiations.

Manitoba Hydro reserves the right to terminate negotiations at any time.

Proponents are advised that Manitoba Hydro may conduct any negotiation through an intensive process. Such process may require a Proponent to make representative(s), who have sufficient decision-making authority, available for telephone, video-conference, and/or in person negotiating sessions.

5.7 Requirement for Contract

Until the execution of a Contract between Manitoba Hydro and a Proponent, there shall be no legal or other binding obligations created on the part of either party with respect to a Contract, the Work, or any matters related to the Work.

5.8 Manitoba Hydro Privilege/Discretion

Manitoba Hydro makes no representation or warranty that responding to this RFP will result in any negotiations or any Contract. Manitoba Hydro is under no obligation to evaluate any proposal, enter into any negotiations, or to award a Contract, with any Proponent or other person.

Manitoba Hydro reserves the right to cancel this RFP either before or after the Closing Date and regardless of whether or not any proposals have been received for any reason whatsoever.

Manitoba Hydro reserves the right to re-issue or tender all or any part of the work and services contemplated in this RFP at any time, including after the Closing Date, for any reason whatsoever.

Manitoba Hydro reserves the right to accept, waive or reject any non-compliance or irregularity, including without limitation, the right to accept, waive, or reject non-compliance or irregularity with respect to the requirements of the Instructions to Proponents and/or the submission requirements of this RFP.

Notwithstanding anything to the contrary in this RFP, Manitoba Hydro reserves the right to:

(a) negotiate any or all terms and conditions of a Contract with any one (1) or more Proponents, but not necessarily all Proponents, and to do so serially or concurrently and at any time;
(b) negotiate and enter into a Contract on terms and conditions different than those contained in the RFP and/or any Proposal;
(c) choose not to enter into negotiations with any one (1) or more Proponents;
(d) terminate negotiations with any one (1) or more Proponents at any time;
(e) choose not to award any Contract to any Proponent;
(f) terminate this procurement process at any time for any reason;
(g) choose to not offer the same or substantially the same or comparable terms and conditions of a proposed Contract to more than one (1) Proponent with which Manitoba Hydro may conduct negotiations; and
(h) enter into separate Contracts for different or identical portions of the Work, with any one (1) or more Proponents.

6 SCHEDULE OF RFP ACTIVITIES

The schedule of activities concerning this RFP includes the following:

Description	Date
Closing Date for submission of proposals	As per Subsection 1.1 of these Instructions to Proponents
Evaluation of Proposals complete	June 21, 2017
Negotiations with Selected Proponent	June 26, 2017
Award of Contract	July 21, 2017

Manitoba Hydro may change the said schedule and dates and information without notice (including without notice to any actual or potential Proponent(s)) at any time including before and after the Closing Date of this RFP.

7 ADDENDA

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

8 FORM OF PROPOSAL

The Proponent is requested to use the Form of Proposal attached hereto. If any Form of Proposal page is found to have insufficient space, the Proponent is requested to attach a sheet or sheets immediately after such page.

The Proponent is encouraged to include in their proposal thorough and sufficient information concerning matters under consideration.

9 SIGNING OF PROPOSALS

A proposal submitted by:

(a) an individual shall be signed by the individual in the presence of a subscribing witness;
(b) a corporation shall be signed by the properly authorized signing officer or officers and the corporate seal affixed or by the properly authorized signing officer or officers in the presence of a subscribing witness or witnesses; or,
(c) a partnership or joint venture shall be signed by all partners or joint venturers in the presence of a subscribing witness or witnesses.

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. Each signature shall be accompanied by a printed name.

10 JOINT VENTURES/CONSORTIA

Proponents which are comprised of more than one legal entity, such as a joint venture or consortium of corporations, are to identify their duly appointed leader in the proposal.

Proponents are to execute the 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.

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 Contract awarded.

A copy of a written agreement binding the legal entities involved in each proposal shall be provided to Manitoba Hydro upon request. If no such writing exists at the time of request, it may be necessary for such entities to document their

arrangement to fulfill such requirement at any time, including after the time and date of closing for receipt of proposals and before or after an award of a Contract.

Where a Proponent is or includes a First Nation Band, the proposal shall be accompanied by a Band Council Resolution authorizing the provision of the proposal on behalf of the First Nation Band.

11 AMENDMENT OF PROPOSAL

A Proponent may amend its submitted Proposal on MERX at any time prior to the Closing Date. A Proponent may not amend its Proposal after the Closing Date except at the written request of Manitoba Hydro.

In order to advance toward a formal and binding contract during negotiations, Manitoba Hydro may issue a written request to the Preferred Proponent(s) for specific amendment(s) to its Proposal, and if the Proponent finds the request satisfactory, shall provide the requested amendment(s) via fax or letter.

All amendments must be signed by the person or persons having the authority to bind the Proponent.

Manitoba Hydro shall consider each Proponent’s Proposal to be the Proponent’s best position for entering into negotiations and for seeking award of a contract to perform the Work.

12 WITHDRAWAL OF PROPOSAL

At any time throughout the procurement process prior to execution of an agreement, a Proponent may revoke and withdraw a submitted Proposal by either removing the Proposal from MERX, if withdrawal is prior to the Closing Date, or by providing written notice to Manitoba Hydro via FAX or letter, if withdrawal is after the Closing Date.

Written notice of withdrawal of a Proposal must be duly signed by the authorized representative of the Proponent.

Manitoba Hydro is under no obligation to return withdrawn Proposals.

13 LANGUAGE

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

14 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 a proposal, satisfactory to Manitoba Hydro, that the Proponent has the ability, experience, capital and plant required to undertake and perform the Work successfully, and complete it within the time specified.

Manitoba Hydro may inspect any Plant and /or facilities that the Proponent proposes to use for doing the Work.

15 ESTIMATED QUANTITIES

Any quantities stated in the Request for Proposal or Form of Proposal are estimates only. Manitoba Hydro makes no guarantee with respect to any of same.

16 UNBALANCED PROPOSALS

Unbalanced unit prices or lump sum prices proposed may not be considered by Manitoba Hydro.

17 PROPONENT'S EXPENSES

The Proponent shall be responsible for all expenses concerning or related to the preparation of its proposal, including any subsequent discussions and/or negotiations.

18 PROPOSED PRICES

Proposed prices shall be stated in Canadian currency and shall include all customs duties, surcharges, insurance premiums, permit and licence fees, Workers Compensation and vacation pay assessments, and all other payroll benefits. Canadian Goods and Services Tax (GST) and Manitoba provincial retail sales tax (PST) shall be treated as specified in the Form of Proposal for each ITEM. All other applicable taxes shall be included and shall not be subject to any adjustment. No payment shall be made to the Contractor for sales tax (if any) which may be imposed by Canada or Manitoba in respect of the Contractor's plant, tools and any other items not included in the Work.

Prices in the accepted proposal, if any, shall be firm and not subject to adjustment for changes or unexpected contingencies of any kind whatsoever, including without restricting the generality of the foregoing, changes in wages, material costs, or taxes which may in future be imposed by lawful authority within or outside of Canada.

19 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 Business.

20 CORRUPT OR FRAUDULENT PRACTICES

Manitoba Hydro has the right at any time to reject any Proposal submitted by a Proponent or terminate negotiations with a Proponent if, in Manitoba Hydro's determination, the Proponent has engaged in any Corrupt, Fraudulent, Collusive, Coercive or Obstructive Practice or has breached any laws regarding corruption or fraud. For these purposes the following defined terms shall apply:

(a) **"Coercive Practice"** means impairing or harming, or threatening to impair or harm, directly or indirectly, persons or their property to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(b) **"Collusive Practice"** means an arrangement between two or more persons (including, without limitation, a Proponent and any other person) designed to achieve an improper purpose, including but not limited to the establishment of prices for the Work at artificial, non-competitive levels in the procurement process or in entering of the Contract.

(c) **"Corrupt Practice"** means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(d) **"Fraudulent Practice"** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, Manitoba Hydro, a Proponent, or any other person, to obtain a financial or other benefit or to avoid an obligation in the procurement process, or in the negotiation and signing of the Contract.

21 EVALUATION CRITERIA

In order to determine best value to Manitoba Hydro, proposals received will be evaluated using the following criteria (in no particular order of preference):

(a) Price
(b) Technical compliance of the proposal (absence of deviations from the Technical Requirements of this RFP)
(c) Commercial compliance (absence of deviations from the commercial terms and conditions of this RFP)
(d) Delivery Dates (includes production schedule and available production capacity)

All things being reasonably equal, the following additional criteria will be considered in the evaluation:

(a) Manitoba content

For the purposes of evaluation, Manitoba Hydro may take into account any or all of the information received from a Proponent under or pursuant to the RFP, Manitoba Hydro's knowledge of, and past experience with, the Proponent (including Proponent's performance on previous contracts with Manitoba Hydro, if any), and any information about the Proponent received from third parties and deemed reliable by Manitoba Hydro.

22 WAIVER

By submitting a proposal, the Proponent acknowledges Manitoba Hydro's rights under Request for Proposal 040565 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.

END OF INSTRUCTIONS TO PROPONENTS

Manitoba Hydro

GENERAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES	MAY 2017

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040565

GENERAL REQUIREMENTS

1 SCOPE OF THE WORK

The Work shall consist of design, material procurement, manufacture, supervision, labour, plant, tools, equipment, quality control, shop assembly and testing, packaging, shipping, delivery, installation instructions, Contractor’s insurance, and warranty of spacer-damper assemblies.

ITEMS of the Work include, but are not limited to, the following:

ITEM	DESCRIPTION	QTY
1	Spacer-Damper (helical rod attachment system) for 1192.5 MCM ACSR 45/7 Bunting – Triple Bundle, including all testing noted in the Technical Requirements.	3650
2	Spacer-Damper (bolted type) for 1192.5 MCM ACSR 45/7 Bunting – Triple Bundle, including all testing noted in the Technical Requirements.	630

Descriptions of ITEMS of the Work listed above are provided as a general overview. A detailed scope and requirements of the Work are provided in the Technical Requirements. The Work and any ITEM forming part of the Work shall also, in all respects, comply with the terms and conditions of the Contract.

2 WORK SCHEDULE

The Purchaser expects that all ITEMS of the Work will be delivered by **January 31, 2018**.

In carrying out the Work, the Contractor shall have reasonable latitude to organize the sequence of the Work, provided that the various stages of the Work are completed by the specified date(s) or the date(s) proposed by the Contractor and accepted by the Purchaser.

3 DELIVERY POINT(S)

If the Purchaser chooses delivery by the Contractor, the ITEMS of the Work shall be delivered to:

Gate 6
59029 PR 207
Dugald, Manitoba
R0E 0K0

4 DELIVERY OR LOADING OF THE WORK

4.1 Delivery of the Work

If the Purchaser chooses delivery of the Work by the Contractor, the Contractor shall prepare the Work for shipment in such a manner as to protect the Work from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation, loading, shipping, transporting, unloading, handling, or lifting. The Contractor shall be responsible for verifying the carrier's right-of-way clearances and weight limitations, if any, and for making all shipping arrangements.

4.2 Loading of the Work

If the Purchaser chooses to have the Work loaded, blocked, braced and secured by the Contractor at the Contractor's shipping facility or factory for transportation by the Purchaser or the Purchaser's designated carrier to the final destination, the Contractor shall prepare the Work for shipment in such a manner as to protect it from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation and loading.

5 CONTRACTOR'S DRAWINGS

5.1 Contractor's Drawings Submission

Within 8 weeks after the effective date of the Contract, and before commencing manufacture, the Contractor shall submit drawings for the Purchaser's approval. Three (3) paper copies and an AutoCAD electronic drawing file in 2016 or earlier version shall be submitted for each drawing.

All drawings submitted for approval shall be dated and marked "Preliminary" until such time as final approval has been obtained from the Purchaser.

The Purchaser will reject drawings of unsuitable standards and these drawings shall be redrawn by the Contractor within the specified schedule.

All drawings shall be set up in the Manitoba Hydro drawing borders format with the title blocks provided and shall be validated prior to submission. Final drawings shall be eSealed by a Professional Engineer registered in Manitoba in PDF/A format along with a computer generated AutoCAD .dwg version of the drawing.

5.2 Purchaser's Checking and Approval of the Contractor's Drawings

The Contractor shall allow a total of 25 working days, from receipt of the drawings, for review and commenting of drawings without affecting the delivery schedule. The first 10 out of 25 working days are for the Purchaser's initial review and the remaining 15 working days are for the subsequent review if required. Should a further review be required, the Contractor shall ensure that the delivery schedule is not affected.

After checking, the Purchaser will return to the Contractor one paper print marked with the Purchaser's comments and stamped "Approved", "Approved, Subject to Changes Noted" or "Not Approved", upon receipt of which the Contractor shall modify each drawing as required and resubmit in both of the media specified above within 5 working days.

Fabrication and testing shall not commence until the Contractor's drawings have been approved by the Purchaser, and thereafter, no change shall be made on any drawing so approved without the written permission of the Purchaser. Upon authorization of subsequent revisions, the Contractor shall resubmit any change, clearly shown on each drawing in both of the specified media, to the Purchaser for re approval.

Approval by the Purchaser of the Contractor's drawings shall not relieve the Contractor from liability for correctness thereof, nor from any loss, costs, damage or expense which may result from error in, or omission from, such drawings.

The Contractor shall supply to the Purchaser three (3) first generation paper copies and an AutoCAD electronic file in 2016 or earlier version after approval of each drawing. The paper copies must be capable of reproducing excellent microfilm images.

The Contractor shall ensure that the final approved drawings furnished to the Purchaser show the shipped condition of the equipment or structure. Any changes to be made on site shall be clearly marked thereon.

5.3 Minimum Drawing Standards for Contractor's Drawings

Minimum drawing standards for Contractor's drawings shall be in accordance with the "MINIMUM STANDARDS FOR DRAWINGS PRODUCED AND SUBMITTED BY FABRICATORS, MANUFACTURERS AND CONSTRUCTION COMPANIES," included as Appendix D along with "Transmission and Civil Design Department AutoCAD Drawing Standards," included as Appendix E.

An area 120 mm wide by 70 mm high located immediately above the title block shall be left blank for the Purchaser's use. The Purchaser will use this space to add the Purchaser's drawing registration number and approval stamp.

6 FOREIGN NATIONALS WORKING IN CANADA

The following provisions apply to all workers employed by the Contractor or under the Contractor's control or for whom the Contractor is otherwise responsible under the Contract, who are NOT citizens of Canada or 'permanent residents' of Canada (as defined in the Immigration and Refugee Protection Act). Such persons are defined, collectively, in the Immigration and Refugee Protection Act as 'foreign nationals', which term is used below and has the same meaning.

The Contractor shall ensure that all workers who are foreign nationals and who perform services under the Contract in Canada are legally authorized to work in Canada. The Contractor shall obtain and maintain all necessary work permits, visas and documentation for such foreign nationals, and shall comply with all conditions imposed on the Contractor, as 'employer' of the foreign nationals, under the Immigration and Refugee Protection Act and regulations.

Before permitting any foreign nationals to perform services under the Contract in Canada, the Contractor shall, by notice in writing to the Engineer,

(a) list all such foreign nationals by name;
(b) certify that the said foreign nationals are legally authorized to perform services under the Contract in Canada; and
(c) provide copies of their respective work permits, and visas or other documentation if applicable.

Furthermore, the Contractor shall provide copies of work permit or visa renewals to the Engineer if applicable, so that at no time is any foreign national performing services under the Contract in Canada without the requisite legal authority.

7 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, R.S.M. 1987, c. W200.

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 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.

8 COMPLIANCE WITH STANDARDS

All materials, equipment and articles furnished by the Contractor shall comply with the applicable provisions of the standards of the Canadian Standards Association (CSA) or of the Canadian General Standards Board (CGSB) and where no such standards exist, materials, equipment and articles shall comply with the applicable provisions of the standard specifications of the American Society for Testing and Materials (ASTM).

END OF GENERAL REQUIREMENTS

GENERAL CONDITIONS

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES	MAY 2017

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040565

GENERAL CONDITIONS

1 INTENT

1.1 The Work

The Contractor shall fully and completely fulfill its obligations in respect of the Contract, and shall fully and completely perform the Work in every detail and within the timeframe(s) required, all in accordance with the Contract. The Contractor shall do or cause to be done and shall furnish any and everything necessary for such purposes all in accordance with the Contract.

The Contractor shall carry out the production, manufacture of all goods, products, materials and the Work, and the performance and execution of the Work:

(a) in accordance with the Contract;
(b) in the manner (if any) specified in the Contract;
(c) in a good and workmanlike manner;
(d) using new materials that are free of defects and are of the specified quality, if specified, otherwise of suitable quality as determined by the Engineer; and
(e) with properly equipped facilities and non-hazardous materials, except as otherwise specified in the Contract.

1.2 Application to Engineer

The Contractor shall apply to the Engineer for any explanation which the Contractor may require as to the meaning and intent of any provision in the Contract or in any document forming part thereof, and the Contractor shall be liable for any loss, damage or expense which the Purchaser may incur, suffer or be put to as a result of the Contractor's failure to obtain such explanation.

1.3 Interpretation

Defined words and phrases used in the Contract have the meanings ascribed to them in the Definitions forming a part of this Request for Proposal, or as expressly defined elsewhere in the Contract. Headings are used for convenience only and do not affect the interpretation or meaning of the Contract.

2 CORRUPTION AND FRAUD

The Contractor declares and undertakes in relation to the Contract that it:

(a) has not acted and will not act unfairly or dishonestly so as to cause loss to the Purchaser or deprive the Purchaser of its rights;

(b) has not offered, given, demanded or accepted any bribe or other improper benefit or advantage to any person and will not do so;

(c) has not provided false, inaccurate or misleading information to any person and will not do so;

(d) has not authorized, acquiesced or turned a blind eye to any form of corruption and will not do so;

(e) did not collaborate, directly or indirectly, with any person in competition for this or other contracts with the Purchaser during the procurement process;

(f) will not, in respect of any design services to be provided under the Contract, deliberately, knowingly, with willful blindness or recklessness, provide or approve a design which will provide an improper benefit or advantage to any person or which is in excess of the Purchaser's requirements and has not been fully disclosed and approved by the Purchaser;

(g) will not deliberately, knowingly or with willful blindness or recklessness, carry out, instruct, authorize, condone or be a party to provision of work, materials, equipment or services not of a quality and quantity required under the Contract; or

(h) will not conceal defective work, material, equipment or services.

3 AUTHORITY OF THE ENGINEER

3.1 No Authority to Amend Contract

The Engineer has no authority to amend the Contract.

3.2 Exercise of Authority

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:

(a) whenever carrying out duties or exercising authority, express 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.

3.3 Replacement

The Purchaser may, with notice to the Contractor, replace the Engineer.

3.4 Giving Effect

The Contractor and the Purchaser shall give effect to each determination of the Engineer unless and until revised pursuant to the ARBITRATION Section of the General Conditions.

4 CLARIFICATIONS AND CHANGES TO THE WORK

4.1 General

There will be four (4) mechanisms for clarifying 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	Contractor / Engineer	Clarification to the Work
Extra Work Order (EWO)	Purchaser	Approves change to the Work, related to the Contract Scope
Amending Agreement	Purchaser	Approves change to the Work, not related to the Contract Scope or Amends Terms of the Contract

Each of these mechanisms are described in this Section of the General Conditions.

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 or an Extra Work 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.

4.2 Clarifications to the Work

4.2.1 Work Instructions

Work Instructions are instructions and clarifications issued by the Engineer using the Work Instruction form set out in Appendix B: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 may be issued in response to a Request for Information from the Contractor or may be issued at the initiative of the Purchaser or Engineer.

Work Instructions are enforceable clarifications or refinements of the Contract, not amendments thereto.

Upon receipt of a Work Instruction, the Contractor shall promptly proceed with the Work as clarified therein.

The Contractor is not entitled to additional compensation or to changes in the time for performance of the Work as a result of the issuance of a Work Instruction.

4.2.2 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 28 days, the recipient will notify the requestor in writing.

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 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 28 days or notify the requestor of a required extension to the response period.

4.3 Changes to the Work

The Purchaser shall have the right, without notice to sureties on any bond, and without invalidating the Contract, 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, including additions, deductions, alterations and extras.

Such changes must in all cases be in writing signed by the Purchaser titled "Extra Work Order" and issued by the Engineer to the Contractor.

Upon receipt of a written Extra Work Order from the Engineer, the Contractor shall promptly proceed with the changes in the Work.

Adjustments to the Contract Price as a result of the changes directed by the Engineer in an Extra Work Order shall be determined in accordance with the PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK Section of these General Conditions.

4.3.1 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work.

When initiated by the Engineer, the Proposal for Extra Work is a formal request for quotation for additional work required. The Contractor's responding quotation 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. The quoted price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

When initiated by the Contractor, the Proposal for Extra Work is a formal proposal for an alternate to the Work. The proposed price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

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 14 days, the requesting party shall be notified in writing.

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 14 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 quotation, 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. The Proposal for Extra Work may be accepted by the Purchaser providing written notice to the Contractor in the form of an Extra Work Order issued by the Engineer.

When the Contractor initiates a Proposal for Extra Work, the proposal shall be valid for a period of 14 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 issued by the Engineer.

4.3.2 Extra Work Orders

Extra Work Orders are formal approval of changes to the Work by the Purchaser where the change is related to or within the original Contract scope of the Work. The Purchaser through the Engineer may issue a written Extra Work Order using the Extra Work Order set out in Appendix B: Manitoba Hydro Forms for Clarification and Changes to the Work.

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 the Proposal for Extra Work Subsection of these General Conditions or the preceding sentence, if the Purchaser requires the Contractor to proceed with a change in the Work 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.

4.4 Contract Amendments

No amendment to any other terms or conditions of the Contract, other than those recognized to be made by Extra Work Order as provided in the Contract, shall be made unless first approved and authorized in writing by both the Purchaser and the Contractor. Such amendments shall be documented in an amending agreement signed by both parties.

5 PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK

The method for pricing and payment of all adjustments to the Contract Price due to changes to the Work by virtue of Extra Work Order pursuant to the CLARIFICATION AND CHANGES TO THE WORK Section of these General Conditions or pursuant to the CONTRACTOR CLAIMS Section of these General Conditions (hereinafter "Claims"), shall be as follows unless otherwise agreed to between the Purchaser and the Contractor.

5.1 Additions to the Work or Claims

5.1.1 Lump Sum

Where the Engineer has directed that an addition to the Work or Claim be dealt with by lump sum, the Contractor shall prepare and submit to the Engineer a detailed quoted lump sum cost of the requested addition or Claim. The quote shall not include any mark-up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The quoted lump sum cost shall include the following details as a minimum:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing cost
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

In respect of travel, airfare shall be limited to economy class, receipts shall be required.

(the "Quoted Cost").

The Quoted Cost shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Quoted Cost was not accepted. Within the next 5 days, the Contractor will be entitled to submit a revised Quoted Cost.

Following such five (5) day period, the Engineer may either:

i) accept the latest Quoted Cost of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,

ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Quoted Cost of the addition or Claim as documented by issuance of an Extra Work Order.

5.2 Deductions from the Work

5.2.1 Credit for Deduction from the Work

Where a deduction from the Work is proposed by the Purchaser through issuance by the Engineer of a Proposal for Extra Work to the Contractor setting out such deduction, the Contractor shall prepare and submit to the Engineer a detailed quoted credit for the requested deduction. The quoted credit shall represent the cost to the Contractor to perform the Work to be deducted and shall not include any mark up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The Contractor shall submit a detailed breakdown of the proposed credit and at a minimum include the following:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing hours and rates for specific processes
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

(the "Deduction Credit")

The Deduction Credit shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Deduction Credit was not accepted. Within the next five (5) days, the Contractor will be entitled to submit a revised Deduction Credit.

Following such 5 day period, the Engineer may either:

i) accept the latest Deduction Credit of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,
ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Deduction Credit as documented by issuance of an Extra Work Order.

6 CONTRACTOR CLAIMS

6.1 Notice of Intent to Claim

If the Contractor determines it is entitled to additional costs to perform the Work 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work 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 Contract Price or to any adjustment to the Contract Schedule, and the Purchaser shall be discharged from all liability in connection with the claim.

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.

6.2 Claim Documentation

Within 21 days after the Contractor has given written Notice of Intent to Claim in accordance with the Notice of Intent to Claim Section of these General Conditions, 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;
(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 request.

All subsequent communications with the Engineer respecting a claim or potential 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 of the General Conditions, each party shall take reasonable steps to mitigate its losses.

6.3 Determination of Claim

The Engineer shall proceed in accordance with this Section of the General Conditions to determine:

i) the extension (if any) of the time for completion of the Work in accordance with the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of these General Conditions; and,
ii) the adjustment (if any) to the Contract Price to which the Contractor is entitled to pursuant to the Contract.

Whenever a provision of the Contract provides that the Engineer shall proceed in accordance with this Subsection 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 Subsection, 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 a fair 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 extension of time or an adjustment to the Contract Price, or both, are warranted in the opinion of the Engineer, the Engineer shall document such changes in an Extra Work Order. 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 the ARBITRATION Section of these General Conditions.

For any claims made in accordance with this Section 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 the ARBITRATION Section of the General Conditions.

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 this Section of these General Conditions.

The Contractor shall not delay or hold up performance of the Work during resolution of a claim pursuant to this Section or originating pursuant to the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of the General Conditions or during referral of any such claim to arbitration as permitted above.

7 REQUEST FOR EXTENSION OF TIME

The Contractor shall be entitled, subject to the CONTRACTOR CLAIMS Section of the General Conditions to an extension of time for completion of the Work if completion of the whole of the Work is or will be delayed by any of the following causes:

(a) legal strikes or walkouts;
(b) any peril insured against pursuant to the INSURANCE Section of the General Conditions;
(c) unpreventable accident;
(d) terrorism, war or delay caused by war;
(e) vandalism or malicious mischief not reasonably preventable by the Contractor;
(f) riot or civil commotion;
(g) acts of God;
(h) lawful orders of civil or military authorities; or
(i) a cause of delay giving an entitlement to extension of time 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 Subsection 6.1 Notice of Intent to Claim of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c), (d), (e), (f), (g), (h), and (i) above resulted in a delay to the completion of the Work; and,
ii) 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.

Other than as stated in this section and the PURCHASER CAUSED DELAY Section of the General Conditions, 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.

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.

8 PURCHASER CAUSED DELAY

If the Contractor suffers delay and/or incurs additional costs in relation to the Work as a result of:

(a) an Extra Work Order issued by the Engineer without the agreement or in absence of the agreement of the Contractor;
(b) negligence or default on the part of the Purchaser;
(c) negligence or default on the part of another contractor for whom the Purchaser is responsible; or
(d) deviation from the Contract or temporary suspension of the Work by direction of the Engineer;

then the Contractor shall give notice to the Engineer in accordance with the Notice of Intent to Claim Subsection of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c) and (d), 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;
ii) 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,
iii) the resulting adjustment, if any, to the Contract Price for the substantiated amount of resulting additional costs to the Contractor.

9 SCHEDULE OF THE WORK

The Contractor shall submit to the Engineer within twenty (20) working days of the effective date of the Contract, a time chart or schedule containing all or such part of the following information as the Engineer requires:

(a) the scheduled date of completion of design and submission of working drawings to the Engineer for approval;
(b) the scheduled date of start and completion of type test;
(c) the scheduled date of completion of all orders for material required for the Work;
(d) the scheduled date of completion of manufacture, fabrication and/or assembly of the Work;
(e) the scheduled date of completion of delivery of the Work (and where applicable, unit sections thereof) to the site; and
(f) such other information as is requested in writing by the Engineer.

The Contractor shall also submit reports on the progress of the Work to the Engineer containing such detailed information as the Engineer from time to time requires on the design, material, manufacture, fabrication, assembly, shipment and delivery of the Work. The Contractor shall grant authorized representatives of the Purchaser and Inspector access to the Contractor's factory and to the factory or factories of all subcontractors, during the Contractor's or subcontractor's normal business hours, to enable such representatives to ascertain the state of the Work and the progress being made thereon by the Contractor or subcontractor.

10 LANGUAGE, DIMENSIONS AND WEIGHTS

All communication, including without limitation all notices, documents, notes on drawings, and submissions, required or permitted under the Contract, shall be in English.

Any Work shall be executed in the SI (Metric) System of Units except for bolts and nuts. Dimensions shall be shown in metres and millimetres and weights shall be shown in kilograms and metric tonnes.

11 SUBCONTRACTS

The Contractor shall not, without the prior approval in writing of the Purchaser, assign the Contract, nor make a subcontract with any person, firm or corporation for the execution of any portion of the Work, other than for materials or for any part of the Work for which the manufacturer or supplier is named in the Contract. If the Contractor wishes to sublet any part of the Work, the Contractor shall first submit to the Purchaser for approval, a description of the part of the Work which the Contractor wishes to sublet and the name or names of the subcontractor or subcontractors it wishes to employ. Any approval given by the Purchaser as provided for in the immediate preceding sentence shall not relieve the Contractor from any obligation or liability for the full and complete performance of the Work, all in accordance with the Contract.

If the Purchaser gives its approval thereto in writing, and the Contractor enters into one or more subcontracts, 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.

All work done by a subcontractor shall, for the purposes of the Contract, be deemed to be done by the Contractor and payment therefore 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 therefore. 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.

If the Purchaser so requests, the Contractor shall furnish the Purchaser with duplicate copies of all orders placed by the Contractor with subcontractors.

12 COOPERATION BETWEEN CONTRACTORS

The Contractor shall cooperate with all other contractors who may be performing Work on behalf of the Purchaser, and with the workers who may be employed by the Purchaser on any work at/in the vicinity of the Site. 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 materials and equipment of the Purchaser or of other contractors.

13 INSURANCE

The Contractor shall provide, maintain and pay for the insurance coverage listed below. The Contractor shall supply the Purchaser with a certified copy of the required policy of insurance and all renewals thereof. A Certificate of Insurance may be submitted in place of the policy provided that all terms and conditions of required coverage are specified therein. All documentation must be submitted to the Purchaser prior to the commencement of the Work or delivery of goods or services.

The policy shall be endorsed to provide the Purchaser with not less than thirty (30) days' written notice in advance of cancellation, change or amendment restricting coverage, and to show the Purchaser as an Additional Insured.

The Contractor shall be responsible for any deductible amounts under the policy except where such amounts may be excluded from the Contractor's responsibility. Should a loss be sustained, the Contractor shall act on behalf of both the Purchaser and the Contractor for the purpose of adjusting the amount of loss with the insurance companies.

13.1 General Liability Insurance

General Liability Insurance, shall provide limits of not less than $2 000 000 (CAD) inclusive, per occurrence, for bodily injury, death, and damage to property including loss of use thereof.

The General Liability Insurance shall include insurance coverage for the following:

(a) Premises Property and Operations
(b) Products and Completed Operations
(c) Blanket Contractual Liability
(d) Cross Liability
(e) Non-owned Automobile Liability
(f) Occurrence Property Damage
(g) The Purchaser named as Additional Insured

14 IMPORTS

The Contractor shall be the importer of all non-Canadian goods and services.

15 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 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.

16 MATERIALS AND LABOUR

Unless otherwise specified in the contract, the Contractor shall furnish all material and shall perform all labour necessary for the due and proper design, manufacture, fabrication, completion and delivery of the Work.

All work done and materials supplied pursuant to the Contract shall be of specified quality, if specified, otherwise of suitable quality as determined by the Engineer.

17 INVOICES

The invoices to be submitted by the Contractor shall be satisfactory to the Purchaser in both form and content. The Contractor shall also provide supporting documents and receipts if requested by the Purchaser.

18 RECORDS

The Contractor shall:

(a) keep full and detailed records, books, accounts, correspondence, instructions, drawings, receipts, vouchers, memoranda, and records of labour force, plant, tools, equipment, hours worked, rates required to properly appraise the progress of the Work, (herein “records”), necessary for the proper administration of the Contract and the Work.

(b) provide the Engineer and/or the Purchaser with copies of any records when requested, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(c) provide the Engineer and/or the Purchaser with reasonable access to any premises and to inspect and/or audit records, and permit copies to be made of same, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(d) preserve records for a period of not less than three (3) years from the date of the Completion Certificate.

19 CONFLICTS

For the entire duration of the Contract, the Contractor and its agents shall not provide equipment or services to any other person(s) in a manner which conflicts with the Contract.

20 CONFIDENTIALITY

The Contractor shall keep the Confidential Information confidential, using no less a standard than measures the Contractor uses to keep its own highly confidential information secret, but in any event not less than a reasonable standard of care.

Confidential Information may only be used by the Contractor for providing Services to the Purchaser and for no other purpose whatsoever.

The Contractor shall not, without the prior written consent of the Purchaser, disclose or otherwise make available any Confidential Information to any other Person, except to such directors, officers, and employees of the Contractor who have a need to access Confidential Information to perform their obligations to the Contractor for Hydro. The Contractor shall be responsible for any breach of the terms of this Section by it or any such Person.

The Contractor shall deliver Confidential Information to the Purchaser immediately on demand from the Purchaser and, on demand from Hydro, certify in writing to Hydro within ten (10) days of such demand that Confidential Information has been erased or destroyed.

The Contractor acknowledges that any failure to comply with the provisions of this Section hereof, shall cause irreparable harm to Hydro which cannot be adequately compensated for in damages, and accordingly acknowledges that Hydro shall be entitled, in addition to any other remedies available to it, interlocutory and permanent injunction relief to restrain any anticipated, present, or continuing breach of this Contract.

The Contractor's obligations pursuant to this Section hereof shall continue without limitation of time.

The Contractor shall

(a) have in place and utilize systems, media, policies, and procedures, for the storage of, security for, access to, handling of, transfer of, and destruction of, Personal Information that would satisfy the requirements of: (i) The Freedom of Information and Protection of Privacy Act (Manitoba) as if that Act applies to Contractor; and (ii) the Personal Information Protection and Electronic Documents Act (Canada) requirements for protection of Personal Information; and conform to ISO 27000;

(b) secure Personal Information against unauthorized and accidental access, disclosure or attack.

21 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 the final 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, at the Contractor's expense, 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 the USE OF FAULTY OR DEFECTIVE WORK Section of the General Conditions.

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. The Contractor shall be liable for all 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 invoice therefore certified correct by the Purchaser. The Purchaser may, at the Purchaser's option, apply moneys due or to become due from the Purchaser to the Contractor in or towards payment of such costs, charges and expenses, in which event the Contractor shall remain liable for any deficiency.

22 USE OF FAULTY OR DEFECTIVE WORK

Until all faulty or defective work has been made good or altered as provided by the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions, the Purchaser shall have the right to use any such faulty or defective work at the Contractor's sole risk, and without thereby in any way affecting the Purchaser's rights under the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions 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.

23 CONTRACTOR'S LIABILITY

23.1 The Work

Unless otherwise specifically provided in the Contract, the Work shall be and remain at the risk of the Contractor and the Contractor shall make good loss thereof or damage thereto occurring between the effective date of the Contract and the date of the COMPLETION CERTIFICATE issued in respect thereof, or the date of final payment, whichever shall first occur.

23.2 Labour and Materials

The Contractor 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.

23.3 Injury to Persons or Property

If, at any time after the effective date of the Contract and before the date of the COMPLETION CERTIFICATE, or if at any time thereafter while the Contractor, its officers, servants, agents, employees or subcontractors are on the site for the purpose of making good any breakage, defect or failure in the Work pursuant to the WARRANTY Section of the General Conditions, there shall occur any injury (including loss of life), loss or damage to any person or property, other than property forming part of the Work, caused by or resulting from defective plant, material, workmanship, fabrication, or construction or by anything done, or omitted to be done, or permitted to be done by the Contractor, its officers, servants, agents, employees or subcontractors (but not otherwise), then the Contractor shall 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 by any person, firm or corporation for, or by reason, or on account of such injury, loss or damage, or anything relating thereto.

24 INTELLECTUAL PROPERTY

Drawings, reports, manuals, documents, and other and/or similar materials (herein “Drawings”) produced/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 Drawings shall remain with the Contractor. The Contractor shall grant the Purchaser a perpetual, royalty free, non-transferable (save and except transferable to the Purchaser’s affiliates or transferable to any entity created after the effective date of the Contract and to which the Purchaser assets are assigned or otherwise transferred) limited licence to use, copy, and to allow third parties to use, the Drawings and all proprietary information in the Drawings as may be required for the purpose of proposing, installing, operating, repairing, maintaining, modifying, replacing and/or upgrading the Work, or any part thereof.

25 PAYMENTS BY THE CONTRACTOR

The Contractor shall promptly pay all assessments, premiums, levies, taxes, permit and licence fees and shall promptly pay for all materials, labour, and services obtained or required by the Contractor in the execution of the Contract. If the Contractor fails to pay the same, or unduly delays payment, the Purchaser may, at the Purchaser’s option, make such payment or payments for and on behalf of the Contractor, and thereafter the Contractor shall on demand, pay the Purchaser an amount equal to the aggregate of all the sums so paid by the Purchaser, plus interest on the sums so paid at an interest rate equal to the Prime

Rate of interest charged by the Purchaser's bank plus 3% per annum calculated from the date of payment by the Purchaser to the date when moneys are next due and payable by the Purchaser to the Contractor under the Contract, plus the sum of $10.00 (CAD) as a service charge in respect of each cheque issued by the Purchaser for or on behalf of the Contractor pursuant to this Section of the General Conditions, or the Purchaser may, at its option, deduct the aforesaid sums, interest and service charge from any moneys due or to become due to the Contractor from the Purchaser, provided that no payment by the Purchaser as aforesaid shall be held to relieve the Contractor from the Contractor's liabilities and obligations under the Contract.

The Contractor shall keep a record of the pro rata share of accrued interest on holdbacks due all subcontractors.

26 WARRANTY

If, within twenty-four (24) months from the date when the Work has been accepted by the Purchaser, the Work or any part thereof becomes broken or defective or fails due to faulty or improper design, material, workmanship, manufacture, fabrication, shipment or delivery, or fails to meet the requirements of the contract, then the Contractor, upon notification in writing from the Purchaser, shall forthwith make good every such breakage, defect or failure without cost (including without limitation, transportation costs to and from the place where the Work was delivered) to the Purchaser.

If, after such notification, 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 all costs, charges and expenses incurred by the Purchaser in connection therewith and shall forthwith pay to the Purchaser an amount equal to such costs, charges and expenses upon receipt of invoices therefore certified correct by the Purchaser.

The Contractor's liability under this Section of the General Conditions shall be in lieu of any warranty or condition implied by law as to the quality, design or fitness of the Work for any particular purpose, and save as in this Section of the General Conditions expressed the Contractor shall not be liable for defects in any work after the Work has been taken over by the Purchaser or for any injury or damage resulting from any such defects.

Provided the Contractor is not otherwise in default under the terms of the contract, and subject to the provisions of the CONTRACTOR'S LIABILITY and RESPONSIBILITY AS TO PATENTS Sections of the General Conditions, the Contractor's liability in respect of the Work, whether in contract, tort or otherwise, shall cease upon the fulfilment by the Contractor of the Contractor's obligations under this Section of the General Conditions; provided further that any part of the Work made good under this Section of the General Conditions shall be subject to all provisions of this Section of the General Conditions for a further period of 24 months from the date when the same has been made good as aforesaid.

Where more than one unit section of equipment is included in the Work, the said period of 24 months shall be deemed to commence when each unit section of the Work has been taken over by the Purchaser.

27 INSPECTION AND TESTING

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 or Inspector. Any special tests which the Purchaser requires are set forth in Request for Proposal 040565. The Contractor shall co-operate with the Engineer or Inspector and shall make available every facility which the Contractor possesses for inspecting and testing.

All work, materials and equipment condemned by the Engineer or Inspector shall be removed and rebuilt or replaced in accordance with the Contract at the Contractor's expense 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 work shall be promptly repaired and made good at the Contractor's own proper cost and expense.

If the Purchaser 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, proper operation 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 the USE OF FAULTY OR DEFECTIVE WORK, CONTRACTOR'S LIABILITY, CONTRACTOR'S DEFAULT, TERMINATION FOR BREACH OF CONTRACT, WARRANTY and INTERPRETATION OF THE CONTRACT Sections of the General Conditions.

28 COMPLETION CERTIFICATE

Subject to the provisions of the WARRANTY Section f the General Conditions, 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, the Purchaser will issue a COMPLETION CERTIFICATE (see SAMPLE ONLY COMPLETION CERTIFICATE included as Appendix C) to the Contractor, and from and after the date of said Certificate, the Purchaser shall be deemed to have accepted and taken over the Work, or the unit section thereof, as the case may be.

29 CONTRACTOR'S DEFAULT

If the Contractor:

(a) abandons the Work;
(b) fails to perform the Work in accordance with the terms and provisions specified in the Contract;
(c) fails to perform the Work within the time or times specified in the Contract;
(d) becomes bankrupt or insolvent, or makes an assignment for the general benefits of creditors;
(e) permits any execution to be levied on the Contractor's real or personal property or on any portion of the Work;
(f) assigns or sublets the Contract without the consent in writing of the Purchaser;
(g) loses control of the Work for any cause whatsoever, except by act of God, lawful orders of civil or military authorities, or the public enemy;
(h) refuses or neglects to follow the instructions of the Purchaser;
(i) fails to meet the Purchaser's requirements for material, plant, methods and/or labour within a reasonable time;
(j) refuses or neglects to use measures to protect the Work from damage;
(k) is guilty of carelessness or incompetence in the execution of the Work;
(l) delays the Work or any part thereof unnecessarily or unreasonably; or
(m) is in default of any other of its covenants or obligations in, or arising from, the Contract;

then the Purchaser may, at its option, and without prejudice to any other rights or remedies:

i) at the Contractor's expense, 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; and/or
ii) at the Contractor's risk and expense, remove unsuitable or inefficient material, plant and tools from the site; and/or
iii) at the Contractor's expense, take over and carry on the Work to the extent necessary to avoid loss or waste or damage to the Work already performed; and/or
iv) give notice of intention to terminate the Contract as provided in the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions.

30 TERMINATION FOR BREACH OF CONTRACT

If the Contractor makes default in any manner set forth in the CONTRACTOR'S DEFAULT Section paragraph (b), (c), (h), (i), (j), (k), (l), or (m) of the General Conditions, the Purchaser may give written notice to the Contractor of intention to terminate the Contract, stating the reasons therefore. If the Contractor does not remedy or take steps to remedy the default to the satisfaction of 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 the CONTRACTOR'S DEFAULT Section paragraph (a), (d), (e), (f) or (g) of the General Conditions, 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 thereafter. The Purchaser may, at its 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 may think fit, for the account and at the expense of the Contractor, and the Contractor shall be liable to the Purchaser for any excess cost occasioned the Purchaser.

At any time after the Purchaser has terminated the Contract, the Purchaser, with such assistance 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's material, plant, and tools at the site may be utilized by the Purchaser, without payment, for the purpose of completing the Work, and may be sold by the Purchaser by private sale or by public auction, either for cash or credit, and upon such terms and conditions as the Purchaser deems most advantageous, but without the Purchaser being liable for loss which may be occasioned thereby. The proceeds of such sale shall be applied in and towards the satisfaction of any money due or to become due to the Purchaser from the Contractor under the Contract.

Upon any termination of the Contract as provided herein, 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. 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 or due completion 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 moneys due or to become due to the Contractor. 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.

31 TERMINATION FOR CONVENIENCE

Notwithstanding the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions, the Purchaser may terminate the Contract (for whatever reason the Purchaser deems fit and at any time during the Work) on thirty (30) days' written notice. The Purchaser shall pay for fees and expenses incurred to the date of the termination.

Without restricting its other remedies, the Purchaser may immediately terminate the Contract in writing if the equipment or services are unsatisfactory, inadequate, or improperly performed, the Contractor fails to comply with the Contract, or the Contractor becomes bankrupt or insolvent.

32 RESPONSIBILITY AS TO PATENTS

The Contractor shall pay all royalties payable under or in respect of, and shall fully 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 of, any and all letters patent, registered design, trade mark or copyright of any apparatus or component part thereof forming part of or used in or 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 this proposing document, but such indemnity shall not cover any use of the Work otherwise than for the purpose indicated by or reasonably to be inferred from this proposing document.

In the event of any claim being made or action brought against the Purchaser arising out of the matters referred to in this Section of the General Conditions, the Contractor shall be promptly notified thereof and may at its own expense conduct 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 conduct by the Contractor of such negotiations or litigation shall be conditional upon the Contractor having first given to the Purchaser such reasonable security as shall from time to time be required by the Purchaser to cover the amount ascertained, or agreed, or estimated, as the case may be, of any compensation, damages, expenses, and costs for which the Purchaser may become liable in respect of such infringement or alleged infringement as aforesaid. The Purchaser shall, at the request of the

Contractor, afford all available 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, replace such work with a non-infringing work or modify it so that it becomes non-infringing or remove the said enjoined work and refund the sums paid therefor.

33 OWNERSHIP OF EQUIPMENT AND SUPPLIES

Any equipment and supplies provided by Manitoba Hydro to the Contractor for use pursuant to the Contract shall remain the property of Manitoba Hydro and shall be returned to Manitoba Hydro upon request.

34 ENUREMENT

The Contract shall enure and be binding upon the parties and their executors, administrators, heirs, successors and permitted assigns.

35 ASSIGNMENT OF RIGHTS AND OBLIGATIONS

The Contractor shall not assign any of its rights or obligations arising under the contract without the written consent of the Purchaser, which consent may be arbitrarily withheld.

36 SURVIVAL OF TERMS

Sections RECORDS, CONFIDENTIALITY, CONTRACTOR'S LIABILITY, ENUREMENT, INTELLECTUAL PROPERTY, OWNERSHIP OF EQUIPMENT AND SUPPLIES of the General Conditions shall survive the termination or expiration of the Contract.

37 INTERPRETATION OF THE CONTRACT

The Purchaser's decision shall govern 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 the Purchaser shall be the sole judge of the quality, quantity, suitability and efficiency of labour, workmanship, materials, plant, apparatus, equipment, appliances and methods used, furnished or supplied by the Contractor pursuant to the Contract.

The Contract shall be interpreted according to the laws of the Province of Manitoba, Canada.

38 OBSERVANCE OF LAWS AND REGULATIONS

Until the Work shall have been fully completed and accepted by the Purchaser, the Contractor shall be liable for the due and proper observance, both by itself, and by its servants, agents, employees and subcontractors, of all statutes, by-laws, rules and regulations in any way affecting or relating to the Work, which are lawfully imposed by any federal, provincial or municipal authority.

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 statutes, by-laws, rules and regulations by the Contractor, its servants, agents, employees and subcontractors.

39 APPLICABLE LAWS

The Contract shall be governed by the laws of the Province of Manitoba, Canada.

40 NOTICES

Every notice or communication required or permitted to be given or served pursuant to the Contract shall be in writing, and shall be delivered personally or by fax:

To the Purchaser:
TBD

To the Contractor:
TBD

To the Engineer:
TBD

In addition to forgoing, the Purchaser may effectually give notice to the Contractor:

(a) by giving same on the Superintendent, whether personally, or by fax to the Superintendent's designated Manitoba office; or

(b) by giving same to Contractors address and contact particulars included in the Contract.

Notice given or served by personal service shall be deemed effectually given and received upon such personal service, and notice given or served by fax shall be deemed effectually given and received on the first (1st) calendar day after the day of transmission.

The Contractor acknowledges and agrees that the Engineer is an employee of the Purchaser.

41 ARBITRATION

41.1 Notice of Dissatisfaction Concerning Engineer Determinations

A party shall be conclusively deemed to have accepted a determination by the Engineer issued under any provision of the Contract, 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 seven (7) 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.

41.2 Amicable Settlement of Disputes

The Purchaser and the Contractor shall make all reasonable efforts to resolve any 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 Engineer and Contractor's representative fail to resolve the dispute, 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 a Vice President for the Purchaser and the equivalent senior executive of the Contractor.

41.3 Final and Binding Arbitration

If the dispute has not been resolved within a reasonable time, 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, together with a concise statement of the matters in dispute.

41.4 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.

41.5 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.

41.6 Venue

Arbitration proceedings shall be conducted at Winnipeg, Manitoba.

41.7 Work to Continue

The Contractor shall not suspend, delay or interfere with 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 above, nor during arbitration proceedings.

END OF GENERAL CONDITIONS

Manitoba Hydro

TECHNICAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES	MAY 2017

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040565

TECHNICAL REQUIREMENTS

1 DESCRIPTION OF THE WORK

These Technical Requirements set out the Purchaser's requirements with respect to the design, material procurement, manufacture, supervision, labour, plant, tools, equipment, quality control, shop assembly and testing, packaging, shipping, delivery, installation instructions, Contractor's insurance and warranty of spacer-damper assemblies for a 500 kV AC Transmission Line.

2 REFERENCE STANDARDS

The latest revisions of the following standards, current at the time and the date of the execution of the Contract, shall apply.

Canadian Standards Association (CSA):

CSA C83	Communication and Power Line Hardware
CSA C108.3.1	Limits and Measurement Methods of Electromagnetic Noise from AC Power Systems, 0.15-30 MHz
CSA G164	Hot Dip Galvanizing of Irregularly Shaped Articles

American Society for Testing and Materials (ASTM):

ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM B26	Standard Specification for Aluminum-Alloy Sand Castings
ASTM B85	Standard Specification for Aluminum-Alloy Die Castings
ASTM B108	Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B247	Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM E94	Standard Guide for Radiographic Examination
ASTM F436	Standard Specification for Hardened Steel Washers

American Society of Mechanical Engineers (ASME):

ASME B18.2.1	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)

International Electrotechnical Commission (IEC):

IEC 61284	Overhead lines – Requirements and tests for fittings
IEC 61854	Overhead Lines – Requirements and tests for spacers

Institute of Electrical and Electronics Engineers (IEEE):

IEEE Std 1368	IEEE Guide for Aeolian Vibration Field Measurements of Overhead Conductors

International Organization for Standardization (ISO):

ISO 9001	Quality Management Systems –Requirements

In case of conflict between the Technical Requirements and the referenced standards, the requirements of the Technical Requirements shall take precedence.

3 SYSTEM PARAMETERS

3.1 Operating System Parameters

Spacer-damper assemblies shall be suitable for reliable operation under system parameters and environmental conditions as listed in Table 1 and Table 2.

Table 1
Operating System Parameters

Parameter	Specified Value
Nominal Line-Line Voltage	500 kV
Maximum Continuous Operating Voltage	575 kV
System Configuration	AC 3-phase
Nominal Line Load	2,000 Amps
Emergency Line Load	2,500 Amps
Maximum Conductor Operating Temperature	70 ˚C

Parameter	Specified Value
Maximum Sub-Conductor Surface Gradient	19 kV/cm
SLG Fault Current	23.1 kA
Fault Clearing Time	500 ms

Table 2
Environmental Conditions

Condition	Specified Value
Ambient Air Temperature: Minimum: Maximum:	 -50ºC 40ºC
Altitude	Less than 500 m
Environment Type	Rural and agricultural
Terrain Type	Mainly flat and open with few trees or buildings, snow-covered during winter
Lightning Stroke Density	1.61/km^2/yr

3.2 Conductor Characteristics

Conductor Type:	Aluminum Conductor Steel Reinforced (ACSR)
Conductor Designation:	Bunting
Conductor Size:	1192.5 MCM
Aluminum Type:	1350-H19
Outside Diameter:	33.1 mm
Number of Strands:	45/7
Strand Diameter (Al):	4.14 mm
Strand Diameter (Steel):	2.76 mm
Outer Layer:	20 strands, right hand lay
Linear Density:	1.997 kg/m
Rated Tensile Strength (RTS):	142.3 kN
Bundle Configuration:	Triple – see Figure 1

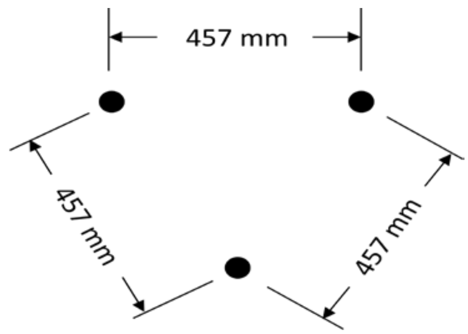

Figure 1, Conductor Symmetric Bundle Configuration

3.3 Line Design Parameters

Manitoba-Minnesota Transmission Line design parameters are as shown below:

Design Span: 470 m
Minimum Span: 00 m
Maximum Span: 631 m

Max. Wind Load: 95 - 100 km/h (10 min average)
Max. Ice Load: 6 mm, radial glazed (8829 N/m³ ice density)

Conductor tension values are as shown in Table 3.

Table 3
Conductor Tensions

Condition	Tension Value
Aeolian Vibration (1)	34.6 – 37.6 kN (Initial) 28.4 – 32.8 kN (Final)
Sub-span Oscillation (2)	31.4 – 33.1 kN (Initial) 24.0 – 31.7 kN (Final)

Notes:
(1) Aeolian vibration tension values are at -20°C which is the average temperature of the coldest month.
(2) Sub-span oscillation tensions are at 0°C which is the annual average temperature.

4 DESIGN REQUIREMENTS

4.1 Functional Requirements

Spacer-damper assemblies shall be designed to perform the following functions:

(a) Maintain sub-conductor spacing in required configuration,
(b) Prevent contact between sub-conductors due to wind,
(c) Provide effective protection against the damaging effects of vibrations and oscillations due to wind,
(d) Maintain stability of the conductor bundle under all service conditions.

4.2 General Requirements

Design of the spacer-damper assemblies shall be the responsibility of the Contractor.

The spacer-damper assemblies shall be designed to:

(a) Accommodate conductor size and bundle configuration,
(b) Avoid damage to the conductor,
(c) Meet all electrical and mechanical requirements listed in the Technical Requirements,
(d) Be free from corona and radio interference under maximum continuous operating voltage,
(e) Withstand mechanical forces from short circuit current without any component failure or permanent deformation,
(f) Allow easy installation without a need to remove any parts prior to installation,
(g) Have no loose parts after installation,
(h) Have an “UP” indication arrow on the body of the damper to aid with installation.

If required, additional devices, such as stockbridge dampers, may be included in the design of the damping system to achieve the specified performance requirements.

4.3 Performance Requirements

Spacer-damper assemblies shall have the ability to effectively control the levels of aeolian vibrations within endurance limits of the conductor as specified below:

- Maximum bending amplitude: $Y_b = 230$ µm (peak-to-peak)
- Maximum $fy_{max} = 118$ mm/s (peak)

Bending amplitude is defined as the peak-to-peak amplitude of conductor motion relative to clamp at 89 mm from the last point of conductor-clamp contact and measured in accordance with IEEE Std.1368.

fy_{max} is defined as the frequency times the antinode amplitude of the conductor.

4.4 Conductor Attachment System

The spacer-damper assemblies for spans between structures shall have the helical rod conductor attachment system. The helical rod must come with parrot-billed ends.

The bolt type clamping system is only acceptable for jumper string.

Only elastomer lined clamps shall be used.

4.5 Bundle Spacing Tolerance

The tolerance on the bundle spacing shall be ± 3.175 mm (1/8").

4.6 Energy Absorption Assembly

The energy absorption assembly shall:

(a) Be electrically semi-conductive
(b) Be capable of operating within the temperature range as specified in Table 2 of the Technical Requirements, without permanent loss of essential properties and while providing effective damping
(c) Resist the effects of ozone, ultraviolet radiation and other environmental contamination over the entire operating temperature range, as specified by Table 2 of the Technical Requirements
(d) Resist any displacement in the housing
(e) The geometry of the spacer-damper assembly shall not rely on any chemical or friction bond.

4.7 Spacer-Damper Assembly Drawings

Upon award of the Contract, the Contractor shall provide detailed drawings of the proposed spacer-damper assembly for approval by the Engineer. These drawings shall include:

(a) Complete bill of materials
(b) All physical dimensions
(c) Conductor diameter range application
(d) Dimensions and tolerances for all parts and assemblies
(e) Mechanical and electrical characteristics, including slip load value
(f) Overall weight and weight of each component

(g) Type of material used, fabrication method and type of finishes and coatings for each component
(h) Marking information
(i) Reference standards used
(j) Drawing and revision number

4.8 Elastomer Characteristics

Upon award of the Contract, the Contractor shall provide detailed characteristic of the elastomer and proposed testing methods for approval by the Purchaser. These test data shall form the basis for acceptance of type tests and sample test during production.

4.9 Damping Effectiveness

The Proponent shall provide evidence confirming the spacer-damper assembly effectiveness in controlling aeolian vibrations and sub-span oscillations, including:

(a) Maximum bending amplitude or fy_{max} levels achieved,
(b) Level of control of sub-span oscillations,
(c) Methods of calculations,
(d) All assumptions used, and
(e) Any references to industry standards.

The spacer-damper assembly effectiveness shall be determined by means of computer programs based on mathematical modeling or by in-field testing. If a computer program is used, sufficient evidence shall be provided to demonstrate that the analytical method used in modeling has been validated against laboratory results and field tests.

4.10 Corona Performance

The spacer-damper assembly shall be designed to perform corona free operation at the maximum continuous operating voltage. The helical rod shall have parrot-billed ends to reduce the chance of corona inception.

4.11 Placement Chart

Upon award of the Contract, the Contractor shall provide a detailed chart showing the placement of the spacer-damper assemblies for the full list of spans involved in the Manitoba–Minnesota Transmission Line Project which will be provided by the Purchaser.

4.12 Installation Procedure

Upon award of the Contract, the Contractor shall provide detailed instructions for the spacer-damper assembly installation procedure.

The Contractor shall also specify installation tolerance and the minimum distances from any conductor joints and repair sleeves.

4.13 Units of Measure and Language

All drawings and technical documents shall be in SI (metric) system and only in the English language.

5 MATERIALS AND MANUFACTURING

5.1 General

Only new manufactured materials shall be used.

All finished components shall be free of defects and regularities. Outside surfaces shall be smooth and all edges well rounded.

All materials shall conform to the general requirements of CSA C83 or IEC 61284 standards unless otherwise specified by the Technical Requirements.

5.2 Aluminum Parts

All aluminum material shall be manufactured from primary ingot.

Material and manufacturing used for the production of aluminum castings shall meet the requirements of ASTM B108, B26 and B85 standards.

Material and manufacturing used for the production of aluminum forgings shall meet the requirements of ASTM B247 standard.

5.3 Ferrous Parts

All ferrous materials shall be galvanized in accordance with CSA G164 standards. Charpy Level I is required excluding nuts and washers.

5.4 Corrosion Resistance

All material shall be resistant to atmospheric corrosion. If dissimilar metals are used, suitable precautions shall be taken to minimize electrolytic corrosion.

5.5 Stainless Steel

All stainless steel components shall meet the requirements of ASTM A276 standard or its equivalent.

5.6 Bolts and Nuts

All nuts and bolts shall be of hexagonal shape.

Bolts shall meet the requirements of ASME B18.2.1 with UNC threads or equivalent

Nuts shall meet the requirements of ASME B18.2.2 or equivalent.

5.7 Washers

Round washers shall meet the requirements of ASTM F436 standard or equivalent.

Helical spring washers shall meet the requirements of ASME B18.21.1 standard or equivalent.

5.8 Elastomer Components

Elastomer components shall be made of a material with conducting properties preventing electrical imbalances and leakage currents that would negatively affect elastomer's life or performance.

The Proponent shall identify the type of the elastomer material and shall provide reasonable evidence supporting its suitability to withstand environmental conditions as listed in Table 2.

5.9 Welding

Welding of any component shall not be permitted.

6 TESTING REQUIREMENTS

6.1 General

The spacer-damper assemblies shall undergo complete type, sample and routine tests as listed in Table 4 below and in accordance with IEC 61854 unless otherwise specified by the Technical Requirements.

All the required tests shall be made on the finished spacer-damper assemblies.

The Contractor shall be responsible for all testing costs which are deemed included in the Contract Price.

The Proponent is allowed to submit the results of laboratory and in-field testing done in the past to demonstrate suitability of their product for the purpose of the Manitoba–Minnesota Transmission Line Project.

The Purchaser may consider some of these test results in the proposal evaluation process, providing:

(a) Tests were performed on the spacer-damper assemblies of the same technology, including the damping element,
(b) Test bundle had a relatively equivalent sensitivity to vibrations and oscillations (i.e. similar sub-conductor spacing to conductor diameter ration, similar H/w value).
(c) The same number of units and the same general spacing scheme principles (maximum sub-span, non-uniform distribution, maximum end sub-span) were used.

6.2 Classification of Tests

The Contractor shall perform all the type, sample and routine tests as listed in Table 4 to demonstrate full conformance of the spacer-damper assembly with all aspects of the Technical Requirements.

Table 4
Test Requirements

Item	Test	Reference Clause of Technical Specifications and/or Standard	Test		
			Type	Sample	Routine
1	Visual examination	IEC 61854 - Clause 7.1	x	x	x
2	Verification of dimensions, materials and mass	IEC 61854 - Clause 7.2	x	x	x
3	Corrosion protection test	IEC 61854 - Clause 7.3	x	x	
4	Galvanizing tests	Technical Requirements - Clause 6.10.1	x	x	
5	Radiographic inspection of aluminum castings test	Technical Requirements - Clause 6.10.2	x	x	
6	Longitudinal slip test	Technical Requirements - Clause 6.10.3 and IEC 61854 - Clause 7.5.1.1	x		
7	Simulated short-circuit current test	Technical Requirements - Clause 6.10.4 and IEC	x		

Item	Test	Reference Clause of Technical Specifications and/or Standard	Test		
			Type	Sample	Routine
		61854 - Clause 7.5.4			
8	Characterisation of the elastic and damping properties	Technical Requirements - Clause 6.10.5 and IEC 61854 - Clause 7.5.5	x		
9	Flexibility tests	Technical Requirements - Clause 6.10.6 and IEC 61854 - Clause 7.5.6	x		
10	Subspan oscillation test	Technical Requirements - Clause 6.10.7 and IEC 61854 - Clause 7.5.7.2	x		
11	Aeolian vibration test	Technical Requirements - Clause 6.10.8 and IEC 61854 - Clause 7.5.7.3	x		
12	Tests to characterize elastomers	IEC 61854 - Clause 7.6	x		
13	Visual corona test	Technical Requirements - Clause 6.10.9	x		
14	Radio influence voltage test	Technical Requirements - Clause 6.10.10	x		
15	Electrical resistance test	Technical Requirements - Clause 6.10.11 and IEC 61854 - Clause 7.7.2	x		

6.3 Access and Notification

Contractor shall allow the Purchaser or his representative access to all tests. The Contractor shall give notice to the Engineer of such testing a minimum of thirty (30) days in advance.

6.4 Third Party Testing

The Purchaser reserves the right to select and test samples from spacer-damper lots fabricated by the Contractor using a qualified third party using the same tests as outlined in the Technical Requirements. If this tested lot fails any of the acceptance criteria set out in the Technical Requirements, then the lot will be refused and returned at the Contractor’s expense. A replacement lot will be provided by the Contractor in accordance with all requirements of the Contract, at no additional expense or cost to the Purchaser.

6.5 Supply of Conductor

The Purchaser will supply conductor required for testing of the spacer-damper assemblies.

6.6 Type Tests

6.6.1 General

Type tests are intended to demonstrate conformance of electrical and mechanical characteristics of the spacer-damper assemblies with all the requirements of the Technical Requirements. The spacer-damper assemblies shall be subjected to type tests listed in Table 4.

All type tests shall be performed on three spacer-damper assembly samples.

Type Test Reports shall be certified by a qualified person and submitted electronically to the Engineer for approval.

The Purchaser shall not accept any material deliveries until the Type Test Report has been approved by the Engineer

6.6.2 Validity of Existing Type Test Report

The Engineer may accept the existing type test reports offered by the Contractor in the Contractor's Proposal, provided that:

(a) All the type tests were made of the same type of spacer-damper assembly as required by the Technical Requirements;
(b) A complete set of tests were performed on the required number of spacer-damper assemblies as prescribed by the Technical Requirements;
(c) Testing was performed in accordance with all the requirements of the Technical Requirements;
(d) Testing was performed within the last ten (10) years;
(e) Testing was done on the spacer-damper assemblies manufactured at the same facility; and
(f) The Contractor's manufacturing process has not changed since the time of the type tests performed.

The Engineer shall advise the Contractor in writing as to whether the above criteria have been satisfied, in the Engineer's sole discretion.

6.6.3 Material Properties and Parameters for Testing Purposes

Upon award of the Contract and prior to commencement of type testing, the Contractor shall provide the Purchaser with a set of material properties and parameters of the spacer-damper assemblies. This data shall form the basis for acceptance of type and sample tests.

6.7 Routine and Sample Tests

The Contractor shall be responsible for all routine and sample tests. The spacer-damper assemblies shall be subjected to sample and routine tests listed in Table 4.

6.8 Sampling and Acceptance Criteria

All spacer-dampers shall be tested using a single sample plan for normal inspection, as defined by CSAC83 standard.

Sample size and acceptance numbers shall be:

(a) Sampling inspection by attributes: as per Table A1 of CSA C83 standard
(b) Sampling inspection by variables – as per Table B1 of CSA C83 standard

except for:

(a) For surface defects: 100% sampling,
(b) For galvanizing: the samples size shall be 5 samples per galvanizing lot.

Alternate sampling plan and acceptance criteria may be acceptable subject to approval by the Engineer.

6.9 Classification of Defects

The following Acceptable Quality Levels shall be used:

Class B:
(a) verification of dimensions, materials and mass
(b) radiographic inspection of aluminum castings test

Class C:
(c) visual examination
(d) corrosion protection test
(e) hot dip galvanizing

Definitions of Acceptable Quality Levels shall be as per Table 3 of CSA C83 standard.

6.10 Individual Test Requirements

6.10.1 Galvanizing Test

Hot dip galvanized components shall be subjected to galvanizing test dimensional verification test to ensure conformity with the detailed design drawings. The test procedure shall be in accordance with CSA G164 Clause 6.

6.10.2 Radiographic Inspection of Aluminum Castings Test

Radiographic inspection shall be performed in accordance with ASTM E94 standard on each type of component casting at the start of production and any time a change has been made in the casting process.

Sampling for compliance with acceptance criteria shall be one radiograph per 200 castings in the first 2,000 castings of each type of component, and one radiograph per production lot thereafter.

In the case of one inspection lot sample not meeting the required acceptance criteria, another random sample from the same inspection lot shall be inspected. If the second sample is rejected, the complete inspection lot shall be rejected.

6.10.3 Longitudinal Slip Test

The test procedure shall be in accordance with IEC 61854 Clause 7.5.1.1 with the following modifications and additions.

The first slip load test shall be performed on the conductor tensioned to 20% of its rated tensile strength (RTS). The tension shall be gradually increased (not faster than 100 N/s) until it reaches 1.5 kN. This load shall be kept constant for 60 seconds. No slippage in the interface of the conductor and the helical rods shall occur. Then the load shall be gradually increased until continuous slippage occurs. Continuous slippage shall be considered as having occurred when the pulling force cannot be increased or the movement of the clamp using helical rods on the conductor is 12 mm.

The second slip test shall be performed taking into account the creeping behaviour of the conductor. A new spacer-damper set shall be installed on the unused conductor which is tensioned to 20% of RTS. Then the tension shall be gradually increased (not more than 100 N/s) to 40% of the conductor RTS and kept for 2 hours at this tension load. Afterwards the tension shall be gradually decreased to 20% of conductor RTS and the slip test shall be performed. No slippage shall occur at or below 1.5 kN slip load value.

6.10.4 Simulated Short-Circuit Current Test

The test procedure shall be in accordance with IEC 61854 Clause 7.5.4.1. The Contractor shall provide the test setup details for approval by the Purchaser prior to commencement of testing.

The compression force shall be gradually increased until it reaches the test value. At this value the forces shall be held constant for 60 seconds and then removed. The test shall be executed twice: the first one with the spacer-damper assembly in its normal position, the second one with one attachment displaced 35 mm longitudinally in reference to the other attachments.

Following the compression force, the tension force shall be applied. This value shall be gradually increased until it reaches 50% of the compression force and then held for 60 seconds.

Acceptance criteria:
After the test

- It shall be possible to return the spacer-damper assembly clamps to their design position using only slight hand pressure;
- The spacer-damper assembly shall be examined by disassembly if necessary. There shall be no deformation or damage which would impair the efficiency of the spacer-damper assembly or affect its function of maintaining the normal bundle spacing.

6.10.5 Characterisation of the Elastic and Damping Properties

The characteristics of the elastomer damping element shall be verified with one or more of the three test methods as specified by IEC 61854. The test procedure shall be in accordance with IEC 61854 Clause 7.5.5.

The stiffness-damping is the method preferred by the Purchaser.

The stiffness method and the damping method are acceptable to the Purchaser only if both are performed.

The tests shall be performed at room temperature of 20±5°C on specimens kept at the room temperature prior to testing for a minimum of 3 hours.

Acceptance criteria:

- The torsional stiffness K_t shall not differ by more than ±20% from the value specified by the Contractor, and
- The ratio H_t/K_t shall not be lower than 20% of the value specified by the Contractor.

6.10.6 Flexibility Tests

The test procedure shall be in accordance with IEC 61854 Clause 7.5.6. The spacer-damper assembly shall be installed on a length of twin bundle tensioned at 20% of the conductor RTS.

The values of the displacements to be used for the tests shall be in accordance with the values specified by the Contractor but not less than:

- Longitudinal displacement: 25 mm (p-p)
- Vertical displacement: 50 mm (p-p)
- Conical displacement: 10 deg
- Transversal displacement: 25 mm (p-p)

The displacements shall be applied gradually for each pair of adjacent attachments.

6.10.7 Sub-Span Oscillation Test

The test procedure shall be in accordance with IEC 61854 Clause 7.5.7.2. Rigid tubes having the same diameter as the conductor shall be used. The clamp under test shall be installed in the middle of the span by the use of helical rods. The adjacent clamp shall be fixed by the use of a tube to the drive mechanism.

The test shall be carried out at a frequency between 1 Hz and 2 Hz for 10 million cycles.

After testing, the spacer-damper assembly shall be dismantled and the damping elements shall be examined.

Acceptance criteria:
- There shall be no cracks in the damping element,
- There shall be no abrasion of the clamp or the helical rods.

6.10.8 Aeolian Vibration Test

The test procedure shall be in accordance with IEC 61854 Clause 7.5.7.3. Rigid tubes having the same diameter as the conductor shall be used. The distance between the two attachment points beside the spacer-damper assembly clamp shall be at least 500 mm.

A frequency range of 20 Hz to 40 Hz shall be covered. The spacer-damper assembly shall be vibrated for 100 million cycles.

After testing, the spacer-damper assembly shall be dismantled and the damping elements shall be examined.

Acceptance criteria:
- There shall be no cracks in the damping element,
- There shall be no abrasion of the clamp or the helical rods, and
- The force corresponding to a clamp displacement of 50 mm shall not be less than 70% of the initial value.

6.10.9 Visual Corona Test

The test procedure shall be in accordance with CSA C83 Appendix E. The test shall be conducted three times, and the value for corona extinction considered for qualification shall be the arithmetic mean of the three voltage gradients.

The visual corona test shall be considered successful, if no visual corona is observed on any part of the tested assembly when the test voltage gradient on the conductor surface for the tested assembly is less than and equal to the value specified in the Technical Requirements.

6.10.10 Radio Influence Voltage Test

The test procedure shall be in accordance with IEC 61284.

The measured RIV level shall not exceed the limits as specified in CSA C108.3.3 standard at the test voltage or the conductor surface voltage gradient as specified in the Technical Requirements.

For both series of measurements the RIV vs. conductor surface voltage gradient is to be plotted and reported.

6.10.11 Electrical Resistance Test

The test procedure shall be in accordance with IEC 61854 Clause 7.7.2.

The electrical resistance of the elastomeric elements between each spacer clamp and the spacer frame shall be determined by the application of 100 Vrms (±10%) at 50Hz/60 Hz AC and the resistance determined from Vrms/Irms.

For spacer-damper assemblies with elastomeric clamp liners the resistance between the conductor and the spacer-damper clamp shall also be tested. The elastomeric element and clamp liners shall be free from moisture or any liquid used during the assembly when testing is performed.

The test shall be carried out at room temperature (20±5°C) and the temperature shall be reported. The specimens shall be kept in room temperature prior the test for at least 3 hours. The arms should not be moved during the time of conditioning to avoid any stress on to the damping elements.

Acceptance criteria:

- The resistance between the spacer arm and the central frame and between the conductor and the spacer arm in case of rubber lined clamps shall be within the range specified by the Contractor.

6.11 Field Test

The Contractor shall provide the Purchaser with vibration recorders for field test purposes. These recorders will be required to monitor effectiveness of the Contractor's damping system to control both Aeolian vibrations and sub-span oscillation. The installation of the recorders will be done:

- within one year after completion of construction,
- in 3 locations mutually agreed between the Engineer and the Contractor, and
- during the winter months when conductor tensions are high.

Installation of the vibration recorders will be responsibility of the Purchaser. Installation will be done according to the installation procedures provided by the Contractor and under Contractor's supervision.

Field measurements will be done for a minimum of 30 days without any interruptions.

Removal of the vibration recorders will be responsibility of the Purchaser. The Purchaser will return the vibration recorders to the Contractor for the removal of the data and the data analysis.

The Contractor shall analyze the recorded data and shall issue the Field Measurements Report to the Engineer within 60 days after return of the vibration recorders.

6.12 Notice of Tests

If additional testing is required to satisfy requirements of the Technical Requirements, the Contractor shall give notice of such testing of a minimum of 30 days to the Engineer.

6.13 Certified Test Reports

Upon award of the contract and completion of all testing, all test reports shall be submitted electronically to the Engineer to confirm that all requirements of the Technical Requirements have been met.

Test reports shall be sent to:

Chen Wang, P. Eng. – Transmission Line Engineer
Manitoba Hydro
Transmission & Civil Design Department

820 Taylor Avenue (4)
P.O. Box 7950
Winnipeg, Manitoba, Canada R3C 0J1
Email: cwang@hydro.mb.ca

7 QUALITY ASSURANCE

7.1 General

The Contractor shall comply with the quality assurance program requirements of ISO 9001 standard or its equivalent in the performance of the Work, the Contract, and the Contractor's obligations in respect of both. If the Contractor's proposed program is not based on ISO 9001 series of standards, the Contractor shall submit evidence, satisfactory to the Engineer that the proposed program conforms fully to the spirit and intent of ISO 9001.

The Engineer may, in his sole discretion, reject Work that is not produced under the Quality requirements specified in this Section.

The Contractor is responsible to identify in its Quality Plan the specific activities it will undertake to perform:

(a) Quality Assurance: The process of auditing the quality requirements and the results from Quality Control measurements to ensure quality standards are being met.

(b) Quality Control: The process of monitoring and recording results of Quality activities to assess performance and recommend necessary changes.

7.2 Quality Documentation

All quality documentation shall be in the English language. Where the original document is in a single language other than English, the Contractor is responsible to have the document translated into English without causing delays to the documentation process.

7.3 Access to Contractor's Facilities

The Purchaser reserves the right to audit the Contractor's Quality Management System program at any time during the Work.

The Purchaser or its representative shall be granted unescorted access to the Contractor's facilities and to the facilities of all of its Subcontractors, at any time during the Contractor's or Subcontractors' normal business hours to verify that the Contractor and its Subcontractors are satisfactorily carrying out the Work and that the Work complies with the requirements of this Section of the Technical Requirements. The Purchaser or its representative shall be allowed at any time and under any circumstance to take photographs of any portion of the Work he deems necessary.

While attending at the Contractor's facilities, the Purchaser or its representative will comply with the reasonable policies of the Contractor concerning confidentiality (and with respect to matters not related to the Work and the Contract) which have been disclosed in writing to the Purchaser prior to attendance and for which no objection has been made; provided further however that nothing in the Contract is altered or diminished by reason of any such policy or compliance with same. While attending at Contractor's facilities, the Purchaser or its representative will use best efforts to limit disruption of other activities at such facilities.

7.4 Tools and Equipment

All tools and equipment used to carry out inspection activities by the Contractor shall have been calibrated within the one (1) year proceeding of the date of inspection by accredited third party inspection company. Calibration records shall be provided to the Purchaser or its representative upon request. If it is discovered that tools and equipment that were used for the Work have not been calibrated within one (1) year of the inspection date, the inspections shall be repeated, at the sole risk of the Contractor, with tools and equipment that are properly calibrated.

7.5 Inspection and Test Plan

At least 30 days prior to commencing production, the Contractor shall submit the Inspection and Test Plan for approval by the Engineer. The ITP document shall identify in detail:

(a) Production process and associated test,
(b) Parameter to be controlled,
(c) Sampling and frequency,
(d) Acceptance criteria,
(e) Reference standard or document,
(f) Control equipment,
(g) Testing location,
(h) Person/position responsible for the test, and
(i) Quality Control record form.

The Engineer will determine the Purchaser's level of involvement in testing. This will be reflected in the ITP document.

7.6 Non-Conformance Reports

The Contractor shall provide the Purchaser or its representative, within 7 days of such request, information related to any present non-conformance reports regarding spacer-damper assembly quality and manufacturing, testing, shipping, internal and external QA audits, including corrective and preventative actions in accordance with CAN/CSA-ISO 9001.

8 MARKING, PACKAGING AND SHIPPING

8.1 Marking

Marking is required to ensure traceability for each of the component of the spacer-damper assembly.

Each spacer-damper assembly shall be marked with letters and numerals identifying:

(a) Name of manufacturer,
(b) Manufacturer’s catalogue number,
(c) Year of manufacture, and
(d) Conductor diameter.

The letters and numerals shall be distinct, durable, and conspicuous. Markings may be raised or depressed but must be clearly legible after galvanizing. The identifying letters and numerals shall be cast or die stamped and shall be at least 6 mm high.

8.2 Packaging, Shipping and Deliveries

8.2.1 General

The Contractor shall prepare the spacer-dampers for shipment in such manner as to protect them from dust and dirt, damages during transportation, handling and outdoor storage. The Contractor shall be responsible for and make good any and all damage resulting in loading and transportation.

8.2.2 Packaging

The packaging arrangements shall be optimized to allow for an ease of field handling and installation.

All spacer-damper assemblies shall be shipped assembled and packaged into solid wooden crates. OSB or similar particle board material is not acceptable.

Proper protection shall be provided to prevent movement of the components inside the crates or boxes during transportation. These crates or boxes shall be grouped into pallets in such manner that they can be easily lifted by a forklift. Shrink wrap or other appropriate packaging option shall be used to protect the pallets.

The loaded pallets shall be capable of withstanding environmental conditions as listed in Table 2 for at least 24 months without loss of characteristic properties of all the hardware components in the pallet.

8.2.3 Approval of Packaging

The Contractor shall provide the packaging details to the Purchaser for approval. No packaging shall proceed without Purchaser's approval.

8.2.4 Deliveries

The Contractor shall deliver all shipments on an open flatbed trucks for offloading using a forklift. Deliveries using sea containers will not be accepted.

8.2.5 Marking of Crates or Boxes

Each box shall be clearly marked with the following information:

(a) Project name specified on the Purchase Order
(b) Purchase Order number
(c) Contractor's name
(d) Name of item, including conductor size and assembly type
(e) Destination
(f) Weight, in kilograms
(g) Date of manufacture

All markings shall be legible and made of waterproof paint or stamped metal tag securely attached to the box. All identification marks shall appear on the side and on the top of each box.

8.2.6 Shipping Reports

The Contractor shall, within 24 hours of each shipment, provide Purchaser with the shipping report, which shall include:

(a) Project name specified on the Purchase Order
(b) Purchase Order number
(c) Items and quantities shipped
(d) Net and gross mass of each box
(e) Carrier
(f) Bill of Lading number

(g) Shipping date
(h) Expected delivery date

The Contractor shall be responsible for tracking and expediting all shipments and for obtaining all required permits.

END OF TECHNICAL REQUIREMENTS

TERMS AND CONDITIONS OF PAYMENT

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES	MAY 2017

DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040565

TERMS AND CONDITIONS OF PAYMENT

1 ITEMS 1 to 2

Subject always to satisfactory performance of the Work by the Contractor in accordance with the Contract, the Purchaser shall pay the Contractor the cost of the Work and all services of the Contractor in connection therewith, in Canadian currency, as follows.

1.1 Major Payment

An amount equal to 92.5% of the cost of the Work shall be paid thirty (30) days after receipt of the Contractor's invoice following the completion of the Work.

Prior to payment of 92.5% of the cost of the Work to the Contractor as aforesaid, the Purchaser may require the Contractor to furnish the Purchaser with an Affidavit sworn by the Contractor in the form set out in Schedule 'A' (see SAMPLE ONLY) to these Terms and Conditions of Payment.

1.2 Performance Holdback

The 7.5% Performance Holdback balance of the cost of the Work shall be paid thirty (30) days after the date of the COMPLETION CERTIFICATE issued in respect thereof.

END OF TERMS AND CONDITIONS OF PAYMENT

Terms and Conditions of Payment Schedule 'A'

CANADA	)	I, ______________________________
	)	
PROVINCE OF MANITOBA	)	of the __________ of ____________ in the
	)	
TO WIT:		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__

FORM OF PROPOSAL

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

Important: Macro Security level to Medium

1. The first field to be completed in the Form of Proposal is your full legal company name. Once your proposal is complete and converted to pdf, your full legal company name will automatically appear inside the header of every page.

2 Continue preparing your proposal by completing the gray shaded fields on each page.

3. 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.

4. Certain fields which contain the drop-down selection feature will allow you to make a selection from a list. For checkboxes, click inside the applicable YES or NO box to make a selection. To deselect, click inside the YES or NO box you wish to deselect.

5. After you are satisfied with your electronic completion of the Form of Proposal, save the document and convert it to pdf.

6. Print and sign the signing page manually. Scan the signed page and insert it into the Form of Proposal pdf. Delete the unsigned page.

7. Certain fields have been limited to a maximum number of rows or characters that you can type. If the space provided is insufficient, you can use the document provided titled “Additional Form of Proposal.docx”.

8. If the “Additional Form of Proposal.docx” document has been utilized, convert it to pdf.

9. Submit the Form of Proposal, Additional Form of Proposal (if used) and any other applicable documents that you wish to accompany your proposal.

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

**DESIGN, MANUFACTURE AND SUPPLY OF
SPACER-DAMPER ASSEMBLIES
500kV AC TRANSMISSION LINES
REQUEST FOR PROPOSAL 040565**

FORM OF PROPOSAL 040565

COMPANY INFORMATION

This proposal is submitted by: ______________________________
(legal company name)
hereinafter called the "Proponent", a company duly incorporated under the laws of:

____

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

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

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

The Proponent's principal office dealing with this Form of Proposal is at:

____
(number, street)

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

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

THE WORK

The Proponent shall provide the information below:

Indicate if you are a Non-Resident Importer of Record into Canada:

YES ☐ NO ☐

If YES please indicate your GST Registration # below:

.1 If you are a Non-Resident Importer of Record into Canada and HAVE A GST number, provide EXW and **DDP** pricing in the table on the following page.

.2 If you are a Non-Resident Importer of Record into Canada and DO NOT HAVE A GST number, provide EXW and **DAP** pricing in the table on the following page.

.3 If you are not shipping product from a country outside of Canada, provide EXW and **DDP** pricing in the table on the following page.

THE WORK (CONT'D)

For the provision of DESIGN, MANUFACTURE AND SUPPLY OF SPACER-DAMPER ASSEMBLIES - 500kV AC TRANSMISSION LINES, all in accordance with Manitoba Hydro Request for Proposal 040565, the following prices.

(GST) and Manitoba provincial retail sales tax (PST) are not included in the proposed price. GST and PST shall be shown as "extra" on each invoice. All other applicable taxes shall be included.

***QUANTITIES ARE NOT GUARANTEED AND THE PURCHASER SHALL NOT BE OBLIGATED TO PURCHASE STATED QUANTITIES. QUANTITIES ARE SUBJECT TO CHANGE.**

THE CONTRACTOR SHALL BE RESPONSIBLE FOR <u>ALL TESTING COSTS</u> WHICH ARE DEEMED INCLUDED IN THE CONTRACT PRICE.

ITEM	Description	Shipping Options	UNIT Price ($CAD)	EXTENDED* Price ($CAD)
1	Spacer-Damper (helical rod attachment system) for 1192.5 MCM ACSR 45/7 Bunting – Triple Bundle	EXW LOADED	(per unit)	(for 3650 units)
		DDP: Gate 6 59029 PR 207 Dugald, Manitoba	(per unit)	(for 3650 units)
		DAP: Gate 6 59029 PR 207 Dugald, Manitoba	(per unit)	(for 3650 units)
2	Spacer-Damper (bolted type) for 1192.5 MCM ACSR 45/7 Bunting – Triple Bundle	EXW LOADED	(per unit)	(for 630 units)
		DDP: Gate 6 59029 PR 207 Dugald, Manitoba	(per unit)	(for 630 units)
		DAP: Gate 6 59029 PR 207 Dugald, Manitoba	(per unit)	(for 630 units)

COMMERCIAL COMPLIANCE

Below are proposed changes to the commercial terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

TECHNICAL COMPLIANCE

Below are proposed changes to the technical terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

TYPE TEST REPORT BY THIRD PARTY LABORATORY

.1 The Proponent submits with its proposal existing type test report that meets all requirements of Subsection 6.6.2 in Technical Requirements of this RFP:

YES ☐ NO ☐

Comments:

.2 If existing type test report is not available or fails to meet any requirement of Subsection 6.6.2 in Technical Requirements of this RFP, Proponent should identify the Third Party Laboratory that will perform type test outlined in the Technical Requirements.

Name and Address of the proposed Type Testing Facility:

NOTE: The Purchaser reserves the right to accept or reject the Proponent's listed Type Testing Facility.

DELIVERY DATE(S)

The Proponent offers to deliver the ITEMS of the Work on the Purchaser's specified date:

YES ☐ NO ☐

If the above answer was NO or if the Proponent can deliver the Work earlier than the Purchaser's preferred date, the Proponent indicates below its earliest dates upon which the ITEMS of the Work could be delivered:

ITEM 1 , 20

ITEM 2 , 20

SHIPMENT/TRANSPORTATION DETAILS

Delivery of the Work

The Purchaser requires the Proponent to provide the following information regarding shipment/transportation of the Work:

The total shipment weight is ___________lb or ___________ kg.

The total shipment volume is __________ ft^3 or ___________m^3.

The shipment's dimensions are:
length ___________ ft x width ___________ ft x height ___________ ft, or
length ___________ m x width___________ m x height ___________ m.

The total shipment quantity is _________ (No. of cartons / No. of pallets, etc.)

The shipment will be transported via:

Road:
____________(qty) ___________ (length in ft) enclosed van(s), or
___________ (qty) ___________ (length in ft) flatdeck trailer(s).

OR
Rail:
__________ (qty) ___________ (length in ft) boxcar(s), or
__________ (qty) ___________ (length in ft) flatcar(s), or
___________ (qty) ___________ (length in ft) gondola car(s).

SHIPMENT/TRANSPORTATION DETAILS (CONT'D)

Loading of the Work

The following is the location of the Proponent's shipping facility or factory where the ITEMS of the Work will be loaded, blocked, braced and secured for transportation by the Proponent or the Proponent's designated carrier:

Street Name and Number: ______________________________
City Province/State: ______________________________
Postal Code/Zip Code: ____________

The estimated travel time from the Proponent's shipping facility or factory to the Purchaser's designated arrival destination is _____ day(s).

The Proponent intends to load the ITEMS of the Work in containers weighing: ___________(kg) approximately and measuring __________ (m) x ___________ (m) x __________ (m).

The Proponent indicates below any special equipment and requirements necessary for the transportation of the Work:

PRODUCTION SCHEDULE

The Proponent shall provide a detailed production schedule.

Include a GANTT chart, proposed schedule from ordering raw materials, manufacturing, shipping and delivery of products to final destination.

PLANT CAPACITY

.1 The Proponent identifies its total plant capacity by month and details what portion of the capacity has been allocated to other orders:

.2 The Proponent identifies its work arrangements:

Number of active shifts per day:

Number of working days per week:

Attach additional sheets if required.

PACKAGING METHOD

The Proponent shall provide a detailed packaging method that meets all requirements of Section 8 in Technical Requirements of this RFP:

Include packaging drawings for each item.

Comments:

MANITOBA CONTENT

The Proponent shall provide the estimated percentage of total proposed price that it considers to be Manitoba Content: ____________%

The Proponent shall provide a detailed breakdown of Manitoba Content that would be incorporated into the Work substantiating the above percentages (inputs originating from the Province of Manitoba such as labour, materials, transportation, etc):

NOTE: Upon request, the Contractor shall provide to Manitoba Hydro records substantiating the percentage of Manitoba Content.

a) Labour by Own Workforce

COMPONENT OF THE WORK	TYPE OF LABOUR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

b) Manitoba Subcontractors

TYPE OF WORK TO BE SUBCONTRACTED	NAME AND ADDRESS OF SUBCONTRACTOR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

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

MANITOBA CONTENT (CONT'D – 1)

c) Purchase of Goods from Manitoba Companies

TYPE OF GOODS	NAME AND ADDRESS OF SUPPLIER	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

d) Purchase of Equipment from Manitoba Companies

TYPE OF EQUIPMENT	NAME AND ADDRESS OF SUPPLIER	TOTAL VALUE OF PURCHASE PRICE $

e) Leased Equipment/Facility from Manitoba Companies

TYPE OF EQUIPMENT	OWNER	TOTAL VALUE OF LEASE $

Provide information regarding any lease agreements such as the following:

- Length of lease
- Lease payment
- Maintenance
- Residual value

MANITOBA CONTENT (CONT'D – 2)

f) Other Manitoba Content:

OTHER INPUTS	OWNER	TOTAL VALUE OF LEASE $

ALTERNATIVE METHODS, PROCEDURES, SCHEDULES, SEQUENCES OR ENVIRONMENTALLY PREFERABLE PRODUCTS/SERVICES

The following is a list of all of the Proponent's proposed alternative methods, procedures, schedules, sequences or environmentally preferable products/services that affect the Work:

EQUAL ARTICLES, MATERIALS OR EQUIPMENT

The following is a list of the equal articles, materials or equipment that the Proponent proposes to substitute for those specified:

Article, Material, or Equipment		Price Change $	
Specified	**Proposed**	**Increase**	**Decrease**

NOTE: Names of manufacturers of equals and catalogue numbers are stated, if applicable. All technical data and literature are appended to this proposal. No equal articles, materials, or equipment will be permitted unless listed above and approved by the Purchaser.

JOINT VENTURES

The extent and nature of Manitoba business participation in a joint venture is detailed below.

A Band Council Resolution authorizing the provision of the Form of Proposal on behalf of the First Nation Band is submitted with this proposal:

YES ☐ NO ☐

PROPONENT'S TECHNICAL AND NON-TECHNICAL CONTACT PERSONS

All enquiries concerning the technical aspects of this proposal should be directed to:

___

(please print name and title of Proponent's Representative)
whose telephone number is: ( ) -
FAX number is: ( ) -
Internet e-mail address is: @ .
and World Wide Web is: http://www. .

All enquiries concerning the non-technical aspects of this proposal should be directed to:

___

(please print name and title of Proponent's Representative)
whose telephone number is: ( ) -
FAX number is: ( ) -
Internet e-mail address is: @ .
and World Wide Web is: http://www. .

SIGNING PAGE

The words used in this Proposal have the meanings ascribed to them in RFP 040565.

We/I the undersigned, having examined all of RFP 040565 together with all addenda issued prior to the Closing Date, and having attended all mandatory meetings and mandatory site visits, hereby submit this proposal with all necessary enclosures.

The Proponent agrees that RFP 040565, and any proposal submitted in respect of same, is not a legal offer. By signing below, the Proponent certifies that the information submitted herein is true and correct as of the date set out below to the best of the Proponent's knowledge, and that the Proponent agrees to the terms and conditions set out in the RFP.

______________________________ [Insert legal name(s) of Proponent]

Per ______________________________ Name ______________________________
Authorized signing officer Print Name

I have authority to bind the Proponent

Dated ___________________________ ________________________
Title

Manitoba Hydro

REQUEST FOR PROPOSAL 040408

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS

500kV AC TRANSMISSION LINES

JANUARY 27, 2017 **DRAFT 3**

MANITOBA HYDRO DISCLAIMER

Manitoba Hydro does not represent or warrant that any electronic files provided hereunder are usable by the recipient, are error-free, or are free of viruses or other harmful or destructive properties. Such electronic files provided hereunder, and any content/part thereof, are provided on an "as is" basis, without warranty of any kind. The entire risk as to use of and/or reliance on such electronic files is assumed by the recipient.

Manitoba Hydro works in the Acrobat X1 Standard, Excel 2003-2007 and Word 2003-2007 environments. The recipient may not be able to view or utilize the full software features of Manitoba Hydro's electronic files if the recipient has earlier versions of the aforementioned software.

NOTE: To open any supplied Word documents, your Macro Security level must be set to Medium.

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040408

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INSTRUCTIONS TO PROPONENTS (10 pages)

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TECHNICAL REQUIREMENTS (14 pages)

TERMS AND CONDITIONS OF PAYMENT (1 page)

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DEFINITIONS

DESIGN, MANUFACTURE AND SUPPLY OF	JANUARY 2017
500kV AC SUSPENSION INSULATORS	
500kV AC TRANSMISSION LINES	**DRAFT 3**

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040408

DEFINITIONS

"Confidential Information" means any and all information, regardless of form, format or medium, of or concerning or related to the Purchaser, the Work, etc. depending on situation, customer information, and Personal Information, which has or shall come into the possession or knowledge of the Contractor.

"Contract" means the entire agreement entered into between the Purchaser and the Contractor upon execution of the Cover Agreement for performance of the Work by the Contractor in accordance with the Contract Documents.

"Contract Documents" means the Cover Agreement, Definitions, General Conditions, the General Requirements, Purchaser's Drawings, if any, the Technical Requirements, the Contract Forms listed in the Cover Agreement, all appendices and attachments to the foregoing documents, and amendments to any of them duly executed by both the Purchaser and the Contractor.

"Contractor" shall mean the party or parties named as such in the Contract and the legal personal representatives, successors and assigns of the Contractor.

"other contractor" or **"another contractor"** shall mean any person, firm or corporation employed by or having a contract directly or indirectly with the Purchaser otherwise than through the Contractor.

"DAP" shall mean "Delivered at Place" per Incoterms 2010.

"DDP" shall mean "Delivered Duty Paid" per Incoterms 2010.

"Engineer" shall mean the engineer, engineers, or firm of consulting engineers, as the case may be, appointed in writing by the Purchaser to take charge of the Work, or a designated part (including the design) thereof, acting directly or through his or their properly authorized assistants or agents.

"Equipment" means all documents, designs, computer software, computer hardware, plant, materials, apparatus, tools, components, machinery, equipment, hardware, systems and other things required for the execution and completion of the Work and the remedying of any defects, or otherwise in respect of, and involving, Contractor's performance of obligations under the Contract.

"EXW" shall mean "Ex Works" per Incoterms 2010.

"Inspector" shall mean the person, firm or corporation authorized by the Purchaser to inspect the Work to be done and/or material to be furnished pursuant to the Contract acting directly or through his or their properly authorized assistants or agents.

"ID#" or "ITEM" shall mean a separate and designated part of the Work to be proposed, as defined in the Form of Proposal.

"Manitoba Business" is a business which is registered to do business in the Province of Manitoba, and the firm, or its principals, maintains their facilities, equipment and staff in Manitoba on a continuous basis.

"Personal Information" has the meaning given in The Freedom of Information and Protection of Privacy Act (Manitoba) and the Personal Information Protection and Electronic Documents Act (Canada).

“plant” shall mean all vehicles, transportation equipment, construction equipment, erection and installation equipment, falsework, forms, scaffolding, cofferdams, crushers, boilers, temporary storehouses and other temporary structures, lumber, timber, materials, power tools, machinery, appliances and apparatus which are brought on or constructed upon the site by the Contractor for the performance of the Work.

“Proponent” shall mean, as the context requires, any party or parties proposing on one or more of the various classes of work covered by the Instructions to Proponents, the General Requirements, the General Conditions, and the Technical Requirements.

“Purchaser” shall mean Manitoba Hydro, its successors and assigns.

“Site” shall mean the place or places where the Work is to be carried out for the Purchaser, and the immediate vicinity of such place or places.

“subcontractor” shall mean a person, firm or corporation having a contract with the Contractor for part of the Work, including without limitation the furnishing of labour, material, equipment or apparatus therefor.

“Superintendent” shall mean the duly appointed representative of the Contractor on duty at the site.

“tools” shall mean all small hand tools, other than power 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 or by any employee of the Contractor for the performance of the Work.

“Work” or “Services” shall mean all of the various classes of work to be done, executed and performed, whether temporary or permanent, and other equipment, apparatus, machinery and materials to be furnished and supplied by the Contractor pursuant to the Contract.

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.

END OF DEFINITIONS

INSTRUCTIONS TO PROPONENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES	JANUARY 2017 **DRAFT 3**

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040408

INSTRUCTIONS TO PROPONENTS

1 INVITATION

To be evaluated, a Proposal **must** be submitted not later than the Closing Date which is:

16:00:00 hours Manitoba local time
February 21, 2017 (the "Closing Date")

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

Proposals not submitted through MERX will not be accepted.

1.1 Delivery and Receipt of Submissions

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

(a) the timely delivery of any information or documentation, including, without limitation, the RFP by MERX, in connection with this RFP;
(b) the timely receipt of any proposals, revisions, amendments, notice of withdrawals, or any other information or documentation from any Proponent or potential Proponent, or;
(c) the working order, functioning or malfunctioning, of any electronic information system (including MERX).

2 PURPOSE

Issuing this RFP, Manitoba Hydro desires an experienced Contractor to enter into a Contract(s) for the design, test, manufacture, supply and delivery of suspension insulators for 500kV AC transmission lines.

Proponents are encouraged to review the balance of the RFP for additional information concerning Manitoba Hydro's anticipated commercial and technical needs in respect of any potential Contract.

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

By submitting a proposal, the Proponent agrees to the terms and conditions set out in this RFP.

3 GENERAL INTERPRETATION

Defined words and phrases used in this Request for Proposal have the meanings ascribed to them in the Definitions section or as expressly defined elsewhere in this Request for Proposal. Headings are used for convenience only, and they shall not affect the interpretation or meaning of the clauses, terms and conditions or the Request for Proposal or any resulting Contract.

4 ENQUIRIES

Enquiries concerning Request for Proposal 040408 including technical enquiries, should be in writing, using the Proposal Clarification Form, attached as Appendix A.

Enquiries should be submitted not less than **seven (7) calendar days** prior to the Closing Date. Enquiries received after that time may not be considered or answered.

Manitoba Hydro has the sole discretion to respond, or not, to an enquiry. Responses may be issued to the enquiring party only, or to any or all prospective Proponents.

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

5 PROPOSAL EVALUATION AND NEGOTIATION

5.1 General

Manitoba Hydro desires, through an evaluation and negotiation process, to determine if basis exists to award one (1) or more Contracts for performance of the Work described in this RFP.

Manitoba Hydro may select one (1) or more Proponent(s) for negotiation of a potential Contract.

Proposals submitted in respect to this RFP are for information and evaluation/negotiation/discussion purposes only.

5.2 Technical and Commercial Terms

The RFP describes the anticipated scope of work and anticipated technical and commercial needs of Manitoba Hydro. Manitoba Hydro is interested in receiving proposals that meet the technical and commercial needs outlined in this RFP.

With respect to technical needs, the Proponent may note in its proposal any technical exceptions which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative solution for addressing the matter in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

With respect to commercial needs, the Proponent may note in its proposal any commercial terms which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative wording for addressing the term(s) in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

5.3 Evaluation

Evaluation of proposals is expected to commence shortly after the Closing Date.

Manitoba Hydro reserves the right to complete or terminate evaluation of proposals at any time, or to extend the time of evaluation, without notifying Proponents.

Upon completion or termination of evaluation, Proponents may be notified that evaluation is complete.

5.4 Presentations

During evaluation of proposals, one (1) or more Proponents may be invited to attend at Manitoba Hydro's facilities in Winnipeg to make a presentation or participate in an interview concerning its proposal.

5.5 Amendments/ Further Information/Clarifications

During evaluation and negotiations, Manitoba Hydro reserves the right to request one (1) or more Proponents to:

(a) amend its proposal;
(b) provide additional, missing, and/or other information or documentation concerning its proposal; and
(c) clarify any matter(s) concerning its proposal.

In respect of any such matters, Manitoba Hydro shall have no duty or obligation to advise any other Proponent of any of the same, or to request them to vary their proposal as a result of any of the same.

5.6 Negotiation Process

Upon completion or termination of evaluation of proposals, Manitoba Hydro may select one (1) or more Proponents for negotiation of a Contract(s).

Manitoba Hydro will notify a Proponent if it has been selected for negotiations.

Manitoba Hydro reserves the right to terminate negotiations at any time.

Proponents are advised that Manitoba Hydro may conduct any negotiation through an intensive process. Such process may require a Proponent to make representative(s), who have sufficient decision-making authority, available for telephone, video-conference, and/or in person negotiating sessions.

5.7 Requirement for Contract

Until the execution of a Contract between Manitoba Hydro and a Proponent, there shall be no legal or other binding obligations created on the part of either party with respect to a Contract, the Work, or any matters related to the Work.

5.8 Manitoba Hydro Privilege/Discretion

Manitoba Hydro makes no representation or warranty that responding to this RFP will result in any negotiations or any Contract. Manitoba Hydro is under no obligation to evaluate any proposal, enter into any negotiations, or to award a Contract, with any Proponent or other person.

Manitoba Hydro reserves the right to cancel this RFP either before or after the Closing Date and regardless of whether or not any proposals have been received for any reason whatsoever.

Manitoba Hydro reserves the right to re-issue or tender all or any part of the work and services contemplated in this RFP at any time, including after the Closing Date, for any reason whatsoever.

Manitoba Hydro reserves the right to accept, waive or reject any non-compliance or irregularity, including without limitation, the right to accept, waive, or reject non-compliance or irregularity with respect to the requirements of the Instructions to Proponents and/or the submission requirements of this RFP.

Notwithstanding anything to the contrary in this RFP, Manitoba Hydro reserves the right to:

(a) negotiate any or all terms and conditions of a Contract with any one (1) or more Proponents, but not necessarily all Proponents, and to do so serially or concurrently and at any time;
(b) negotiate and enter into a Contract on terms and conditions different than those contained in the RFP and/or any Proposal;
(c) choose not to enter into negotiations with any one (1) or more Proponents;
(d) terminate negotiations with any one (1) or more Proponents at any time;
(e) choose not to award any Contract to any Proponent;
(f) terminate this procurement process at any time for any reason;
(g) choose to not offer the same or substantially the same or comparable terms and conditions of a proposed Contract to more than one (1) Proponent with which Manitoba Hydro may conduct negotiations; and
(h) enter into separate Contracts for different or identical portions of the Work, with any one (1) or more Proponents.

6 SCHEDULE OF RFP ACTIVITIES

The schedule of activities concerning this RFP includes the following:

Description	Date
Closing Date for submission of proposals	As per Subsection 1.1 of these Instructions to Proponents
Evaluation of Proposals complete	March 17, 2017
Negotiations with Selected Proponent	March 31, 2017
Award of Contract	April 13, 2017

Manitoba Hydro may change the said schedule and dates and information without notice (including without notice to any actual or potential Proponent(s)) at any time including before and after the Closing Date of this RFP.

7 ADDENDA

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

8 FORM OF PROPOSAL

The Proponent is requested to use the Form of Proposal attached hereto. If any Form of Proposal page is found to have insufficient space, the Proponent is requested to attach a sheet or sheets immediately after such page.

The Proponent is encouraged to include in their proposal thorough and sufficient information concerning matters under consideration.

9 SIGNING OF PROPOSALS

A proposal submitted by:

(a) an individual shall be signed by the individual in the presence of a subscribing witness;
(b) a corporation shall be signed by the properly authorized signing officer or officers and the corporate seal affixed or by the properly authorized signing officer or officers in the presence of a subscribing witness or witnesses; or,
(c) a partnership or joint venture shall be signed by all partners or joint venturers in the presence of a subscribing witness or witnesses.

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. Each signature shall be accompanied by a printed name.

10 JOINT VENTURES/CONSORTIA

Proponents which are comprised of more than one legal entity, such as a joint venture or consortium of corporations, are to identify their duly appointed leader in the proposal.

Proponents are to execute the 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.

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 Contract awarded.

A copy of a written agreement binding the legal entities involved in each proposal shall be provided to Manitoba Hydro upon request. If no such writing exists at the time of request, it may be necessary for such entities to document their

arrangement to fulfill such requirement at any time, including after the time and date of closing for receipt of proposals and before or after an award of a Contract.

Where a Proponent is or includes a First Nation Band, the proposal shall be accompanied by a Band Council Resolution authorizing the provision of the proposal on behalf of the First Nation Band.

11 AMENDMENT OF PROPOSAL

A Proponent may amend its submitted Proposal on MERX at any time prior to the Closing Date. A Proponent may not amend its Proposal after the Closing Date except at the written request of Manitoba Hydro.

In order to advance toward a formal and binding contract during negotiations, Manitoba Hydro may issue a written request to the Preferred Proponent(s) for specific amendment(s) to its Proposal, and if the Proponent finds the request satisfactory, shall provide the requested amendment(s) via fax or letter.

All amendments must be signed by the person or persons having the authority to bind the Proponent.

Manitoba Hydro shall consider each Proponent's Proposal to be the Proponent's best position for entering into negotiations and for seeking award of a contract to perform the Work.

12 WITHDRAWAL OF PROPOSAL

At any time throughout the procurement process prior to execution of an agreement, a Proponent may revoke and withdraw a submitted Proposal by either removing the Proposal from MERX, if withdrawal is prior to the Closing Date, or by providing written notice to Manitoba Hydro via FAX or letter, if withdrawal is after the Closing Date.

Written notice of withdrawal of a Proposal must be duly signed by the authorized representative of the Proponent.

Manitoba Hydro is under no obligation to return withdrawn Proposals.

13 LANGUAGE

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

14 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 a proposal, satisfactory to Manitoba Hydro, that the Proponent has the ability, experience, capital and plant required to undertake and perform the Work successfully, and complete it within the time specified.

Manitoba Hydro may inspect any Plant and /or facilities that the Proponent proposes to use for doing the Work.

15 ESTIMATED QUANTITIES

Any quantities stated in the Request for Proposal or Form of Proposal are estimates only. Manitoba Hydro makes no guarantee with respect to any of same.

16 UNBALANCED PROPOSALS

Unbalanced unit prices or lump sum prices proposed may not be considered by Manitoba Hydro.

17 PROPONENT'S EXPENSES

The Proponent shall be responsible for all expenses concerning or related to the preparation of its proposal, including any subsequent discussions and/or negotiations.

18 PROPOSED PRICES

Proposed prices shall be stated in Canadian currency and shall include all customs duties, surcharges, insurance premiums, permit and licence fees, Workers Compensation and vacation pay assessments, and all other payroll benefits. Canadian Goods and Services Tax (GST) and Manitoba provincial retail sales tax (PST) shall be treated as specified in the Form of Proposal for each ITEM. All other applicable taxes shall be included and shall not be subject to any adjustment. No payment shall be made to the Contractor for sales tax (if any) which may be imposed by Canada or Manitoba in respect of the Contractor's plant, tools and any other items not included in the Work.

Prices in the accepted proposal, if any, shall be firm and not subject to adjustment for changes or unexpected contingencies of any kind whatsoever, including without restricting the generality of the foregoing, changes in wages, material costs, or taxes which may in future be imposed by lawful authority within or outside of Canada.

19 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 Business.

20 CORRUPT OR FRAUDULENT PRACTICES

Manitoba Hydro has the right at any time to reject any Proposal submitted by a Proponent or terminate negotiations with a Proponent if, in Manitoba Hydro's determination, the Proponent has engaged in any Corrupt, Fraudulent, Collusive, Coercive or Obstructive Practice or has breached any laws regarding corruption or fraud. For these purposes the following defined terms shall apply:

(a) **"Coercive Practice"** means impairing or harming, or threatening to impair or harm, directly or indirectly, persons or their property to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(b) **"Collusive Practice"** means an arrangement between two or more persons (including, without limitation, a Proponent and any other person) designed to achieve an improper purpose, including but not limited to the establishment of prices for the Work at artificial, non-competitive levels in the procurement process or in entering of the Contract.

(c) **"Corrupt Practice"** means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(d) **"Fraudulent Practice"** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, Manitoba Hydro, a Proponent, or any other person, to obtain a financial or other benefit or to avoid an obligation in the procurement process, or in the negotiation and signing of the Contract.

21 EVALUATION CRITERIA

In order to determine best value to Manitoba Hydro, proposals received will be evaluated using the following criteria (in no particular order of preference):

(a) Total evaluated cost (includes unit prices, transportation costs, life cycle replacement cost based on breakage rate, Purchaser's cost to inspect manufacturing facilities, and type testing)
(b) Technical compliance of the proposal (absence of deviations from the Technical Requirements of this RFP)
(c) Commercial compliance (absence of deviations from the commercial terms and conditions of this RFP)
(d) Delivery Dates (includes production schedule and available production capacity)

All things being reasonably equal, the following additional criteria will be considered in the evaluation:

(e) Manitoba content

For the purposes of evaluation, Manitoba Hydro may take into account any or all of the information received from a Proponent under or pursuant to the RFP, Manitoba Hydro's knowledge of, and past experience with, the Proponent (including Proponent's performance on previous contracts with Manitoba Hydro, if any), and any information about the Proponent received from third parties and deemed reliable by Manitoba Hydro.

22 WAIVER

By submitting a proposal, the Proponent acknowledges Manitoba Hydro's rights under Request for Proposal 040408 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.

END OF INSTRUCTIONS TO PROPONENTS

GENERAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF	JANUARY 2017
500kV AC SUSPENSION INSULATORS	
500kV AC TRANSMISSION LINES	**DRAFT 3**

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040408

GENERAL REQUIREMENTS

1 SCOPE OF THE WORK

The Work shall consist of design, material procurement, manufacture, supervision, labour, equipment, quality control, testing, shipping, delivery, Contractor's insurance and warranty of wet-process porcelain or toughened glass ball and socket type suspension insulators for suspension, deadend and jumper strings to be installed on the Manitoba-Minnesota 500 kV AC Transmission Line from Dorsey to Iron Range.

The Contractor shall design, prepare detailed product drawings and perform all the required type tests to demonstrate full conformance of the insulators with all aspects of the Technical Requirements prior to commencement of mass production.

ITEMS of the Work include, but are not limited to, the following:

ITEM	DESCRIPTION	QTY
1	INSULATOR SUSPENSION BALL & SOCKET PORCELAIN OR GLASS CS-8 160 kN	76,555
2	INSULATOR SUSPENSION BALL & SOCKET PORCELAIN OR GLASS CS-11 220 kN	3,800
3	TYPE TESTING (PURCHASER'S OPTION)	

2 PURCHASER'S OPTION

The Purchaser has the option, but not the obligation, to purchase ITEMS of the Work identified in Section 1 – SCOPE OF THE WORK as a "Purchaser's Option" and set out in the Form of Proposal(the "Option") as follows:

(a) the term for the Purchaser's acceptance of an Option shall be 6 months from the Effective Date (the "Option Period"),

(b) the Purchaser may exercise an Option with respect to any of the said ITEMS individually, severally, or in any combination, at any time during the Option Period, and

(c) the Purchaser shall exercise an Option by written notice to the Contractor in the form of an Extra Work Order informing of its election to do so with respect to an ITEM within the Option Period. Such notice from the Purchaser exercising an Option shall constitute a binding agreement of purchase and sale and the Contract shall be deemed amended thereby and all terms and conditions of the Contract shall apply mutatis mutandis to the exercised Option.

3 WORK SCHEDULE

The Purchaser expects that all ITEMS of the Work will be delivered by **October 31, 2017**.

In carrying out the Work, the Contractor shall have reasonable latitude to organize the sequence of the Work, provided that the various stages of the Work are completed by the specified date(s) or the date(s) proposed by the Contractor and accepted by the Purchaser.

4 DELIVERY POINT(S)

If the Purchaser chooses delivery by the Contractor, the ITEMS of the Work shall be delivered to:

Gate 6
59029 Hwy 207
Dugald, Manitoba

5 DELIVERY OR LOADING OF THE WORK

5.1 Delivery of the Work

If the Purchaser chooses delivery of the Work by the Contractor, the Contractor shall prepare the Work for shipment in such a manner as to protect the Work from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation, loading, shipping, transporting, unloading, handling, or lifting. The Contractor shall be responsible for verifying the carrier's right-of-way clearances and weight limitations, if any, and for making all shipping arrangements.

5.2 Loading of the Work

If the Purchaser chooses to have the Work loaded, blocked, braced and secured by the Contractor at the Contractor's shipping facility or factory for transportation by the Purchaser or the Purchaser's designated carrier to the final destination, the Contractor shall prepare the Work for shipment in such a manner as to protect it from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation and loading.

6 FOREIGN NATIONALS WORKING IN CANADA

The following provisions apply to all workers employed by the Contractor or under the Contractor's control or for whom the Contractor is otherwise responsible under the Contract, who are NOT citizens of Canada or 'permanent residents' of Canada (as defined in the Immigration and Refugee Protection Act). Such persons are defined, collectively, in the Immigration and Refugee Protection Act as 'foreign nationals', which term is used below and has the same meaning.

The Contractor shall ensure that all workers who are foreign nationals and who perform services under the Contract in Canada are legally authorized to work in Canada. The Contractor shall obtain and maintain all necessary work permits, visas and documentation for such foreign nationals, and shall comply with all conditions imposed on the Contractor, as 'employer' of the foreign nationals, under the Immigration and Refugee Protection Act and regulations.

Before permitting any foreign nationals to perform services under the Contract in Canada, the Contractor shall, by notice in writing to the Engineer,

(a) list all such foreign nationals by name;
(b) certify that the said foreign nationals are legally authorized to perform services under the Contract in Canada; and
(c) provide copies of their respective work permits, and visas or other documentation if applicable.

Furthermore, the Contractor shall provide copies of work permit or visa renewals to the Engineer if applicable, so that at no time is any foreign national performing services under the Contract in Canada without the requisite legal authority.

7 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, R.S.M. 1987, c. W200.

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 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.

8 COMPLIANCE WITH STANDARDS

All materials, equipment and articles furnished by the Contractor shall comply with the applicable provisions of the standards of the Canadian Standards Association (CSA) or of the Canadian General Standards Board (CGSB) and where no such standards exist, materials, equipment and articles shall comply with the applicable provisions of the standard specifications of the American Society for Testing and Materials (ASTM).

END OF GENERAL REQUIREMENTS

Manitoba Hydro

GENERAL CONDITIONS

DESIGN, MANUFACTURE AND SUPPLY OF	JANUARY 2017
500kV AC SUSPENSION INSULATORS	
500kV AC TRANSMISSION LINES	**DRAFT 3**

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040408

GENERAL CONDITIONS

1 INTENT

1.1 The Work

The Contractor shall fully and completely fulfill its obligations in respect of the Contract, and shall fully and completely perform the Work in every detail and within the timeframe(s) required, all in accordance with the Contract. The Contractor shall do or cause to be done and shall furnish any and everything necessary for such purposes all in accordance with the Contract.

The Contractor shall carry out the production, manufacture of all goods, products, materials and the Work, and the performance and execution of the Work:

(a) in accordance with the Contract;
(b) in the manner (if any) specified in the Contract;
(c) in a good and workmanlike manner;
(d) using new materials that are free of defects and are of the specified quality, if specified, otherwise of suitable quality as determined by the Engineer; and
(e) with properly equipped facilities and non-hazardous materials, except as otherwise specified in the Contract.

1.2 Application to Engineer

The Contractor shall apply to the Engineer for any explanation which the Contractor may require as to the meaning and intent of any provision in the Contract or in any document forming part thereof, and the Contractor shall be liable for any loss, damage or expense which the Purchaser may incur, suffer or be put to as a result of the Contractor’s failure to obtain such explanation.

1.3 Interpretation

Defined words and phrases used in the Contract have the meanings ascribed to them in the Definitions forming a part of this Request for Proposal, or as expressly defined elsewhere in the Contract. Headings are used for convenience only and do not affect the interpretation or meaning of the Contract.

2 CORRUPTION AND FRAUD

The Contractor declares and undertakes in relation to the Contract that it:

(a) has not acted and will not act unfairly or dishonestly so as to cause loss to the Purchaser or deprive the Purchaser of its rights;

(b) has not offered, given, demanded or accepted any bribe or other improper benefit or advantage to any person and will not do so;

(c) has not provided false, inaccurate or misleading information to any person and will not do so;

(d) has not authorized, acquiesced or turned a blind eye to any form of corruption and will not do so;

(e) did not collaborate, directly or indirectly, with any person in competition for this or other contracts with the Purchaser during the procurement process;

(f) will not, in respect of any design services to be provided under the Contract, deliberately, knowingly, with willful blindness or recklessness, provide or approve a design which will provide an improper benefit or advantage to any person or which is in excess of the Purchaser's requirements and has not been fully disclosed and approved by the Purchaser;

(g) will not deliberately, knowingly or with willful blindness or recklessness, carry out, instruct, authorize, condone or be a party to provision of work, materials, equipment or services not of a quality and quantity required under the Contract; or

(h) will not conceal defective work, material, equipment or services.

3 AUTHORITY OF THE ENGINEER

3.1 No Authority to Amend Contract

The Engineer has no authority to amend the Contract.

3.2 Exercise of Authority

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:

(a) whenever carrying out duties or exercising authority, express 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.

3.3 Replacement

The Purchaser may, with notice to the Contractor, replace the Engineer.

3.4 Giving Effect

The Contractor and the Purchaser shall give effect to each determination of the Engineer unless and until revised pursuant to the ARBITRATION Section of the General Conditions.

4 CLARIFICATIONS AND CHANGES TO THE WORK

4.1 General

There will be four (4) mechanisms for clarifying 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	Contractor / Engineer	Clarification to the Work
Extra Work Order (EWO)	Purchaser	Approves change to the Work, related to the Contract Scope
Amending Agreement	Purchaser	Approves change to the Work, not related to the Contract Scope or Amends Terms of the Contract

Each of these mechanisms are described in this Section of the General Conditions.

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 or an Extra Work 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.

4.2 Clarifications to the Work

4.2.1 Work Instructions

Work Instructions are instructions and clarifications issued by the Engineer using the Work Instruction form set out in Appendix B: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 may be issued in response to a Request for Information from the Contractor or may be issued at the initiative of the Purchaser or Engineer.

Work Instructions are enforceable clarifications or refinements of the Contract, not amendments thereto.

Upon receipt of a Work Instruction, the Contractor shall promptly proceed with the Work as clarified therein.

The Contractor is not entitled to additional compensation or to changes in the time for performance of the Work as a result of the issuance of a Work Instruction.

4.2.2 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 28 days, the recipient will notify the requestor in writing.

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 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 28 days or notify the requestor of a required extension to the response period.

4.3 Changes to the Work

The Purchaser shall have the right, without notice to sureties on any bond, and without invalidating the Contract, 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, including additions, deductions, alterations and extras.

Such changes must in all cases be in writing signed by the Purchaser titled “Extra Work Order” and issued by the Engineer to the Contractor.

Upon receipt of a written Extra Work Order from the Engineer, the Contractor shall promptly proceed with the changes in the Work.

Adjustments to the Contract Price as a result of the changes directed by the Engineer in an Extra Work Order shall be determined in accordance with the PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK Section of these General Conditions.

4.3.1 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work.

When initiated by the Engineer, the Proposal for Extra Work is a formal request for quotation for additional work required. The Contractor’s responding quotation 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. The quoted price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

When initiated by the Contractor, the Proposal for Extra Work is a formal proposal for an alternate to the Work. The proposed price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

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 14 days, the requesting party shall be notified in writing.

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 14 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 quotation, 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. The Proposal for Extra Work may be accepted by the Purchaser providing written notice to the Contractor in the form of an Extra Work Order issued by the Engineer.

When the Contractor initiates a Proposal for Extra Work, the proposal shall be valid for a period of 14 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 issued by the Engineer.

4.3.2 Extra Work Orders

Extra Work Orders are formal approval of changes to the Work by the Purchaser where the change is related to or within the original Contract scope of the Work. The Purchaser through the Engineer may issue a written Extra Work Order using the Extra Work Order set out in Appendix B: Manitoba Hydro Forms for Clarification and Changes to the Work.

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 the Proposal for Extra Work Subsection of these General Conditions or the preceding sentence, if the Purchaser requires the Contractor to proceed with a change in the Work 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.

4.4 Contract Amendments

No amendment to any other terms or conditions of the Contract, other than those recognized to be made by Extra Work Order as provided in the Contract, shall be made unless first approved and authorized in writing by both the Purchaser and the Contractor. Such amendments shall be documented in an amending agreement signed by both parties.

5 PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK

The method for pricing and payment of all adjustments to the Contract Price due to changes to the Work by virtue of Extra Work Order pursuant to the CLARIFICATION AND CHANGES TO THE WORK Section of these General Conditions or pursuant to the CONTRACTOR CLAIMS Section of these General Conditions (hereinafter "Claims"), shall be as follows unless otherwise agreed to between the Purchaser and the Contractor.

5.1 Additions to the Work or Claims

5.1.1 Lump Sum

Where the Engineer has directed that an addition to the Work or Claim be dealt with by lump sum, the Contractor shall prepare and submit to the Engineer a detailed quoted lump sum cost of the requested addition or Claim. The quote shall not include any mark-up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The quoted lump sum cost shall include the following details as a minimum:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing cost
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

In respect of travel, airfare shall be limited to economy class, receipts shall be required.

(the "Quoted Cost").

The Quoted Cost shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Quoted Cost was not accepted. Within the next 5 days, the Contractor will be entitled to submit a revised Quoted Cost.

Following such five (5) day period, the Engineer may either:

i) accept the latest Quoted Cost of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,

ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Quoted Cost of the addition or Claim as documented by issuance of an Extra Work Order.

5.2 Deductions from the Work

5.2.1 Credit for Deduction from the Work

Where a deduction from the Work is proposed by the Purchaser through issuance by the Engineer of a Proposal for Extra Work to the Contractor setting out such deduction, the Contractor shall prepare and submit to the Engineer a detailed quoted credit for the requested deduction. The quoted credit shall represent the cost to the Contractor to perform the Work to be deducted and shall not include any mark up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The Contractor shall submit a detailed breakdown of the proposed credit and at a minimum include the following:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing hours and rates for specific processes
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

(the "Deduction Credit")

The Deduction Credit shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Deduction Credit was not accepted. Within the next five (5) days, the Contractor will be entitled to submit a revised Deduction Credit.

Following such 5 day period, the Engineer may either:

i) accept the latest Deduction Credit of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,

ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Deduction Credit as documented by issuance of an Extra Work Order.

6 CONTRACTOR CLAIMS

6.1 Notice of Intent to Claim

If the Contractor determines it is entitled to additional costs to perform the Work 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 B: Manitoba Hydro Forms for Clarification and Changes to the Work 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 Contract Price or to any adjustment to the Contract Schedule, and the Purchaser shall be discharged from all liability in connection with the claim.

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.

6.2 Claim Documentation

Within 21 days after the Contractor has given written Notice of Intent to Claim in accordance with the Notice of Intent to Claim Section of these General Conditions, 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;

(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 request.

All subsequent communications with the Engineer respecting a claim or potential 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 of the General Conditions, each party shall take reasonable steps to mitigate its losses.

6.3 Determination of Claim

The Engineer shall proceed in accordance with this Section of the General Conditions to determine:

i) the extension (if any) of the time for completion of the Work in accordance with the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of these General Conditions; and,

ii) the adjustment (if any) to the Contract Price to which the Contractor is entitled to pursuant to the Contract.

Whenever a provision of the Contract provides that the Engineer shall proceed in accordance with this Subsection 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 Subsection, 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 a fair 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 extension of time or an adjustment to the Contract Price, or both, are warranted in the opinion of the Engineer, the Engineer shall document such changes in an Extra Work Order. 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 the ARBITRATION Section of these General Conditions.

For any claims made in accordance with this Section 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 the ARBITRATION Section of the General Conditions.

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 this Section of these General Conditions.

The Contractor shall not delay or hold up performance of the Work during resolution of a claim pursuant to this Section or originating pursuant to the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of the General Conditions or during referral of any such claim to arbitration as permitted above.

7 REQUEST FOR EXTENSION OF TIME

The Contractor shall be entitled, subject to the CONTRACTOR CLAIMS Section of the General Conditions, to an extension of time for completion of the Work if completion of the whole of the Work is or will be delayed by any of the following causes:

(a) legal strikes or walkouts;
(b) any peril insured against pursuant to the INSURANCE Section of the General Conditions;
(c) unpreventable accident;
(d) terrorism, war or delay caused by war;
(e) vandalism or malicious mischief not reasonably preventable by the Contractor;
(f) riot or civil commotion;
(g) acts of God;
(h) lawful orders of civil or military authorities; or
(i) a cause of delay giving an entitlement to extension of time 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 Subsection 6.1 Notice of Intent to Claim of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c), (d), (e), (f), (g), (h), and (i) above resulted in a delay to the completion of the Work; and,
ii) 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.

Other than as stated in this section and the PURCHASER CAUSED DELAY Section of the General Conditions, 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.

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.

8 PURCHASER CAUSED DELAY

If the Contractor suffers delay and/or incurs additional costs in relation to the Work as a result of:

(a) an Extra Work Order issued by the Engineer without the agreement or in absence of the agreement of the Contractor;
(b) negligence or default on the part of the Purchaser;
(c) negligence or default on the part of another contractor for whom the Purchaser is responsible; or
(d) deviation from the Contract or temporary suspension of the Work by direction of the Engineer;

then the Contractor shall give notice to the Engineer in accordance with the Notice of Intent to Claim Subsection of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c) and (d), 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;
ii) 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,

iii) the resulting adjustment, if any, to the Contract Price for the substantiated amount of resulting additional costs to the Contractor.

9 SCHEDULE OF THE WORK

The Contractor shall submit to the Engineer within 20 working days of the effective date of the Contract, a time chart or schedule containing all or such part of the following information as the Engineer requires:

(a) the scheduled date of completion of design and submission of working drawings to the Engineer for approval;
(b) the scheduled date of start and completion of type test
(c) the scheduled date of completion of all orders for material required for the Work;
(d) the scheduled date of completion of manufacture, fabrication and/or assembly of the Work;
(e) the scheduled date of completion of delivery of the Work (and where applicable, unit sections thereof) to the site; and
(f) such other information as is requested in writing by the Engineer.

The Contractor shall also submit reports on the progress of the Work to the Engineer containing such detailed information as the Engineer from time to time requires on the design, material, manufacture, fabrication, assembly, shipment and delivery of the Work. The Contractor shall grant authorized representatives of the Purchaser and Inspector access to the Contractor’s factory and to the factory or factories of all subcontractors, during the Contractor’s or subcontractor’s normal business hours, to enable such representatives to ascertain the state of the Work and the progress being made thereon by the Contractor or subcontractor.

10 LANGUAGE, DIMENSIONS AND WEIGHTS

All communication, including without limitation all notices, documents, notes on drawings, and submissions, required or permitted under the Contract, shall be in English.

Any Work shall be executed in the SI (Metric) System of Units except for bolts and nuts. Dimensions shall be shown in metres and millimetres and weights shall be shown in kilograms and metric tonnes.

11 SUBCONTRACTS

The Contractor shall not, without the prior approval in writing of the Purchaser, assign the Contract, nor make a subcontract with any person, firm or corporation for the execution of any portion of the Work, other than for materials or for any part of the Work for which the manufacturer or supplier is named in the Contract. If the Contractor wishes to sublet any part of the Work, the Contractor shall first submit to the Purchaser for approval, a description of the part of the Work which the Contractor wishes to sublet and the name or names of the subcontractor or subcontractors it wishes to employ. Any approval given by the Purchaser as provided for in the immediate preceding sentence shall not relieve the Contractor from any obligation or liability for the full and complete performance of the Work, all in accordance with the Contract.

If the Purchaser gives its approval thereto in writing, and the Contractor enters into one or more subcontracts, 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.

All work done by a subcontractor shall, for the purposes of the Contract, be deemed to be done by the Contractor and payment therefore 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 therefore. 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.

If the Purchaser so requests, the Contractor shall furnish the Purchaser with duplicate copies of all orders placed by the Contractor with subcontractors.

12 COOPERATION BETWEEN CONTRACTORS

The Contractor shall cooperate with all other contractors who may be performing Work on behalf of the Purchaser, and with the workers who may be employed by the Purchaser on any work at/in the vicinity of the Site. 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 materials and equipment of the Purchaser or of other contractors.

13 INSURANCE

The Contractor shall provide, maintain and pay for the insurance coverage listed below. The Contractor shall supply the Purchaser with a certified copy of the required policy of insurance and all renewals thereof. A Certificate of Insurance may be submitted in place of the policy provided that all terms and conditions of required coverage are specified therein. All documentation must be submitted to the Purchaser prior to the commencement of the Work or delivery of goods or services.

The policy shall be endorsed to provide the Purchaser with not less than 30 days' written notice in advance of cancellation, change or amendment restricting coverage, and to show the Purchaser as an Additional Insured.

The Contractor shall be responsible for any deductible amounts under the policy except where such amounts may be excluded from the Contractor's responsibility. Should a loss be sustained, the Contractor shall act on behalf of both the Purchaser and the Contractor for the purpose of adjusting the amount of loss with the insurance companies.

13.1 General Liability Insurance

General Liability Insurance, shall provide limits of not less than $2 000 000 (CAD) inclusive, per occurrence, for bodily injury, death, and damage to property including loss of use thereof.

The General Liability Insurance shall include insurance coverage for the following:

(a) Premises Property and Operations
(b) Products and Completed Operations
(c) Blanket Contractual Liability
(d) Cross Liability
(e) Non-owned Automobile Liability
(f) Occurrence Property Damage
(g) The Purchaser named as Additional Insured

14 IMPORTS

The Contractor shall be the importer of all non-Canadian goods and services.

15 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

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.

16 MATERIALS AND LABOUR

Unless otherwise specified in the contract, the Contractor shall furnish all material and shall perform all labour necessary for the due and proper design, manufacture, fabrication, completion and delivery of the Work.

All work done and materials supplied pursuant to the contract shall be of specified quality, if specified, otherwise of suitable quality as determined by the Engineer.

17 INVOICES

The invoices to be submitted by the Contractor shall be satisfactory to the Purchaser in both form and content. The Contractor shall also provide supporting documents and receipts if requested by the Purchaser.

18 RECORDS

The Contractor shall:

(a) keep full and detailed records, books, accounts, correspondence, instructions, drawings, receipts, vouchers, memoranda, and records of labour force, plant, tools, equipment, hours worked, rates required to properly appraise the progress of the Work, (herein "records"), necessary for the proper administration of the Contract and the Work.

(b) provide the Engineer and/or the Purchaser with copies of any records when requested, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(c) provide the Engineer and/or the Purchaser with reasonable access to any premises and to inspect and/or audit records, and permit copies to be made of same, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(d) preserve records for a period of not less than three (3) years from the date of the Completion Certificate.

19 CONFLICTS

For the entire duration of the Contract, the Contractor and its agents shall not provide equipment or services to any other person(s) in a manner which conflicts with the Contract.

20 CONFIDENTIALITY

The Contractor shall keep the Confidential Information confidential, using no less a standard than measures the Contractor uses to keep its own highly confidential information secret, but in any event not less than a reasonable standard of care.

Confidential Information may only be used by the Contractor for providing Services to the Purchaser and for no other purpose whatsoever.

The Contractor shall not, without the prior written consent of the Purchaser, disclose or otherwise make available any Confidential Information to any other Person, except to such directors, officers, and employees of the Contractor who have a need to access Confidential Information to perform their obligations to the Contractor for Hydro. The Contractor shall be responsible for any breach of the terms of this Section by it or any such Person.

The Contractor shall deliver Confidential Information to the Purchaser immediately on demand from the Purchaser and, on demand from Hydro, certify in writing to Hydro within ten (10) days of such demand that Confidential Information has been erased or destroyed.

The Contractor acknowledges that any failure to comply with the provisions of this Section hereof, shall cause irreparable harm to Hydro which cannot be adequately compensated for in damages, and accordingly acknowledges that Hydro shall be entitled, in addition to any other remedies available to it, interlocutory and permanent injunction relief to restrain any anticipated, present, or continuing breach of this Contract.

The Contractor's obligations pursuant to this Section hereof shall continue without limitation of time.

The Contractor shall

(a) have in place and utilize systems, media, policies, and procedures, for the storage of, security for, access to, handling of, transfer of, and destruction of, Personal Information that would satisfy the requirements of: (i) The Freedom of Information and Protection of Privacy Act (Manitoba) as if that Act applies to Contractor; and (ii) the Personal Information Protection and Electronic Documents Act (Canada) requirements for protection of Personal Information; and conform to ISO 27000;

(b) secure Personal Information against unauthorized and accidental access, disclosure or attack.

21 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 the type/sample/routine 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, at the Contractor's expense, 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 the USE OF FAULTY OR DEFECTIVE WORK Section of the General Conditions.

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. The Contractor shall be liable for all 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 invoice therefore certified correct by the Purchaser. The Purchaser may, at the Purchaser's option, apply moneys due or to become due from the Purchaser to the Contractor in or towards payment of such costs, charges and expenses, in which event the Contractor shall remain liable for any deficiency.

22 USE OF FAULTY OR DEFECTIVE WORK

Until all faulty or defective work has been made good or altered as provided by the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions, the Purchaser shall have the right to use any such faulty or defective work at the Contractor's sole risk, and without thereby in any way affecting the Purchaser's rights under the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions 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.

23 CONTRACTOR'S LIABILITY

23.1 The Work

Unless otherwise specifically provided in the Contract, the Work shall be and remain at the risk of the Contractor and the Contractor shall make good loss thereof or damage thereto occurring between the effective date of the Contract and the date of the COMPLETION CERTIFICATE issued in respect thereof, or the date of final payment, whichever shall first occur.

23.2 Labour and Materials

The Contractor 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.

23.3 Injury to Persons or Property

If, at any time after the effective date of the Contract and before the date of the COMPLETION CERTIFICATE, or if at any time thereafter while the Contractor, its officers, servants, agents, employees or subcontractors are on the site for the purpose of making good any breakage, defect or failure in the Work pursuant to the WARRANTY Section of the General Conditions, there shall occur any injury (including loss of life), loss or damage to any person or property, other than property forming part of the Work, caused by or resulting from defective plant, material, workmanship, fabrication, or construction or by anything done, or omitted to be done, or permitted to be done by the Contractor, its officers, servants, agents, employees or subcontractors (but not otherwise), then the Contractor shall 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 by any person, firm or corporation for, or by reason, or on account of such injury, loss or damage, or anything relating thereto.

24 INTELLECTUAL PROPERTY

Drawings, reports, manuals, documents, and other and/or similar materials (herein "Drawings") produced/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 Drawings shall remain with the Contractor. The Contractor shall grant the Purchaser a perpetual, royalty free, non-transferable (save and except transferable to the Purchaser's affiliates or transferable to any entity created after the effective date of the Contract and to which the Purchaser assets are assigned or otherwise transferred) limited licence to use, copy, and to allow third parties to use, the Drawings and all proprietary information in the Drawings as may be required for the purpose of proposing, installing, operating, repairing, maintaining, modifying, replacing and/or upgrading the Work, or any part thereof.

25 PAYMENTS BY THE CONTRACTOR

The Contractor shall promptly pay all assessments, premiums, levies, taxes, permit and licence fees and shall promptly pay for all materials, labour, and services obtained or required by the Contractor in the execution of the Contract. If the Contractor fails to pay the same, or unduly delays payment, the Purchaser may, at the Purchaser's option, make such payment or payments for and on behalf of the Contractor, and thereafter the Contractor shall on demand, pay the Purchaser an amount equal to the aggregate of all the sums so paid by the Purchaser, plus interest on the sums so paid at an interest rate equal to the Prime Rate of interest charged by the Purchaser's bank plus 3% per annum calculated from the date of payment by the Purchaser to the date when moneys are next due and payable by the Purchaser to the Contractor under the Contract, plus the sum of $10.00 (CAD) as a service charge in respect of each cheque issued by the Purchaser for or on behalf of the Contractor pursuant to this Section of the General Conditions, or the Purchaser may, at its option, deduct the aforesaid sums, interest and service charge from any moneys due or to become due to the Contractor from the Purchaser, provided that no payment by the Purchaser as aforesaid shall be held to relieve the Contractor from the Contractor's liabilities and obligations under the Contract.

The Contractor shall keep a record of the pro rata share of accrued interest on holdbacks due all subcontractors.

26 WARRANTY

If, within 24 months from the date when the Work has been accepted by the Purchaser, the Work or any part thereof becomes broken or defective or fails due to faulty or improper design, material, workmanship, manufacture, fabrication, shipment or delivery, or fails to meet the requirements of the contract, then the Contractor, upon notification in writing from the Purchaser, shall forthwith make good every such breakage, defect or failure without cost (including without limitation, transportation costs to and from the place where the Work was delivered) to the Purchaser.

If, after such notification, 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 all costs, charges and expenses incurred by the Purchaser in connection therewith and shall forthwith pay to the Purchaser an amount equal to such costs, charges and expenses upon receipt of invoices therefore certified correct by the Purchaser.

The Contractor's liability under this Section of the General Conditions shall be in lieu of any warranty or condition implied by law as to the quality, design or fitness of the Work for any particular purpose, and save as in this Section of the General Conditions expressed the Contractor shall not be liable for defects in any work after the Work has been taken over by the Purchaser or for any injury or damage resulting from any such defects.

Provided the Contractor is not otherwise in default under the terms of the contract, and subject to the provisions of the CONTRACTOR'S LIABILITY and RESPONSIBILITY AS TO PATENTS Sections of the General Conditions, the Contractor's liability in respect of the Work, whether in contract, tort or otherwise, shall cease upon the fulfilment by the Contractor of the Contractor's obligations under this Section of the General Conditions; provided further that any part of the Work made good under this Section of the General Conditions shall be subject to all provisions of this Section of the General Conditions for a further period of 24 months from the date when the same has been made good as aforesaid.

Where more than one unit section of equipment is included in the Work, the said period of 24 months shall be deemed to commence when each unit section of the Work has been taken over by the Purchaser.

27 INSPECTION AND TESTING

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 or Inspector. Any special tests which the Purchaser requires are set forth in Request for Proposal 040408. The Contractor shall co-operate with the Engineer or Inspector and shall make available every facility which the Contractor possesses for inspecting and testing.

All work, materials and equipment condemned by the Engineer or Inspector shall be removed and rebuilt or replaced in accordance with the Contract at the Contractor's expense 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 work shall be promptly repaired and made good at the Contractor's own proper cost and expense.

If the Purchaser 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, proper operation 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 the USE OF FAULTY OR DEFECTIVE WORK, CONTRACTOR'S LIABILITY, CONTRACTOR'S DEFAULT, TERMINATION FOR BREACH OF CONTRACT, WARRANTY and INTERPRETATION OF THE CONTRACT Sections of the General Conditions.

28 COMPLETION CERTIFICATE

Subject to the provisions of the WARRANTY Section of the General Conditions, 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, the Purchaser will issue a COMPLETION CERTIFICATE (see SAMPLE ONLY COMPLETION CERTIFICATE included as Appendix C) to the Contractor, and from and after the date of said Certificate, the Purchaser shall be deemed to have accepted and taken over the Work, or the unit section thereof, as the case may be.

29 CONTRACTOR'S DEFAULT

If the Contractor:

(a) abandons the Work;
(b) fails to perform the Work in accordance with the terms and provisions specified in the Contract;
(c) fails to perform the Work within the time or times specified in the Contract;
(d) becomes bankrupt or insolvent, or makes an assignment for the general benefits of creditors;
(e) permits any execution to be levied on the Contractor's real or personal property or on any portion of the Work;
(f) assigns or sublets the Contract without the consent in writing of the Purchaser;
(g) loses control of the Work for any cause whatsoever, except by act of God, lawful orders of civil or military authorities, or the public enemy;
(h) refuses or neglects to follow the instructions of the Purchaser;
(i) fails to meet the Purchaser's requirements for material, plant, methods and/or labour within a reasonable time;
(j) refuses or neglects to use measures to protect the Work from damage;
(k) is guilty of carelessness or incompetence in the execution of the Work;

(l) delays the Work or any part thereof unnecessarily or unreasonably; or

(m) is in default of any other of its covenants or obligations in, or arising from, the Contract;

then the Purchaser may, at its option, and without prejudice to any other rights or remedies:

i) at the Contractor’s expense, 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; and/or

ii) at the Contractor’s risk and expense, remove unsuitable or inefficient material, plant and tools from the site; and/or

iii) at the Contractor’s expense, take over and carry on the Work to the extent necessary to avoid loss or waste or damage to the Work already performed; and/or

iv) give notice of intention to terminate the Contract as provided in the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions.

30 TERMINATION FOR BREACH OF CONTRACT

If the Contractor makes default in any manner set forth in the CONTRACTOR’S DEFAULT Section paragraph (b), (c), (h), (i), (j), (k), (l), or (m) of the General Conditions, the Purchaser may give written notice to the Contractor of intention to terminate the Contract, stating the reasons therefore. If the Contractor does not remedy or take steps to remedy the default to the satisfaction of 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 the CONTRACTOR’S DEFAULT Section paragraph (a), (d), (e), (f) or (g) of the General Conditions, 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 thereafter. The Purchaser may, at its 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 may think fit, for the account and at the expense of the Contractor, and the Contractor shall be liable to the Purchaser for any excess cost occasioned the Purchaser.

At any time after the Purchaser has terminated the Contract, the Purchaser, with such assistance 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's material, plant, and tools at the site may be utilized by the Purchaser, without payment, for the purpose of completing the Work, and may be sold by the Purchaser by private sale or by public auction, either for cash or credit, and upon such terms and conditions as the Purchaser deems most advantageous, but without the Purchaser being liable for loss which may be occasioned thereby. The proceeds of such sale shall be applied in and towards the satisfaction of any money due or to become due to the Purchaser from the Contractor under the Contract.

Upon any termination of the Contract as provided herein, 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. 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 or due completion 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 moneys due or to become due to the Contractor. 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.

31 TERMINATION FOR CONVENIENCE

Notwithstanding the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions, the Purchaser may terminate the Contract (for whatever reason the Purchaser deems fit and at any time during the Work) on 30 days' written notice. The Purchaser shall pay for fees and expenses incurred to the date of the termination.

Without restricting its other remedies, the Purchaser may immediately terminate the Contract in writing if the equipment or services are unsatisfactory, inadequate, or improperly performed, the Contractor fails to comply with the Contract, or the Contractor becomes bankrupt or insolvent.

32 RESPONSIBILITY AS TO PATENTS

The Contractor shall pay all royalties payable under or in respect of, and shall fully 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 of, any and all letters patent, registered design, trade mark or copyright of any apparatus or component part thereof forming part of or used in or 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 this proposing document, but such indemnity shall not cover any use of the Work otherwise than for the purpose indicated by or reasonably to be inferred from this proposing document.

In the event of any claim being made or action brought against the Purchaser arising out of the matters referred to in this Section of the General Conditions, the Contractor shall be promptly notified thereof and may at its own expense conduct 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 conduct by the Contractor of such negotiations or litigation shall be conditional upon the Contractor having first given to the Purchaser such reasonable security as shall from time to time be required by the Purchaser to cover the amount ascertained, or agreed, or estimated, as the case may be, of any compensation, damages, expenses, and costs for which the Purchaser may become liable in respect of such infringement or alleged infringement as aforesaid. The Purchaser shall, at the request of the Contractor, afford all available 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, replace such work with a non-infringing work or modify it so that it becomes non-infringing or remove the said enjoined work and refund the sums paid therefor.

33 OWNERSHIP OF EQUIPMENT AND SUPPLIES

Any equipment and supplies provided by Manitoba Hydro to the Contractor for use pursuant to the Contract shall remain the property of Manitoba Hydro and shall be returned to Manitoba Hydro upon request.

34 ENUREMENT

The Contract shall enure and be binding upon the parties and their executors, administrators, heirs, successors and permitted assigns.

35 ASSIGNMENT OF RIGHTS AND OBLIGATIONS

The Contractor shall not assign any of its rights or obligations arising under the contract without the written consent of the Purchaser, which consent may be arbitrarily withheld.

36 SURVIVAL OF TERMS

Sections RECORDS, CONFIDENTIALITY, CONTRACTOR'S LIABILITY, ENUREMENT, INTELLECTUAL PROPERTY, OWNERSHIP OF EQUIPMENT AND SUPPLIES of the General Conditions shall survive the termination or expiration of the Contract.

37 INTERPRETATION OF THE CONTRACT

The Purchaser's decision shall govern 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 the Purchaser shall be the sole judge of the quality, quantity, suitability and efficiency of labour, workmanship, materials, plant, apparatus, equipment, appliances and methods used, furnished or supplied by the Contractor pursuant to the Contract.

The Contract shall be interpreted according to the laws of the Province of Manitoba, Canada.

38 OBSERVANCE OF LAWS AND REGULATIONS

Until the Work shall have been fully completed and accepted by the Purchaser, the Contractor shall be liable for the due and proper observance, both by itself, and by its servants, agents, employees and subcontractors, of all statutes, by-laws, rules and regulations in any way affecting or relating to the Work, which are lawfully imposed by any federal, provincial or municipal authority.

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 statutes, by-laws, rules and regulations by the Contractor, its servants, agents, employees and subcontractors.

39 APPLICABLE LAWS

The Contract shall be governed by the laws of the Province of Manitoba, Canada.

40 NOTICES

Every notice or communication required or permitted to be given or served pursuant to the Contract shall be in writing, and shall be delivered personally or by fax:

To the Purchaser:
TBD

To the Contractor:
TBD

To the Engineer:
TBD

In addition to forgoing, the Purchaser may effectually give notice to the Contractor:

(a) by giving same on the Superintendent, whether personally, or by fax to the Superintendent's designated Manitoba office; or
(b) by giving same to Contractors address and contact particulars included in the Contract.

Notice given or served by personal service shall be deemed effectually given and received upon such personal service, and notice given or served by fax shall be deemed effectually given and received on the first (1st) calendar day after the day of transmission.

The Contractor acknowledges and agrees that the Engineer is an employee of the Purchaser.

41 ARBITRATION

41.1 Notice of Dissatisfaction Concerning Engineer Determinations

A party shall be conclusively deemed to have accepted a determination by the Engineer issued under any provision of the Contract, 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 seven (7) 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.

41.2 Amicable Settlement of Disputes

The Purchaser and the Contractor shall make all reasonable efforts to resolve any 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 Engineer and Contractor’s representative fail to resolve the dispute, 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 a Vice President for the Purchaser and the equivalent senior executive of the Contractor.

41.3 Final and Binding Arbitration

If the dispute has not been resolved within a reasonable time, 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, together with a concise statement of the matters in dispute.

41.4 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.

41.5 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.

41.6 Venue

Arbitration proceedings shall be conducted at Winnipeg, Manitoba.

41.7 Work to Continue

The Contractor shall not suspend, delay or interfere with 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 above, nor during arbitration proceedings.

END OF GENERAL CONDITIONS

Manitoba Hydro

TECHNICAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF	JANUARY 2017
500kV AC SUSPENSION INSULATORS	
500kV AC TRANSMISSION LINES	**DRAFT 3**

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040408

TECHNICAL REQUIREMENTS

1 GENERAL

1.1 Description of the Work

These Technical Requirements set out the Purchaser's requirements with respect to the design, material procurement, manufacture, supervision, labour, equipment, quality control, testing, shipping, delivery, Contractor's insurance and warranty of wet-process porcelain or toughened glass ball and socket type suspension insulators for suspension, deadend and jumper strings to be installed on the Manitoba-Minnesota 500 kV AC Transmission Line from Dorsey to Iron Range.

The Contractor shall design, prepare detailed product drawings and perform all the required type tests to demonstrate full conformance of the insulators with all aspects of the Technical Requirements prior to commencement of mass production.

1.2 Reference Standards

The latest revision of the following standards, current at the date of signing of the Contract, shall apply. In the case where conflict between several referenced documents exists, the more stringent requirements shall be followed.

Canadian Standards Association (CSA)

CSA-C411.1	AC suspension insulators
CSA-C83	Communication and Power Line Hardware

International Electrotechnical Commission (IEC)

IEC 60437	Radio interference test on high-voltage insulators

International Organization for Standardization (ISO)

ISO 9001	Quality Management Systems – Requirements

2 SERVICE AND ENVIRONMENTAL CONDITIONS

The insulators shall be suitable for reliable operations under the specified environmental conditions as shown in Table 1.

Table 1
Environmental Conditions

Condition	Value
Ambient Air Temperature: Minimum Maximum	 -50ºC 40ºC
Maximum Conductor Operating Temperature	70ºC
Contamination level (ESDD)	0.01 mg/cm^2 (Light)
Altitude	less than 500 m
Environment Type	Rural and agricultural
Lightning Stroke Density	1.61/km^2/yr

The minimum expected service life of the insulators is 50 years under the environmental conditions as specified above.

3 DESIGN REQUIREMENTS

3.1 General

The insulator units shall be of ball and socket, normal type suitable for AC application. The units shall be made of high quality wet-process porcelain or toughened glass.

3.2 Insulator Unit Characteristics

Two types of AC insulators are required for the Manitoba-Minnesota 500 kV AC Transmission Line: 160 kN and 220 kN units.

The physical dimensions, electrical characteristics and mechanical characteristics of porcelain and/or toughened glass insulator units shall be in accordance with Table 2.

Table 2
Insulator Characteristics

Property	Unit	Requirement	
Mechanical Requirements			
Minimum Electromechanical Failing Load	kN	160	220
Mechanical Impact Strength	N.m	10	10
Dimensional Requirements			
Maximum Nominal Shell Diameter	mm	298	311
Nominal Unit Spacing	mm	146	156
Minimum Nominal Creepage Distance	mm	318	381
Electrical Requirements			
Power Frequency Dry Flashover	kV rms	80	80
Power Frequency Wet Flashover	kV rms	45	45
Critical Impulse Voltage + Flashover	kV	125	140
Critical Impulse Voltage – Flashover	kV	130	140
Power Frequency Puncture Voltage	kV rms	110	125
RIV Max. Level at 1 MHz	μV rms	50	50
RIV Test Voltage	kV rms	10	10
Other Requirements			
Colour of Glaze (Porcelain Only)		Blue	Light Grey
Colour of 25 mm Band Painted On the Cap (Toughened Glass Only)		Blue	Red
Type of Ball and Socket Coupling		CS-8	CS-11

3.3 Insulator Head Design

All insulator units shall have a straight head design. Dove-tail head design will not be accepted.

3.4 Connecting Hardware

All insulator units shall have connecting hardware of the ball and socket type suitable for easy coupling or separation using standard live-line tools and procedures.

Dimensions of the connecting hardware shall be in accordance with CSA C411.1.

3.5 Design Drawings

The Contractor shall provide design drawings to demonstrate insulator unit conformance with the Technical Requirements. Such drawings shall include:

(a) Physical dimensions,
(b) Overall unit weight,
(c) Electrical and mechanical characteristics,
(d) Coupling type,
(e) Types of materials used and method of manufacture for each component,
(f) Drawing and revision number

All design drawings shall be in SI dimensional system using English language only.

4 MATERIALS

4.1 Insulator Shell

The insulator shell shall be made of high quality wet-process porcelain or toughened glass free of any defects that could affect mechanical, electrical and lifespan performance of the insulator.

The surface of the insulator shell shall be smooth and free of any imperfections and shall be evaluated for these characteristics in accordance with Clause 8.6 of CSA C411.1.

The porcelain shall meet the requirements of the porosity test as specified in Clause 7.8 of CSA C411.1.

The toughened glass shall not have air bubbles of a diameter greater than 2 mm.

4.2 Ferrous Parts

All ferrous material shall be galvanized in accordance with CSA G164 standards, with a zinc coating corresponding to not less than 455 g/m².

4.3 Cement

Only hot cured aluminous cement type shall be used in the fabrication of the insulators. Sulphoaluminate or Portland cement is not allowed.

4.4 Cotter Key

The cotter key shall be of the split key type and shall be made of stainless steel.

4.5 Cap-Dielectric Interface

Plastic ring to fill the gap between cap and dielectric is not allowed.

4.6 Pin

The insulator pin shall be forged steel. Charpy level 1 is required.

5 FABRICATION REQUIREMENTS

Each insulator shall be assembled in the same plant where the insulator shell is produced.

6 TEST REQUIREMENTS

6.1 General Requirements

The porcelain and toughened glass insulators shall undergo complete type, sample and routine tests as listed in Table 3 below and in accordance with CSA C411.1 Clauses 6, 7 and 8, unless otherwise specified by the Technical Requirements.

The Contractor shall be responsible for all testing costs which are deemed included in the Contract Prices.

6.2 Classification of Tests

The Contractor shall perform all the type, sample and routine tests as listed in Table 3 and in accordance with CSA C411.1 Clauses 6.2.4.2, 7.2.3 and 8.1 to demonstrate full conformance of the insulators with all aspects of the Technical Requirements.

Table 3
Required Tests

Item	Test	Reference Standard/Clause	Type	Sample	Routine
1	Dry power frequency flashover voltage test	CSA C411.1: Clause 6.3	x		
2	Wet power frequency flashover voltage test	CSA C411.1: Clause 6.4	x		
3	Critical lightning impulse flashover voltage test	CSA C411.1: Clause 6.5	x		
4	Steep-front impulse voltage test	CSA C411.1: Clause 6.6	x		
5	Radio influence voltage test	CSA C411.1: Clause 6.7 and Clause 6.8 of Technical Requirements	x		
6	Impact test	CSA C411.1: Clause 6.8	x		
7	Residual strength test	CSA C411.1: Clause 6.9	x	x	
8	Thermal-mechanical performance test	CSA C411.1: Clause 6.10 and Clause 6.6 of Technical Requirements	x		
9	Verification of coupling locking system	CSA C411.1: Clause 6.11	x		
10	Position of locking device	CSA C411.1: Clause 6.12	x		
11	Electromechanical failing load test	CSA C411.1: Clause 6.13 and Clause 6.7 of Technical Requirements	x	x	
12	Operation test on cotter key	CSA C411.1: Clause 7.3		x	
13	Visual inspection and verification of dimensions	CSA C411.1: Clause 7.4		x	
14	Temperature cycle test	CSA C411.1: Clause 7.5		x	
15	Puncture test	CSA C411.1: Clause 7.7		x	
16	Porosity test (porcelain insulators only)	CSA C411.1: Clause 7.8		x	
17	Galvanizing test	CSA C411.1: Clause 7.9		x	
18	Thermal shocks test (toughened glass insulators only)	CSA C411.1: Clause 8.3		x	x

Item	Test	Reference Standard/Clause	Type	Sample	Routine
19	Routine mechanical test	CSA C411.1: Clause 8.4			x
20	Routine electrical test (porcelain insulators only)	CSA C411.1: Clause 8.5			x
21	Visual inspection	CSA C411.1: Clause 8.6			x
22	Charpy Impact Test	Clause 6.9 of Technical Requirements	x		

6.3 Access and Notification

The Contractor shall allow the Purchaser or its representative access to all tests for the Work as set out in the Technical Requirements. The Contractor shall give notice to the Engineer of such testing a minimum of 30 days in advance.

6.4 Sampling Method and Acceptance Criteria

The sampling method, the number of samples and the acceptance criteria shall be in accordance with the applicable clauses of CAN/CSA-C411.1, unless otherwise specified in the Technical Requirements.

6.5 Validity of Existing Type Test Report

New Type Test Reports shall be completed by a qualified third party laboratory which must be pre-approved by the Engineer. Type Test Reports shall be submitted electronically to the Engineer for approval.

The Purchaser shall not accept any material deliveries until the Type Test Report has been approved by the Engineer.

The Engineer may accept the existing type test reports offered by the Contractor in the Contractor's proposal, provided that:

(a) All the type tests were made of the same type of insulator units as required by the Technical Requirements;
(b) A complete set of tests were performed on the required number of insulator units and in the sequence as prescribed by the Technical Requirements;
(c) Testing was performed in accordance with all the requirements of the Technical Requirements;
(d) Testing was performed within the last five (5) years;

(e) Testing was done on insulators manufactured at the same facility; and
(f) The Contractor's manufacturing process has not changed since the time of the type test was performed.
(g) Manufacture of sub-components of the insulator has not changed.

The Engineer shall advise the Contractor in writing as to whether the above criteria have been satisfied, in the Engineer's sole discretion.

6.6 Thermal-Mechanical Performance Test

6.6.1 Test Method

Both porcelain and toughened glass insulators shall be subjected to a thermal-mechanical performance test. The test procedure shall be in accordance with CSA-C411.1 Clause 6.10.

6.6.2 Acceptance Criteria

Criteria for acceptable thermal-mechanical performance are as follows:

(a) $X \geq R + 4б$

where:
X = mean value of individual failing load
R = electromechanical load rating
б = standard deviation of the sample test units

(b) The individual failing load of each tested insulator shall be $\geq R$.

6.7 Electromechanical Failing Load Test

6.7.1 Test Method

Both porcelain and toughened glass insulators shall be subjected to electromechanical failing load test. The test procedure shall be in accordance with CSA C411.1 Clause 6.13.

The string of wet-process porcelain insulators shall be subjected individually to a power-frequency voltage equal to 75% of the dry power frequency flashover voltage value as specified in Table 2 of the Technical Requirements and to a tensile load applied simultaneously between the metal parts. The voltage shall be maintained throughout the test.

6.7.2 Acceptance Criteria

Criteria for an acceptable electromechanical failing load rating are as follows:

(a) $X \geq R + 4\sigma$

where:

X = mean value of individual failing load
R = electromechanical load rating
σ = standard deviation of the sample test results

(b) The individual failing load of each tested insulator shall be $\geq R$.

6.8 Radio Interference Voltage Test

Both porcelain and toughened glass insulators shall be subjected to a radio interference voltage (RIV) test. The test procedure shall be in accordance with IEC 60437.

6.8.1 Test Method

Five insulators shall be selected at random and tested according to the test procedure of IEC 60437.

6.8.2 Acceptance Criteria

Each insulator subjected to a radio interference voltage test shall demonstrate that it meets the RIV requirement specified in Table 2 set out in Subsection 3.2 Insulator Unit Characteristics of the Technical Requirements. Failure of more than one insulator to meet this requirement during testing shall constitute failure to meet the RIV requirements specified in Table 2. If one insulator fails to meet the RIV requirements specified in Table 2, an additional five insulators shall be selected at random and tested. Failure of any of the insulators in the second sample to meet the RIV requirements specified in Table 2 shall constitute an unsuccessful test.

6.9 Charpy Impact Test

The insulator pins shall be forged steel. A type test shall be performed in which three (3) forged steel pins shall be Charpy tested to Level 1, 20 Joules minimum energy absorption at -20°C according to CAN/CSA-C83. Energy absorption and test temperature of each sample shall be included in the Type Test Report.

6.10 Notice of Tests

If additional testing, as permitted by applicable sections of the Technical Requirements, is required to satisfy requirements of the Technical Requirements, the Contractor shall give notice of such testing of a minimum of 30 days to the Engineer.

6.11 Certified Test Reports

Upon completion of all testing as specified in the Technical Requirements, all test reports shall be submitted electronically to Engineer to confirm that all requirements of the Technical Requirements have been met. The Purchaser shall not accept any material deliveries until all Type Test Reports have been approved by the Engineer.

Test reports shall be sent to:

Chen Wang, P. Eng. – Transmission Line Engineer
Manitoba Hydro
Transmission & Civil Design Department
820 Taylor Avenue (4)
Winnipeg, Manitoba, Canada R3M 3T1
Email: cwang@hydro.mb.ca

6.12 Third Party Testing

The Purchaser reserves the right to select and test samples from insulator lots fabricated by the Contractor using a qualified third party using the same tests as outlined in the Technical Requirements. If this tested lot fails any of the acceptance criteria set out in the Technical Requirements, then the lot will be refused and returned at the Contractor's expense. A replacement lot will be provided by the Contractor in accordance with all requirements of the Contract, at no additional expense or cost to the Purchaser.

6.13 Field Breakage Record

The manufacturer shall declare the annual average insulator breakage rate experienced in the field for this class of insulator. The rate shall be expressed in (number of broken insulators)/100,000/year

7 QUALITY ASSURANCE

7.1 General

The Contractor shall comply with the quality assurance program requirements of ISO 9001 standard or its equivalent in the performance of the Work, the Contract, and the Contractor's obligations in respect of both. If the Contractor's proposed program is not based on ISO 9001 series of standards, the Contractor shall submit evidence, satisfactory to the Engineer that the proposed program conforms fully to the spirit and intent of ISO 9001.

The Engineer may, in his sole discretion, reject Work that is not produced under the Quality requirements specified in this Section.

The Contractor is responsible to identify in its Quality Plan the specific activities it will undertake to perform:

(a) Quality Assurance: The process of auditing the quality requirements and the results from Quality Control measurements to ensure quality standards are being met.

(b) Quality Control: The process of monitoring and recording results of Quality activities to assess performance and recommend necessary changes.

7.2 Quality Documentation

All quality documentation shall be in the English language. Where the original document is in a language other than English, the Contractor is responsible to have the document translated into English without causing delays to the documentation process.

7.3 Access to Contractor's Facilities

The Purchaser reserves the right to audit the Contractor's Quality Management System program at any time during the Work.

The Purchaser or its representative shall be granted unescorted access to the Contractor's facilities and to the facilities of all of its Subcontractors, at any time during the Contractor's or Subcontractors' normal business hours to verify that the Contractor and its Subcontractors are satisfactorily carrying out the Work and that the Work complies with the requirements of this Section of the Technical Requirements. The Purchaser or its representative shall be allowed at any time and under any circumstance to take photographs of any portion of the Work he deems necessary upon mutual agreement.

While attending at the Contractor's facilities, the Purchaser or its representative will comply with the reasonable policies of the Contractor concerning confidentiality (and with respect to matters not related to the Work and the Contract) which have been disclosed in writing to the Purchaser prior to attendance and for which no objection has been made; provided further however that nothing in the Contract is altered or diminished by reason of any such policy or compliance with same. While attending at Contractor's facilities, the Purchaser or its representative will use best efforts to limit disruption of other activities at such facilities.

7.4 Tools and Equipment

All tools and equipment used to carry out inspection activities by the Contractor shall have been calibrated within the one (1) year proceeding of the date of inspection by accredited third party inspection company. Calibration records shall be provided to the Purchaser or its representative upon request. If it is discovered that tools and equipment are used for the Work that have not been calibrated within one (1) year of the inspection date, the inspections shall be repeated, at the sole risk of the Contractor, with tools and equipment that are properly calibrated.

7.5 Information Submitted After Award of Contract

At least 30 days prior to commencing factory production of any insulators, the Contractor shall submit the following information for approval by the Engineer:

- Inspection and test plan (ITP)
- Insulator assembly flow chart
- Insulator testing flow chart

The ITP document shall identify in detail:
(a) Production process and associated test,
(b) Parameter to be controlled,
(c) Sampling and frequency,
(d) Acceptance criteria,
(e) Reference standard or document,
(f) Control equipment,
(g) Testing location,
(h) Person/position responsible for the test, and
(i) Quality Control record form.

The Engineer will determine the Purchaser’s level of involvement in testing. This will be reflected in the ITP document.

7.6 Non-Conformance Reports

The Contractor shall provide the Purchaser or its representative, within 7 days of such request, information related to any present non-conformance reports regarding insulator quality and manufacturing, testing, shipping, internal and external Quality Assurance audits, including corrective and preventative actions in accordance with CAN/CSA-ISO 9001.

8 MARKING, PACKAGING AND SHIPPING

8.1 Insulator Marking

Each insulator shall have permanent markings identifying:

(a) Electromechanical failing load rating in kN, identified by the word “M-E”
(b) Tension-proof test load in kN, identified by the word “TEST”
(c) Manufacturer name or trademark
(d) Place of manufacture
(e) Year of production

An example of the required marking is shown below:

160 kN M-E
80 kN TEST
Company Name/Logo
City/Country
Year

8.2 Packaging and Shipping

8.2.1 General

The Contractor shall prepare the insulators for shipment in such manner as to protect them from dust and dirt, damage during transportation, handling and outdoor storage. The Contractor shall be responsible for and make good any and all damage resulting from loading and transportation. Shipment of insulators from the production lot shall not occur until Manitoba Hydro has confirmed the shipment can proceed. The most recent Certified Type Test Report shall be included with the routine and sample test reports prior to shipment.

8.2.2 Packaging

Insulators shall be assembled into 4 to 6 unit strings and packaged into wooden crates or boxes. Proper protection shall be provided to prevent movement of the components inside the crates or boxes during transportation. These crates or boxes shall be grouped into pallets in such manner that they can be easily lifted by a forklift. Shrink wrap or other appropriate packaging option shall be used to protect the pallets. Those crates or boxes shall be only delivered by flatbed truck which allows using forklift for unloading.

The loaded pallet shall be capable of being exposed to environmental conditions as listed in Table 1 for at least two years without loss of acceptable product performance.

8.2.3 Approval of Packaging

Drawings showing detailed packaging method shall be submitted to Engineer for approval as soon as possible, but not more than 60 days following the signing date of the Contract.

8.2.4 Packing List

Packing lists shall be included with each shipment. They shall include:

(a) Project name specified on the Purchase Order
(b) Purchase Order number
(c) Contractor's name
(d) Description of the pallet contents
(e) Calculated net mass and gross mass of each pallet, in kilograms
(f) The overall dimensions of the pallet, in millimetres
(g) Identification number of each pallet in the shipment

8.2.5 Shipping Reports

The Contractor shall, within 24 hours of each shipment, provide Purchaser with a corresponding shipping report which shall include:

(a) Project name specified on the Purchase Order
(b) Purchase Order number
(c) Items and quantities shipped
(d) Net and gross mass of each box
(e) Carrier
(f) Bill of Lading number
(g) Shipping date
(h) Expected delivery date

The Contractor shall be responsible for tracking and expediting all shipments and for obtaining all required permits.

END OF TECHNICAL REQUIREMENTS

Manitoba Hydro

TERMS AND CONDITIONS OF PAYMENT

DESIGN, MANUFACTURE AND SUPPLY OF	JANUARY 2017
500kV AC SUSPENSION INSULATORS	
500kV AC TRANSMISSION LINES	**DRAFT 3**

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040408

TERMS AND CONDITIONS OF PAYMENT

1 ITEMS 1 to 3

Subject always to satisfactory performance of the Work by the Contractor in accordance with the Contract, the Purchaser shall pay the Contractor the cost of the Work and all services of the Contractor in connection therewith, in Canadian currency, as follows.

1.1 Major Payment

An amount equal to 92.5% of the cost of the Work shall be paid 30 days after receipt of the Contractor's invoice following the completion of the Work.

Prior to payment of 92.5% of the cost of the Work to the Contractor as aforesaid, the Purchaser may require the Contractor to furnish the Purchaser with an Affidavit sworn by the Contractor in the form set out in Schedule 'A' (see SAMPLE ONLY) to these Terms and Conditions of Payment.

1.2 Performance Holdback

The 7.5% Performance Holdback balance of the cost of the Work shall be paid 30 days after the date of the COMPLETION CERTIFICATE issued in respect thereof.

END OF TERMS AND CONDITIONS OF PAYMENT

Terms and Conditions of Payment Schedule 'A'

CANADA	)	I, ______________________________
	)	
PROVINCE OF MANITOBA	)	of the __________ of ____________ in the
	)	
TO WIT:		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__

Manitoba Hydro

FORM OF PROPOSAL

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

Important: Macro Security level to Medium

1. The first field to be completed in the Form of Proposal is your full legal company name. Once your proposal is complete and converted to pdf, your full legal company name will automatically appear inside the header of every page.

2 Continue preparing your proposal by completing the gray shaded fields on each page.

3. 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.

4. Certain fields which contain the drop-down selection feature will allow you to make a selection from a list. For checkboxes, click inside the applicable YES or NO box to make a selection. To deselect, click inside the YES or NO box you wish to deselect.

5. After you are satisfied with your electronic completion of the Form of Proposal, save the document and convert it to pdf.

6. Print and sign the signing page manually. Scan the signed page and insert it into the Form of Proposal pdf. Delete the unsigned page.

7. Certain fields have been limited to a maximum number of rows or characters that you can type. If the space provided is insufficient, you can use the document provided titled "Additional Form of Proposal.docx".

8. If the "Additional Form of Proposal.docx" document has been utilized, convert it to pdf.

9. Submit the Form of Proposal, Additional Form of Proposal (if used) and any other applicable documents that you wish to accompany your proposal.

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

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC SUSPENSION INSULATORS 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040408

FORM OF PROPOSAL 040408

COMPANY INFORMATION

This proposal is submitted by: ______________________________
(legal company name)

hereinafter called the "Proponent", a company duly incorporated under the laws of:

____

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

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

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

The Proponent's principal office dealing with this Form of Proposal is at:

____
(number, street)

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

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

THE WORK

The Proponent shall provide its proposed price for the Work by completing the following information below:

Indicate if you are a Non-Resident Importer of Record into Canada:

YES ☐ NO ☐

If YES please indicate your GST Registration # below:

.1 If you are a Non-Resident Importer of Record into Canada and HAVE A GST number, provide EXW and **DDP** Pricing.

.2 If you are a Non-Resident Importer of Record into Canada and DO NOT HAVE A GST number, provide EXW and **DAP** pricing.

.3 If you are not shipping product from a country outside of Canada, provide EXW and **DDP** Pricing.

ITEM	Description	Shipping Options	UNIT Price ($CAD)	EXTENDED* Price ($CAD)
1	INSULATOR SUSPENSION BALL & SOCKET PORCELAIN CS-8 160 kN	EWX LOADED	(per unit)	(for 76,555 units)
		DDP: Gate 6 59029 Hwy 207 Dugald, Manitoba	(per unit)	(for 76,555 units)
		DAP: Gate 6 59029 Hwy 207 Dugald, Manitoba	(per unit)	(for 76,555 units)
2	INSULATOR SUSPENSION BALL & SOCKET PORCELAIN OR GLASS CS-11 220 kN	EWX LOADED	(per unit)	(for 3,800 units)
		DDP: Gate 6 59029 Hwy 207 Dugald, Manitoba	(per unit)	(for 3,800 units)
		DAP: Gate 6 59029 Hwy 207 Dugald, Manitoba	(per unit)	(for 3,800 units)

(GST) and Manitoba provincial retail sales tax (PST) are not included in the proposed price. GST and PST shall be shown as “extra” on each invoice. All other applicable taxes shall be included.

*Quantities are not guaranteed and the Purchaser shall not be obligated to purchase stated quantities. Quantities are subject to change.

ITEM 3 – TYPE TEST OF ITEMS 1 TO 2 (PURCHASER'S OPTION)

....$_________ **LUMP SUM (CAD)**

(GST) and Manitoba provincial retail sales tax (PST) are not included in the proposed price. GST and PST shall be shown as "extra" on each invoice. All other applicable taxes shall be included.

COMMERCIAL COMPLIANCE

Below are proposed changes to the commercial terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

TECHNICAL COMPLIANCE

The Proponent's product offering fully conforms with all Technical Requirements stated within Manitoba Hydro Request for Proposal 040408:

YES ☐ NO ☐

If NO, below are proposed changes to the technical terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

TYPE TEST REPORT BY THIRD PARTY LABORATORY

.1 The Proponent submits with its proposal existing type test report that meets all requirements of Subsection 6.5 in Technical Requirements of this RFP:

YES ☐ NO ☐

Comments:

.2 If existing type test report is not available or fails to meet any requirement of Subsection 6.5 in Technical Requirements of this RFP, Proponent should identify the Third Party Laboratory that will perform type test outlined in the Technical Requirements.

Name and Address of the proposed Type Testing Facility:

NOTE: The Purchaser reserves the right to accept or reject the Proponent's listed Type Testing Facility.

FIELD BREAKAGE RECORD

As required by Subsection 6.13 in Technical Requirements of this RFP, the Proponent shall submit the annual average insulator breakage rate experienced in the field for this class of insulator. The rate shall be expressed in (number of broken insulators)/100,000/year

_______________ Broken Insulators/100,000/Year

Comments:

The Proponent provides the evidence to prove the above field breakage record in form of statements issued by other customers/utilities

YES ☐ NO ☐

Comments:

DELIVERY DATE(S)

The Proponent offers to deliver the ITEMS of the Work on the Purchaser's specified date:

YES ☐ NO ☐

If the above answer was NO or if the Proponent can deliver the Work earlier than the Purchaser's preferred date, the Proponent indicates below its earliest dates upon which the ITEMS of the Work could be delivered:

ITEM 1	,	20
ITEM 2	,	20
ITEM 3 (PURCHASER'S OPTION)	,	20

SHIPMENT/TRANSPORTATION DETAILS

Delivery of the Work

The Purchaser requires the Proponent to provide the following information regarding shipment/transportation of the Work:

The total shipment weight is ___________lb or ___________ kg.

The total shipment volume is __________ ft^3 or ___________m^3.

The shipment's dimensions are:
length ___________ ft x width ___________ ft x height ___________ ft, or
length ___________ m x width___________ m x height ___________ m.

The total shipment quantity is _________ (No. of cartons / No. of pallets, etc.)

The shipment will be transported via:

Road:
____________(qty) ___________ (length in ft) enclosed van(s), or
___________ (qty) ___________ (length in ft) flatdeck trailer(s).

OR
Rail:
__________ (qty) ___________ (length in ft) boxcar(s), or
__________ (qty) ___________ (length in ft) flatcar(s), or
___________ (qty) ___________ (length in ft) gondola car(s).

SHIPMENT/TRANSPORTATION DETAILS (CONTINUED)

Loading of the Work

The following is the location of the Proponent's shipping facility or factory where the ITEMS of the Work will be loaded, blocked, braced and secured for transportation by the Proponent or the Proponent's designated carrier:

Street Name and Number: ______________________________
City Province/State: ______________________________
Postal Code/Zip Code: ____________

The estimated travel time from the Proponent's shipping facility or factory to the Purchaser's designated arrival destination is _____ day(s).

The Proponent intends to load the ITEMS of the Work in containers weighing:
___________(kg) approximately and measuring __________ (m) x ___________ (m) x __________ (m).

The Proponent indicates below any special equipment and requirements necessary for the transportation of the Work:

PRODUCTION SCHEDULE

The Proponent shall provide a detailed production schedule.

Include a GANTT chart, proposed schedule from ordering raw materials, manufacturing, shipping and delivery of products to final destination.

PLANT CAPACITY

.1 The Proponent identifies its total plant capacity by month and details what portion of the capacity has been allocated to other orders:

.2 The Proponent identifies its work arrangements:

Number of active shifts per day:

Number of working days per week:

Attach additional sheets if required.

PACKAGING METHOD

The Proponent shall provide a detailed packaging method that meets all requirements of Subsection 8.2 in Technical Requirements of this RFP:

Include packaging drawings for each item.

Comments:

MANITOBA CONTENT

The Proponent shall provide the estimated percentage of total proposed price that it considers to be Manitoba Content: ____________%

The Proponent shall provide a detailed breakdown of Manitoba Content that would be incorporated into the Work substantiating the above percentages (inputs originating from the Province of Manitoba such as labour, materials, transportation, etc):

NOTE: Upon request, the Contractor shall provide to Manitoba Hydro records substantiating the percentage of Manitoba Content.

a) Labour by Own Workforce

COMPONENT OF THE WORK	TYPE OF LABOUR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

b) Manitoba Subcontractors

TYPE OF WORK TO BE SUBCONTRACTED	NAME AND ADDRESS OF SUBCONTRACTOR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

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

MANITOBA CONTENT (CONT'D - 1)

c) Purchase of Goods from Manitoba Companies

TYPE OF GOODS	NAME AND ADDRESS OF SUPPLIER	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

d) Purchase of Equipment from Manitoba Companies

TYPE OF EQUIPMENT	NAME AND ADDRESS OF SUPPLIER	TOTAL VALUE OF PURCHASE PRICE $

e) Leased Equipment/Facility from Manitoba Companies

TYPE OF EQUIPMENT	OWNER	TOTAL VALUE OF LEASE $

Provide information regarding any lease agreements such as the following:

- Length of lease
- Lease payment
- Maintenance
- Residual value

MANITOBA CONTENT (CONT'D - 2)

f) Other Manitoba Content:

OTHER INPUTS	OWNER	TOTAL VALUE OF LEASE $

ALTERNATIVE METHODS, PROCEDURES, SCHEDULES, SEQUENCES OR ENVIRONMENTALLY PREFERABLE PRODUCTS/SERVICES

The following is a list of all of the Proponent's proposed alternative methods, procedures, schedules, sequences or environmentally preferable products/services that affect the Work:

EQUAL ARTICLES, MATERIALS OR EQUIPMENT

The following is a list of the equal articles, materials or equipment that the Proponent proposes to substitute for those specified:

Article, Material, or Equipment		Price Change $	
Specified	**Proposed**	**Increase**	**Decrease**

NOTE: Names of manufacturers of equals and catalogue numbers are stated, if applicable. All technical data and literature are appended to this proposal. No equal articles, materials, or equipment will be permitted unless listed above and approved by the Purchaser.

JOINT VENTURES

The extent and nature of Manitoba business participation in a joint venture is detailed below.

A Band Council Resolution authorizing the provision of the Form of Proposal on behalf of the First Nation Band is submitted with this proposal:

YES ☐ NO ☐

PROPONENT'S TECHNICAL AND NON-TECHNICAL CONTACT PERSONS

All enquiries concerning the technical aspects of this proposal should be directed to:

____
(please print name and title of Proponent's Representative)
whose telephone number is: (   )   -
FAX number is: (   )   -
Internet e-mail address is: @ .
and World Wide Web is: http://www. .

All enquiries concerning the non-technical aspects of this proposal should be directed to:

____
(please print name and title of Proponent's Representative)
whose telephone number is: (   )   -
FAX number is: (   )   -
Internet e-mail address is: @ .
and World Wide Web is: http://www. .

SIGNING PAGE

The words used in this Proposal have the meanings ascribed to them in RFP 040408.

We/I the undersigned, having examined all of RFP 040408 together with all addenda issued prior to the Closing Date, and having attended all mandatory meetings and mandatory site visits, hereby submit this proposal with all necessary enclosures.

The Proponent agrees that RFP 040408, and any proposal submitted in respect of same, is not a legal offer. By signing below, the Proponent certifies that the information submitted herein is true and correct as of the date set out below to the best of the Proponent's knowledge, and that the Proponent agrees to the terms and conditions set out in the RFP.

______________________________ [Insert legal name(s) of Proponent]

Per ______________________________ Name ______________________________
Authorized signing officer Print Name

I have authority to bind the Proponent

Dated __________________________ ________________________
Title

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES
500kV AC TRANSMISSION LINES
REQUEST FOR PROPOSAL 040314
ADDENDUM 1

In proposing on Manitoba Hydro Request for Proposal 040314 which will close on **January 17, 2016**, the Proponent shall comply with this addendum which shall form part of Request for Proposal 040314.

....

GENERAL REQUIREMENTS

Page 1, Section 1 SCOPE OF THE WORK

The following note shall be added immediately after ITEM 7:

> ITEM 7 – TYPE TESTING OF ALL ASSEMBLIES (ITEMS 1 – 6)
>
> ***NOTE - The Purchaser reserves the right to accept or reject the Proponents listed Type Testing Facilities. It's Manitoba Hydro's preference that the Contractor use Manitoba Hydro's High Voltage Laboratory for the electrical type tests.***

....

FORM OF PROPOSAL

Existing **pages 2 and 3** of the FORM OF PROPOSAL shall be discarded and substituted with the attached revised pages.

....

Greg Melnichuk
Manitoba Hydro
Purchasing Department
360 Portage Avenue
Winnipeg, Manitoba, R3C 0G8,
Canada.

December 20, 2016

NOTE:	Deletions are shown as ~~strikethrough text~~ and replacements/additions are shown as ***large bold italicized text***.

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES
500kV AC TRANSMISSION LINES
REQUEST FOR PROPOSAL 040314
ADDENDUM 2

In proposing on Manitoba Hydro Request for Proposal 040314 which will now close on **January 24, 2017**, the Proponent shall comply with this addendum which shall form part of Request for Proposal 040314.

....

INSTRUCTIONS TO PROPONENTS

Page 1, Section 1 INVITATION

The first paragraph shall be revised as follows:

> To be evaluated, a Proposal **must** be submitted not later than the Closing Date which is:
>
> 16:00:00 hours Manitoba local time
> ~~January 17, 2016~~ ***January 24, 2017*** (the "Closing Date")
>
> Proposals **must** be submitted electronically through MERX (www.merx.com) preferably in a .pdf electronic format, word searchable, with appropriate bookmarks and organization to allow for easy navigation.

....

Greg Lebans
Manitoba Hydro
Purchasing Department
360 Portage Avenue
Winnipeg, Manitoba, R3C 0G8,
Canada.

January 6, 2017

NOTE:	Deletions are shown as ~~strikethrough text~~ and replacements/additions are shown as ***large bold italicized text***.

Manitoba Hydro

REQUEST FOR PROPOSAL 040314

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES

500kV AC TRANSMISSION LINES

DECEMBER 16, 2016

MANITOBA HYDRO DISCLAIMER

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Manitoba Hydro works in the Acrobat X1 Standard, Excel 2003-2007 and Word 2003-2007 environments. The recipient may not be able to view or utilize the full software features of Manitoba Hydro's electronic files if the recipient has earlier versions of the aforementioned software.

NOTE: To open any supplied Word documents, your Macro Security level must be set to Medium.

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040314

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INSTRUCTIONS TO PROPONENTS (10 pages)

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GENERAL CONDITIONS (30 pages)

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Manitoba Hydro

DEFINITIONS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040314

DEFINITIONS

"Confidential Information" means any and all information, regardless of form, format or medium, of or concerning or related to the Purchaser, the Work, etc. depending on situation, customer information, and Personal Information, which has or shall come into the possession or knowledge of the Contractor.

"Contract" means the entire agreement entered into between the Purchaser and the Contractor upon execution of the Cover Agreement for performance of the Work by the Contractor in accordance with the Contract Documents.

"Contract Documents" means the Cover Agreement, Definitions, General Conditions, the General Requirements, Purchaser's Drawings, if any, the Technical Requirements, the Contract Forms listed in the Cover Agreement, all appendices and attachments to the foregoing documents, and amendments to any of them duly executed by both the Purchaser and the Contractor.

"Contractor" shall mean the party or parties named as such in the Contract and the legal personal representatives, successors and assigns of the Contractor.

"other contractor" or **"another contractor"** shall mean any person, firm or corporation employed by or having a contract directly or indirectly with the Purchaser otherwise than through the Contractor.

"DDP" shall mean "Delivered Duty Paid" per Incoterms 2010.

"Engineer" shall mean the engineer, engineers, or firm of consulting engineers, as the case may be, appointed in writing by the Purchaser to take charge of the Work, or a designated part (including the design) thereof, acting directly or through his or their properly authorized assistants or agents.

"Equipment" means all documents, designs, computer software, computer hardware, plant, materials, apparatus, tools, components, machinery, equipment, hardware, systems and other things required for the execution and completion of the Work and the remedying of any defects, or otherwise in respect of, and involving, Contractor's performance of obligations under the Contract.

"EXW" shall mean "Ex Works" per Incoterms 2010.

"Inspector" shall mean the person, firm or corporation authorized by the Purchaser to inspect the Work to be done and/or material to be furnished pursuant to the Contract acting directly or through his or their properly authorized assistants or agents.

"ID#" or "ITEM" shall mean a separate and designated part of the Work to be proposed, as defined in the Form of Proposal.

"Manitoba Business" is a business which is registered to do business in the Province of Manitoba, and the firm, or its principals, maintains their facilities, equipment and staff in Manitoba on a continuous basis.

"Personal Information" has the meaning given in The Freedom of Information and Protection of Privacy Act (Manitoba) and the Personal Information Protection and Electronic Documents Act (Canada).

"plant" shall mean all vehicles, transportation equipment, construction equipment, erection and installation equipment, falsework, forms, scaffolding, cofferdams, crushers, boilers, temporary storehouses and other temporary structures, lumber, timber, materials, power tools, machinery, appliances and apparatus which are brought on or constructed upon the site by the Contractor for the performance of the Work.

“Proponent” shall mean, as the context requires, any party or parties proposing on one or more of the various classes of work covered by the Instructions to Proponents, the General Requirements, the General Conditions, and the Technical Requirements.

“Purchaser” shall mean Manitoba Hydro, its successors and assigns.

“Site” shall mean the place or places where the Work is to be carried out for the Purchaser, and the immediate vicinity of such place or places.

“subcontractor” shall mean a person, firm or corporation having a contract with the Contractor for part of the Work, including without limitation the furnishing of labour, material, equipment or apparatus therefor.

“Superintendent” shall mean the duly appointed representative of the Contractor on duty at the site.

“tools” shall mean all small hand tools, other than power 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 or by any employee of the Contractor for the performance of the Work.

“Work” or “Services” shall mean all of the various classes of work to be done, executed and performed, whether temporary or permanent, and other equipment, apparatus, machinery and materials to be furnished and supplied by the Contractor pursuant to the Contract.

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.

END OF DEFINITIONS

INSTRUCTIONS TO PROPONENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040314

INSTRUCTIONS TO PROPONENTS

1 INVITATION

To be evaluated, a Proposal **must** be submitted not later than the Closing Date which is:

16:00:00 hours Manitoba local time
January 17, 2016 (the "Closing Date")

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

Proposals not submitted through MERX will not be accepted.

1.1 Delivery and Receipt of Submissions

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

(a) the timely delivery of any information or documentation, including, without limitation, the RFP by MERX, in connection with this RFP;
(b) the timely receipt of any proposals, revisions, amendments, notice of withdrawals, or any other information or documentation from any Proponent or potential Proponent, or;
(c) the working order, functioning or malfunctioning, of any electronic information system (including MERX).

2 PURPOSE

Issuing this RFP, Manitoba Hydro desires an experienced Contractor for the test, design, manufacture and supply of 500kV AC conductor hardware assemblies.

Proponents are encouraged to review the balance of the RFP for additional information concerning Manitoba Hydro's anticipated commercial and technical needs in respect of any potential Contract.

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

By submitting a proposal, the Proponent agrees to the terms and conditions set out in this RFP.

3 GENERAL INTERPRETATION

Defined words and phrases used in this Request for Proposal have the meanings ascribed to them in the Definitions section or as expressly defined elsewhere in this Request for Proposal. Headings are used for convenience only, and they shall not affect the interpretation or meaning of the clauses, terms and conditions or the Request for Proposal or any resulting Contract.

Proponents are requested to submit enquiries concerning this RFP addressed as follows:

4 ENQUIRIES

Enquiries concerning Request for Proposal 040314 including technical enquiries, should be in writing, using the Proposal Clarification Form, attached as Appendix A.

Enquiries should be submitted not less than **seven (7) calendar days** prior to the Closing Date. Enquiries received after that time may not be considered or answered.

Manitoba Hydro has the sole discretion to respond, or not, to an enquiry. Responses may be issued to the enquiring party only, or to any or all prospective Proponents.

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

5 PROPOSAL EVALUATION AND NEGOTIATION

5.1 General

Manitoba Hydro desires, through an evaluation and negotiation process, to determine if basis exists to award one (1) or more Contracts for performance of the Work described in this RFP.

Manitoba Hydro may select one (1) or more Proponent(s) for negotiation of a potential Contract.

Proposals submitted in respect to this RFP are for information and evaluation/negotiation/discussion purposes only.

5.2 Technical and Commercial Terms

The RFP describes the anticipated scope of work and anticipated technical and commercial needs of Manitoba Hydro. Manitoba Hydro is interested in receiving proposals that meet the technical and commercial needs outlined in this RFP.

With respect to technical needs, the Proponent may note in its proposal any technical exceptions which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative solution for addressing the matter in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

With respect to commercial needs, the Proponent may note in its proposal any commercial terms which it wishes to be addressed during any negotiations that may be conducted with respect to the Proponent's proposal. In such event, the Proponent shall provide its alternative wording for addressing the term(s) in question. Such alternatives may be taken into consideration when evaluating the Proponent's proposal.

5.3 Evaluation

Evaluation of proposals is expected to commence shortly after the Closing Date.

Manitoba Hydro reserves the right to complete or terminate evaluation of proposals at any time, or to extend the time of evaluation, without notifying Proponents.

Upon completion or termination of evaluation, Proponents may be notified that evaluation is complete.

5.4 Presentations

During evaluation of proposals, one (1) or more Proponents may be invited to attend at Manitoba Hydro's facilities in Winnipeg to make a presentation or participate in an interview concerning its proposal.

5.5 Amendments/ Further Information/Clarifications

During evaluation and negotiations, Manitoba Hydro reserves the right to request one (1) or more Proponents to:

(a) amend its proposal;
(b) provide additional, missing, and/or other information or documentation concerning its proposal; and
(c) clarify any matter(s) concerning its proposal.

In respect of any such matters, Manitoba Hydro shall have no duty or obligation to advise any other Proponent of any of the same, or to request them to vary their proposal as a result of any of the same.

5.6 Negotiation Process

Upon completion or termination of evaluation of proposals, Manitoba Hydro may select one (1) or more Proponents for negotiation of a Contract(s).

Manitoba Hydro will notify a Proponent if it has been selected for negotiations.

Manitoba Hydro reserves the right to terminate negotiations at any time.

Proponents are advised that Manitoba Hydro may conduct any negotiation through an intensive process. Such process may require a Proponent to make representative(s), who have sufficient decision-making authority, available for telephone, video-conference, and/or in person negotiating sessions.

5.7 Requirement for Contract

Until the execution of a Contract between Manitoba Hydro and a Proponent, there shall be no legal or other binding obligations created on the part of either party with respect to a Contract, the Work, or any matters related to the Work.

5.8 Manitoba Hydro Privilege/Discretion

Manitoba Hydro makes no representation or warranty that responding to this RFP will result in any negotiations or any Contract. Manitoba Hydro is under no obligation to evaluate any proposal, enter into any negotiations, or to award a Contract, with any Proponent or other person.

Manitoba Hydro reserves the right to cancel this RFP either before or after the Closing Date and regardless of whether or not any proposals have been received for any reason whatsoever.

Manitoba Hydro reserves the right to re-issue or tender all or any part of the work and services contemplated in this RFP at any time, including after the Closing Date, for any reason whatsoever.

Manitoba Hydro reserves the right to accept, waive or reject any non-compliance or irregularity, including without limitation, the right to accept, waive, or reject non-compliance or irregularity with respect to the requirements of the Instructions to Proponents and/or the submission requirements of this RFP.

Notwithstanding anything to the contrary in this RFP, Manitoba Hydro reserves the right to:

(a) negotiate any or all terms and conditions of a Contract with any one (1) or more Proponents, but not necessarily all Proponents, and to do so serially or concurrently and at any time;
(b) negotiate and enter into a Contract on terms and conditions different than those contained in the RFP and/or any Proposal;
(c) choose not to enter into negotiations with any one (1) or more Proponents;
(d) terminate negotiations with any one (1) or more Proponents at any time;
(e) choose not to award any Contract to any Proponent;
(f) terminate this procurement process at any time for any reason;
(g) choose to not offer the same or substantially the same or comparable terms and conditions of a proposed Contract to more than one (1) Proponent with which Manitoba Hydro may conduct negotiations; and
(h) enter into separate Contracts for different or identical portions of the Work, with any one (1) or more Proponents.

6 SCHEDULE OF RFP ACTIVITIES

The schedule of activities concerning this RFP includes the following:

Description	Date
Closing Date for submission of proposals	As per Section 1.1 of these INSTRUCTIONS TO PROPONENTS
Evaluation of Proposals complete	February 9, 2017
Negotiations with Selected Proponent	February 15, 2017
Award of Contract	February 28, 2017

Manitoba Hydro may change the said schedule and dates and information without notice (including without notice to any actual or potential Proponent(s)) at any time including before and after the Closing Date of this RFP.

7 ADDENDA

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

8 FORM OF PROPOSAL

The Proponent is requested to use the Form of Proposal attached hereto. If any Form of Proposal page is found to have insufficient space, the Proponent is requested to attach a sheet or sheets immediately after such page.

The Proponent is encouraged to include in their proposal thorough and sufficient information concerning matters under consideration.

9 SIGNING OF PROPOSALS

A proposal submitted by:

(a) an individual shall be signed by the individual in the presence of a subscribing witness;
(b) a corporation shall be signed by the properly authorized signing officer or officers and the corporate seal affixed or by the properly authorized signing officer or officers in the presence of a subscribing witness or witnesses; or,
(c) a partnership or joint venture shall be signed by all partners or joint venturers in the presence of a subscribing witness or witnesses.

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. Each signature shall be accompanied by a printed name.

10 JOINT VENTURES/CONSORTIA

Proponents which are comprised of more than one legal entity, such as a joint venture or consortium of corporations, are to identify their duly appointed leader in the proposal.

Proponents are to execute the 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.

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 Contract awarded.

A copy of a written agreement binding the legal entities involved in each proposal shall be provided to Manitoba Hydro upon request. If no such writing exists at the time of request, it may be necessary for such entities to document their arrangement to fulfill such requirement at any time, including after the time and date of closing for receipt of proposals and before or after an award of a Contract.

Where a Proponent is or includes a First Nation Band, the proposal shall be accompanied by a Band Council Resolution authorizing the provision of the proposal on behalf of the First Nation Band.

11 AMENDMENT OF PROPOSAL

A Proponent may amend its submitted Proposal on MERX at any time prior to the Closing Date. A Proponent may not amend its Proposal after the Closing Date except at the written request of Manitoba Hydro.

In order to advance toward a formal and binding contract during negotiations, Manitoba Hydro may issue a written request to the Preferred Proponent(s) for specific amendment(s) to its Proposal, and if the Proponent finds the request satisfactory, shall provide the requested amendment(s) via fax or letter.

All amendments must be signed by the person or persons having the authority to bind the Proponent.

Manitoba Hydro shall consider each Proponent's Proposal to be the Proponent's best position for entering into negotiations and for seeking award of a contract to perform the Work.

12 WITHDRAWAL OF PROPOSAL

At any time throughout the procurement process prior to execution of a contract, a Proponent may revoke and withdraw a submitted Proposal by either removing the Proposal from MERX, if withdrawal is prior to the Closing Date, or by providing written notice to Manitoba Hydro via FAX or letter, if withdrawal is after the Closing Date.

Written notice of withdrawal of a Proposal must be duly signed by the authorized representative of the Proponent.

Manitoba Hydro is under no obligation to return withdrawn Proposals.

13 LANGUAGE

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

14 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 a proposal, satisfactory to Manitoba Hydro, that the Proponent has the ability, experience, capital and plant required to undertake and perform the Work successfully, and complete it within the time specified.

Manitoba Hydro may inspect any Plant and /or facilities that the Proponent proposes to use for doing the Work.

15 ESTIMATED QUANTITIES

Any quantities stated in the Request for Proposal or Form of Proposal are estimates only. Manitoba Hydro makes no guarantee with respect to any of same.

16 UNBALANCED PROPOSALS

Unbalanced unit prices or lump sum prices proposed may not be considered by Manitoba Hydro.

17 PROPONENT'S EXPENSES

The Proponent shall be responsible for all expenses concerning or related to the preparation of its proposal, including any subsequent discussions and/or negotiations.

18 PROPOSED PRICES

Proposed prices shall be stated in Canadian currency and shall include all customs duties, surcharges, insurance premiums, permit and licence fees, Workers Compensation and vacation pay assessments, and all other payroll benefits.

Canadian Goods and Services Tax (GST) and Manitoba provincial retail sales tax (PST) shall be treated as specified in the Form of Proposal for each ITEM. All other applicable taxes shall be included and shall not be subject to any adjustment. No payment shall be made to the Contractor for sales tax (if any) which may be imposed by Canada or Manitoba in respect of the Contractor's plant, tools and any other items not included in the Work.

Prices in the accepted proposal, if any, shall be firm and not subject to adjustment for changes or unexpected contingencies of any kind whatsoever, including without restricting the generality of the foregoing, changes in wages, material costs, or taxes which may in future be imposed by lawful authority within or outside of Canada.

19 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 Business.

20 CORRUPT OR FRAUDULENT PRACTICES

Manitoba Hydro has the right at any time to reject any Proposal submitted by a Proponent or terminate negotiations with a Proponent if, in Manitoba Hydro's determination, the Proponent has engaged in any Corrupt, Fraudulent, Collusive, Coercive or Obstructive Practice or has breached any laws regarding corruption or fraud. For these purposes the following defined terms shall apply:

(a) **"Coercive Practice"** means impairing or harming, or threatening to impair or harm, directly or indirectly, persons or their property to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(b) **"Collusive Practice"** means an arrangement between two or more persons (including, without limitation, a Proponent and any other person) designed to achieve an improper purpose, including but not limited to the establishment of prices for the Work at artificial, non-competitive levels in the procurement process or in entering of the Contract.

(c) **"Corrupt Practice"** means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of Manitoba Hydro, a Proponent, or any other person, in the procurement process, or in the negotiation and signing of the Contract.

(d) **"Fraudulent Practice"** means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, Manitoba Hydro, a Proponent, or any other person, to obtain a financial or other benefit or to avoid an obligation in the procurement process, or in the negotiation and signing of the Contract.

21 EVALUATION CRITERIA

In order to determine best value to Manitoba Hydro, proposals received will be evaluated using the following criteria (in no particular order of preference):

(a) Total evaluated cost (includes unit prices, packaging costs, transportation costs, Purchaser's inspection costs, and type testing)
(b) Technical compliance of the proposal (absence of deviations from the Technical Requirements of this RFP)
(c) Commercial compliance (absence of deviations from the commercial terms and conditions of this RFP)
(d) Delivery Dates (includes production schedule and plant capacity)

All things being reasonably equal, the following additional criteria will be considered in the evaluation:

(e) Manitoba content

For the purposes of evaluation, Manitoba Hydro may take into account any or all of the information received from a Proponent under or pursuant to the RFP, Manitoba Hydro's knowledge of, and past experience with, the Proponent (including Proponent's performance on previous contracts with Manitoba Hydro, if any), and any information about the Proponent received from third parties and deemed reliable by Manitoba Hydro.

22 WAIVER

By submitting a proposal, the Proponent acknowledges Manitoba Hydro's rights under Request for Proposal 040314 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.

END OF INSTRUCTIONS TO PROPONENTS

GENERAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040314

GENERAL REQUIREMENTS

1 SCOPE OF THE WORK

The Work shall consist in all that is required for the design, test, manufacture and supply of 500kV AC conductor hardware assemblies which includes suspension, dead-end and jumper string assemblies, consisting of but not limited to, the following ITEMS:

ITEM 1 - DEADEND STRING HARDWARE ASSEMBLY

ITEM 2 - 177 KN I-STRING HARDWARE ASSEMBLY

ITEM 3 - 177 KN V-STRING HARDWARE ASSEMBLY

ITEM 4 - 243 KN I-STRING HARDWARE ASSEMBLY

ITEM 5 - 243 KN V-STRING HARDWARE ASSEMBLY

ITEM 6 - JUMPER STRING HARDWARE ASSEMBLY

ITEM 7 – TYPE TESTING OF ALL ASSEMBLIES (ITEMS 1 – 6)

Descriptions of ITEMS of the Work listed above are provided as a general overview. A detailed scope and requirements of the Work are provided in the Technical Requirements. The Work and any ITEM forming part of the Work shall also, in all respects, comply with the terms and conditions of the Contract.

2 ESTIMATED REQUIREMENTS

The table provided in Appendix B states the estimated requirements by tower type.

3 WORK SCHEDULE

The Purchaser expects that all ITEMS of the Work will be delivered by December 30, 2017.

In carrying out the Work, the Contractor shall have reasonable latitude to organize the sequence of the Work, provided that the various stages of the Work are completed by the specified date(s) or the date(s) proposed by the Contractor and accepted by the Purchaser.

4 DELIVERY POINT

If the Purchaser chooses delivery by the Contractor, the ITEMS of the Work shall be delivered to:

Gate 6
59029 Hwy 207
Dugald, Manitoba

5 DELIVERY OR LOADING OF THE WORK

5.1 Delivery of the Work

If the Purchaser chooses delivery of the Work by the Contractor, the Contractor shall prepare the Work for shipment in such a manner as to protect the Work from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation, loading, shipping, transporting, unloading, handling, or lifting. The Contractor shall be responsible for verifying the carrier’s right-of-way clearances and weight limitations, if any, and for making all shipping arrangements.

5.2 Loading of the Work

If the Purchaser chooses to have the Work loaded, blocked, braced and secured by the Contractor at the Contractor’s shipping facility or factory for transportation by the Purchaser or the Purchaser’s designated carrier to the final destination, the Contractor shall prepare the Work for shipment in such a manner as to protect it from damage in transit and shall be liable for all losses, costs, damages and expenses which the Purchaser may suffer or be put to caused by or resulting from improper or inadequate preparation and loading.

6 DESIGN REQUIREMENTS DRAWINGS

The drawings which accompany Request for Proposal 040314 form part of the Contract.

During the course of the Work, additional drawings may be issued by the Purchaser, if and as required to supplement or further set forth the details shown on the above drawings, and such additional drawings shall thereupon become part of the Contract.

When required dimensions or details do not appear on the Purchaser's drawings, the Contractor shall obtain such information from the Purchaser before proceeding with the Work.

7 CONTRACTOR'S DRAWINGS

7.1 Contractor's Drawings Submission

Within 8 weeks after the effective date of the Contract, and before commencing manufacture, the Contractor shall submit drawings for the Purchaser's approval. Three (3) paper copies and an AutoCAD electronic drawing file in 2016 or earlier version shall be submitted for each drawing.

All drawings submitted for approval shall be dated and marked "Preliminary" until such time as final approval has been obtained from the Purchaser.

The Purchaser will reject drawings of unsuitable standards and these drawings shall be redrawn by the Contractor within the specified schedule.

All drawings shall be set up in the Manitoba Hydro drawing borders format with the title blocks provided and shall be validated prior to submission. Final drawings shall be eSealed by a Professional Engineer registered in Manitoba in PDF/A format along with a computer generated AutoCAD .dwg version of the drawing.

7.2 Purchaser's Checking and Approval of the Contractor's Drawings

The Contractor shall allow a total of 25 working days, from receipt of the drawings, for review and commenting of drawings without affecting the delivery schedule. The first 10 out of 25 working days are for the Purchaser's initial review and the remaining 15 working days are for the subsequent review if required. Should a further review be required, the Contractor shall ensure that the delivery schedule is not affected.

After checking, the Purchaser will return to the Contractor one paper print marked with the Purchaser's comments and stamped "Approved", "Approved, Subject to Changes Noted" or "Not Approved", upon receipt of which the Contractor shall modify each drawing as required and resubmit in both of the media specified above within 5 working days.

Fabrication and testing shall not commence until the Contractor's drawings have been approved by the Purchaser, and thereafter, no change shall be made on any drawing so approved without the written permission of the Purchaser. Upon authorization of subsequent revisions, the Contractor shall resubmit any change, clearly shown on each drawing in both of the specified media, to the Purchaser for re approval.

Approval by the Purchaser of the Contractor's drawings shall not relieve the Contractor from liability for correctness thereof, nor from any loss, costs, damage or expense which may result from error in, or omission from, such drawings.

The Contractor shall supply to the Purchaser three (3) first generation paper copies and an AutoCAD electronic file in 2016 or earlier version after approval of each drawing. The paper copies must be capable of reproducing excellent microfilm images.

The Contractor shall ensure that the final approved drawings furnished to the Purchaser show the shipped condition of the equipment or structure. Any changes to be made on site shall be clearly marked thereon.

7.3 Minimum Drawing Standards for Contractor's Drawings

Minimum drawing standards for Contractor's drawings shall be in accordance with the "MINIMUM STANDARDS FOR DRAWINGS PRODUCED AND SUBMITTED BY FABRICATORS, MANUFACTURERS AND CONSTRUCTION COMPANIES" included as Appendix C along with "Transmission and Civil Design Department AutoCAD Drawing Standards" included as Appendix D.

An area 120 mm wide by 70 mm high located immediately above the title block shall be left blank for the Purchaser's use. The Purchaser will use this space to add the Purchaser's drawing registration number and approval stamp.

8 FOREIGN NATIONALS WORKING IN CANADA

The following provisions apply to all workers employed by the Contractor or under the Contractor's control or for whom the Contractor is otherwise responsible under the Contract, who are NOT citizens of Canada or 'permanent residents' of Canada (as defined in the Immigration and Refugee Protection Act).

Such persons are defined, collectively, in the Immigration and Refugee Protection Act as 'foreign nationals', which term is used below and has the same meaning.

The Contractor shall ensure that all workers who are foreign nationals and who perform services under the Contract in Canada are legally authorized to work in Canada. The Contractor shall obtain and maintain all necessary work permits, visas and documentation for such foreign nationals, and shall comply with all conditions imposed on the Contractor, as 'employer' of the foreign nationals, under the Immigration and Refugee Protection Act and regulations.

Before permitting any foreign nationals to perform services under the Contract in Canada, the Contractor shall, by notice in writing to the Engineer:

(a) list all such foreign nationals by name;

(b) certify that the said foreign nationals are legally authorized to perform services under the Contract in Canada; and

(c) provide copies of their respective work permits, and visas or other documentation if applicable.

Furthermore, the Contractor shall provide copies of work permit or visa renewals to the Engineer if applicable, so that at no time is any foreign national performing services under the Contract in Canada without the requisite legal authority.

9 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, R.S.M. 1987, c. W200.

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 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.

10 COMPLIANCE WITH STANDARDS

All materials, equipment and articles furnished by the Contractor shall comply with the applicable provisions of the standards of the Canadian Standards Association (CSA) or of the Canadian General Standards Board (CGSB) and where no such standards exist, materials, equipment and articles shall comply with the applicable provisions of the standard specifications of the American Society for Testing and Materials (ASTM).

END OF GENERAL REQUIREMENTS

GENERAL CONDITIONS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040314

GENERAL CONDITIONS

1 INTENT

1.1 The Work

The Contractor shall fully and completely fulfill its obligations in respect of the Contract, and shall fully and completely perform the Work in every detail and within the timeframe(s) required, all in accordance with the Contract. The Contractor shall do or cause to be done and shall furnish any and everything necessary for such purposes all in accordance with the Contract.

The Contractor shall carry out the production, manufacture of all goods, products, materials and the Work, and the performance and execution of the Work:

(a) in accordance with the Contract;
(b) in the manner (if any) specified in the Contract;
(c) in a good and workmanlike manner;
(d) using new materials that are free of defects and are of the specified quality, if specified, otherwise of suitable quality as determined by the Engineer; and
(e) with properly equipped facilities and non-hazardous materials, except as otherwise specified in the Contract.

1.2 Application to Engineer

The Contractor shall apply to the Engineer for any explanation which the Contractor may require as to the meaning and intent of any provision in the Contract or in any document forming part thereof, and the Contractor shall be liable for any loss, damage or expense which the Purchaser may incur, suffer or be put to as a result of the Contractor's failure to obtain such explanation.

1.3 Interpretation

Defined words and phrases used in the Contract have the meanings ascribed to them in the Definitions forming a part of this Request for Proposal, or as expressly defined elsewhere in the Contract. Headings are used for convenience only and do not affect the interpretation or meaning of the Contract.

2 CORRUPTION AND FRAUD

The Contractor declares and undertakes in relation to the Contract that it:

(a) has not acted and will not act unfairly or dishonestly so as to cause loss to the Purchaser or deprive the Purchaser of its rights;
(b) has not offered, given, demanded or accepted any bribe or other improper benefit or advantage to any person and will not do so;
(c) has not provided false, inaccurate or misleading information to any person and will not do so;
(d) has not authorized, acquiesced or turned a blind eye to any form of corruption and will not do so;
(e) did not collaborate, directly or indirectly, with any person in competition for this or other contracts with the Purchaser during the procurement process;
(f) will not, in respect of any design services to be provided under the Contract, deliberately, knowingly, with willful blindness or recklessness, provide or approve a design which will provide an improper benefit or advantage to any person or which is in excess of the Purchaser's requirements and has not been fully disclosed and approved by the Purchaser;
(g) will not deliberately, knowingly or with willful blindness or recklessness, carry out, instruct, authorize, condone or be a party to provision of work, materials, equipment or services not of a quality and quantity required under the Contract; or
(h) will not conceal defective work, material, equipment or services.

3 AUTHORITY OF THE ENGINEER

3.1 No Authority to Amend Contract

The Engineer has no authority to amend the Contract.

3.2 Exercise of Authority

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:

(a) whenever carrying out duties or exercising authority, express 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.

3.3 Replacement

The Purchaser may, with notice to the Contractor, replace the Engineer.

3.4 Giving Effect

The Contractor and the Purchaser shall give effect to each determination of the Engineer unless and until revised pursuant to the ARBITRATION Section of the General Conditions.

4 CLARIFICATIONS AND CHANGES TO THE WORK

4.1 General

There will be four (4) mechanisms for clarifying 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	Contractor / Engineer	Clarification to the Work
Extra Work Order (EWO)	Purchaser	Approves change to the Work, related to the Contract Scope
Amending Agreement	Purchaser	Approves change to the Work, not related to the Contract Scope or Amends Terms of the Contract

Each of these mechanisms are described in this Section of the General Conditions.

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 or an Extra Work 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.

4.2 Clarifications to the Work

4.2.1 Work Instructions

Work Instructions are instructions and clarifications issued by the Engineer using the Work Instruction form set out in Appendix E: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 may be issued in response to a Request for Information from the Contractor or may be issued at the initiative of the Purchaser or Engineer.

Work Instructions are enforceable clarifications or refinements of the Contract, not amendments thereto.

Upon receipt of a Work Instruction, the Contractor shall promptly proceed with the Work as clarified therein.

The Contractor is not entitled to additional compensation or to changes in the time for performance of the Work as a result of the issuance of a Work Instruction.

4.2.2 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 E: Manitoba Hydro Forms for Clarification and Changes to the Work. 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 28 days, the recipient will notify the requestor in writing.

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 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 28 days or notify the requestor of a required extension to the response period.

4.3 Changes to the Work

The Purchaser shall have the right, without notice to sureties on any bond, and without invalidating the Contract, 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, including additions, deductions, alterations and extras.

Such changes must in all cases be in writing signed by the Purchaser titled "Extra Work Order" and issued by the Engineer to the Contractor.

Upon receipt of a written Extra Work Order from the Engineer, the Contractor shall promptly proceed with the changes in the Work.

Adjustments to the Contract Price as a result of the changes directed by the Engineer in an Extra Work Order shall be determined in accordance with the PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK Section of these General Conditions.

4.3.1 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 E: Manitoba Hydro Forms for Clarification and Changes to the Work.

When initiated by the Engineer, the Proposal for Extra Work is a formal request for quotation for additional work required. The Contractor's responding quotation 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. The quoted price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

When initiated by the Contractor, the Proposal for Extra Work is a formal proposal for an alternate to the Work. The proposed price set out in such Proposal for Extra Work shall include the detail described in the Additions to the Work or Claims Subsection of these General Conditions.

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 14 days, the requesting party shall be notified in writing.

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 14 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 quotation, 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. The Proposal for Extra Work may be accepted by the Purchaser providing written notice to the Contractor in the form of an Extra Work Order issued by the Engineer.

When the Contractor initiates a Proposal for Extra Work, the proposal shall be valid for a period of 14 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 issued by the Engineer.

4.3.2 Extra Work Orders

Extra Work Orders are formal approval of changes to the Work by the Purchaser where the change is related to or within the original Contract scope of the Work. The Purchaser through the Engineer may issue a written Extra Work Order using the Extra Work Order set out in Appendix E: Manitoba Hydro Forms for Clarification and Changes to the Work.

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 the Proposal for Extra Work Subsection of these General Conditions or the preceding sentence, if the Purchaser requires the Contractor to proceed with a change in the Work 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.

4.4 Contract Amendments

No amendment to any other terms or conditions of the Contract, other than those recognized to be made by Extra Work Order as provided in the Contract, shall be made unless first approved and authorized in writing by both the Purchaser and the Contractor. Such amendments shall be documented in an amending agreement signed by both parties.

5 PRICING AND PAYMENT METHODS FOR CHANGES TO THE WORK

The method for pricing and payment of all adjustments to the Contract Price due to changes to the Work by virtue of Extra Work Order pursuant to the CLARIFICATION AND CHANGES TO THE WORK Section of these General Conditions or pursuant to the CONTRACTOR CLAIMS Section of these General Conditions (hereinafter “Claims”), shall be as follows unless otherwise agreed to between the Purchaser and the Contractor.

5.1 Additions to the Work or Claims

5.1.1 Lump Sum

Where the Engineer has directed that an addition to the Work or Claim be dealt with by lump sum, the Contractor shall prepare and submit to the Engineer a detailed quoted lump sum cost of the requested addition or Claim. The quote shall not include any mark-up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The quoted lump sum cost shall include the following details as a minimum:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing cost
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

In respect of travel, airfare shall be limited to economy class, receipts shall be required.

(the “Quoted Cost”).

The Quoted Cost shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Quoted Cost was not accepted. Within the next 5 days, the Contractor will be entitled to submit a revised Quoted Cost.

Following such five (5) day period, the Engineer may either:

i) accept the latest Quoted Cost of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,

ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Quoted Cost of the addition or Claim as documented by issuance of an Extra Work Order;

5.2 Deductions from the Work

5.2.1 Credit for Deduction from the Work

Where a deduction from the Work is proposed by the Purchaser through issuance by the Engineer of a Proposal for Extra Work to the Contractor setting out such deduction, the Contractor shall prepare and submit to the Engineer a detailed quoted credit for the requested deduction. The quoted credit shall represent the cost to the Contractor to perform the Work to be deducted and shall not include any mark up for overhead, profit, research and development or any other mark up that is not a direct cost to the Contractor. The Contractor shall submit a detailed breakdown of the proposed credit and at a minimum include the following:

(a) Engineering hours and rates
(b) Drafting hours and rates
(c) Project management hours and rates
(d) Material quantity and cost by type
(e) Manufacturing and processing hours and rates for specific processes
(f) Delivery cost
(g) Travel, meals, and accommodations
(h) Site labour by trade
(i) Equipment, Tools, and plant

(the "Deduction Credit")

The Deduction Credit shall be reviewed and either approved by the Engineer or returned to the Contractor with an explanation as to why the Deduction Credit was not accepted. Within the next five (5) days, the Contractor will be entitled to submit a revised Deduction Credit.

Following such 5 day period, the Engineer may either:

i) accept the latest Deduction Credit of the Contractor within 14 days of its receipt as documented by issuance of an Extra Work Order; or,

ii) advise the Contractor as to the Engineer's determination, acting reasonably, of the Deduction Credit as documented by issuance of an Extra Work Order.

6 CONTRACTOR CLAIMS

6.1 Notice of Intent to Claim

If the Contractor determines it is entitled to additional costs to perform the Work 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 E: Manitoba Hydro Forms for Clarification and Changes to the Work 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 Contract Price or to any adjustment to the Contract Schedule, and the Purchaser shall be discharged from all liability in connection with the claim.

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.

6.2 Claim Documentation

Within 21 days after the Contractor has given written Notice of Intent to Claim in accordance with the Notice of Intent to Claim Section of these General Conditions, 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;
(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 request.

All subsequent communications with the Engineer respecting a claim or potential 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 of the General Conditions, each party shall take reasonable steps to mitigate its losses.

6.3 Determination of Claim

The Engineer shall proceed in accordance with this Section of the General Conditions to determine:

i) the extension (if any) of the time for completion of the Work in accordance with the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of these General Conditions; and,

ii) the adjustment (if any) to the Contract Price to which the Contractor is entitled to pursuant to the Contract.

Whenever a provision of the Contract provides that the Engineer shall proceed in accordance with this Subsection 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 Subsection, 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 a fair 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 extension of time or an adjustment to the Contract Price, or both, are warranted in the opinion of the Engineer, the Engineer shall document such changes in an Extra Work Order. 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 the ARBITRATION Section of these General Conditions.

For any claims made in accordance with this Section 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 the ARBITRATION Section of the General Conditions.

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 this Section of these General Conditions.

The Contractor shall not delay or hold up performance of the Work during resolution of a claim pursuant to this Section or originating pursuant to the REQUESTS FOR EXTENSION OF TIME Section or the PURCHASER CAUSED DELAY Section of the General Conditions or during referral of any such claim to arbitration as permitted above.

7 REQUESTS FOR EXTENSIONS OF TIME

The Contractor shall be entitled, subject to the CONTRACTOR CLAIMS Section of the General Conditions, to an extension of time for completion of the Work if completion of the whole of the Work is or will be delayed by any of the following causes:

(a) legal strikes or walkouts;
(b) any peril insured against pursuant to the INSURANCE Section of the General Conditions;
(c) unpreventable accident;
(d) terrorism, war or delay caused by war;
(e) vandalism or malicious mischief not reasonably preventable by the Contractor;
(f) riot or civil commotion;
(g) acts of God;
(h) lawful orders of civil or military authorities; or
(i) a cause of delay giving an entitlement to extension of time 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 Subsection 9.1 Notice of Intent to Claim of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c), (d), (e), (f), (g), (h), and (i) above resulted in a delay to the completion of the Work; and,

ii) 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.

Other than as stated in this section and the PURCHASER CAUSED DELAY Section of the General Conditions, 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.

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.

8 PURCHASER CAUSED DELAY

If the Contractor suffers delay and/or incurs additional costs in relation to the Work as a result of:

(a) an Extra Work Order issued by the Engineer without the agreement or in absence of the agreement of the Contractor;
(b) negligence or default on the part of the Purchaser;
(c) negligence or default on the part of another contractor for whom the Purchaser is responsible; or
(d) deviation from the Contract or temporary suspension of the Work by direction of the Engineer;

then the Contractor shall give notice to the Engineer in accordance with the Notice of Intent to Claim Subsection of the General Conditions.

After receiving this notice, the Engineer shall proceed in accordance with the Determination of Claim Subsection of the General Conditions to determine:

i) whether, and (if so) to what extent the factors described in (a), (b), (c) and (d), 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;
ii) 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,
iii) the resulting adjustment, if any, to the Contract Price for the substantiated amount of resulting additional costs to the Contractor.

9 SCHEDULE OF THE WORK

The Contractor shall submit to the Engineer within 20 working days of the effective date of the Contract, a time chart or schedule containing all or such part of the following information as the Engineer requires:

(a) the scheduled date of completion of design and submission of working drawings to the Engineer for approval;
(b) the scheduled date of start and completion of type test
(c) the scheduled date of completion of all orders for material required for the Work;
(d) the scheduled date of completion of manufacture, fabrication and/or assembly of the Work;
(e) the scheduled date of completion of delivery of the Work (and where applicable, unit sections thereof) to the site; and
(f) such other information as is requested in writing by the Engineer.

The Contractor shall also submit reports on the progress of the Work to the Engineer containing such detailed information as the Engineer from time to time requires on the design, material, manufacture, fabrication, assembly, shipment and delivery of the Work. The Contractor shall grant authorized representatives of the Purchaser and Inspector access to the Contractor's factory and to the factory or factories of all subcontractors, during the Contractor's or subcontractor's normal business hours, to enable such representatives to ascertain the state of the Work and the progress being made thereon by the Contractor or subcontractor.

10 PURCHASER'S DRAWINGS AND SPECIFICATIONS

10.1 Drawings

The Work shall be executed in strict conformity with the Purchaser's drawings and specifications and the Contractor shall do no work without proper drawings, specifications and instructions. The Purchaser shall furnish the Contractor free of charge with copies of all Purchaser's drawings and specifications reasonably necessary to carry out the Work.

The Purchaser's drawings and specifications are intended to complement each other, so that if anything is shown on the drawings but not mentioned in the specifications, 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 specifications, or if any feature of the figures, drawings or specifications shall appear to the Contractor to be indefinite or unclear, the same shall be referred to the Engineer as soon as possible whose written confirmation, correction or explanation shall be obtained before proceeding with the Work. If the drawings conflict with specifications in any particular, the Contractor shall apply to the Engineer for an explanation. Purchaser shall respond to the request in 10 working days

Approval of the Contractor's drawings by the Engineer shall not release the Contractor from liability for errors or omissions thereon nor from any loss, cost, damage or expense which may result from any such error or omission or from entire responsibility for the complete and accurate performance of the Work in accordance with the Purchaser's drawings and specifications, neither shall such approval release the Contractor from any liability placed upon it by the Contract.

10.2 Drawing Errors

If the Contractor suffers delay and/or incurs additional costs as a result of failure by the Engineer to issue a revised drawing or other remedial action, direction, or instruction with respect to an error in Purchaser's drawings, the Contractor shall give notice to the Engineer and shall be entitled subject to the CONTRACTOR CLAIMS Section of the General Conditions to:

(a) an extension of time for any such delay, if completion is or will be delayed, under the REQUEST FOR EXTENSION OF TIME Section of the General Conditions, and

(b) an adjustment to the Contract price for the substantiated amount of resulting additional costs.

After receiving this notice, the Engineer shall proceed in accordance with the ENGINEER DETERMINATIONS subsection of the CONTRACTOR CLAIMS Section of the General Conditions to agree or determine (i) the existence of such error; and (ii) the matters described in sub-paragraphs (a) and (b) above related to this extent.

11 LANGUAGE, DIMENSIONS AND WEIGHTS

All communication, including without limitation all notices, documents, notes on drawings, and submissions, required or permitted under the Contract, shall be in English.

Any Work shall be executed in the SI (Metric) System of Units except for bolts and nuts. Dimensions shall be shown in metres and millimetres and weights shall be shown in kilograms and metric tonnes.

12 SUBCONTRACTS

The Contractor shall not, without the prior approval in writing of the Purchaser, assign the Contract, nor make a subcontract with any person, firm or corporation for the execution of any portion of the Work, other than for materials or for any part of the Work for which the manufacturer or supplier is named in the Contract. If the Contractor wishes to sublet any part of the Work, the Contractor shall first submit to the Purchaser for approval, a description of the part of the Work which the Contractor wishes to sublet and the name or names of the subcontractor or subcontractors it wishes to employ. Any approval given by the Purchaser as provided for in the immediate preceding sentence shall not relieve the Contractor from any obligation or liability for the full and complete performance of the Work, all in accordance with the Contract.

If the Purchaser gives its approval thereto in writing, and the Contractor enters into one or more subcontracts, 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.

All work done by a subcontractor shall, for the purposes of the Contract, be deemed to be done by the Contractor and payment therefore 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 therefore. 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.

If the Purchaser so requests, the Contractor shall furnish the Purchaser with duplicate copies of all orders placed by the Contractor with subcontractors.

13 COOPERATION BETWEEN CONTRACTORS

The Contractor shall cooperate with all other contractors who may be performing Work on behalf of the Purchaser, and with the workers who may be employed by the Purchaser on any work at/in the vicinity of the Site. 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 materials and equipment of the Purchaser or of other contractors.

14 INSURANCE

The Contractor shall provide, maintain and pay for the insurance coverage listed below. The Contractor shall supply the Purchaser with a certified copy of the required policy of insurance and all renewals thereof. A Certificate of Insurance may be submitted in place of the policy provided that all terms and conditions of required coverage are specified therein. All documentation must be submitted to the Purchaser prior to the commencement of the Work or delivery of goods or services.

The policy shall be endorsed to provide the Purchaser with not less than 30 days' written notice in advance of cancellation, change or amendment restricting coverage, and to show the Purchaser as an Additional Insured.

The Contractor shall be responsible for any deductible amounts under the policy except where such amounts may be excluded from the Contractor's responsibility. Should a loss be sustained, the Contractor shall act on behalf of both the Purchaser and the Contractor for the purpose of adjusting the amount of loss with the insurance companies.

14.1 General Liability Insurance

General Liability Insurance, shall provide limits of not less than $2 000 000 (CAD) inclusive, per occurrence, for bodily injury, death, and damage to property including loss of use thereof.

The General Liability Insurance shall include insurance coverage for the following:

(a) Premises Property and Operations
(b) Products and Completed Operations
(c) Blanket Contractual Liability
(d) Cross Liability
(e) Non-owned Automobile Liability
(f) Occurrence Property Damage
(g) The Purchaser named as Additional Insured

15 IMPORTS

The Contractor shall be the importer of all non-Canadian goods and services.

16 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 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.

17 MATERIALS AND LABOUR

Unless otherwise specified in the contract, the Contractor shall furnish all material and shall perform all labour necessary for the due and proper design, manufacture, fabrication, completion and delivery of the Work.

All work done and materials supplied pursuant to the contract shall be of specified quality, if specified, otherwise of suitable quality as determined by the Engineer.

18 INVOICES

The invoices to be submitted by the Contractor shall be satisfactory to the Purchaser in both form and content. The Contractor shall also provide supporting documents and receipts if requested by the Purchaser.

19 RECORDS

The Contractor shall:

(a) keep full and detailed records, books, accounts, correspondence, instructions, drawings, receipts, vouchers, memoranda, and records of labour force, plant, tools, equipment, hours worked, rates required to properly appraise the progress of the Work, (herein “records”), necessary for the proper administration of the Contract and the Work.

(b) provide the Engineer and/or the Purchaser with copies of any records when requested, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(c) provide the Engineer and/or the Purchaser with reasonable access to any premises and to inspect and/or audit records, and permit copies to be made of same, provided such rights of review shall not extend to the audit of profits, expenses or costs associated with sums payable on a lump sum basis under the Contract or the compositions of such lump sum amounts.

(d) preserve records for a period of not less than three (3) years from the date of the Completion Certificate.

20 CONFLICTS

For the entire duration of the Contract, the Contractor and its agents shall not provide equipment or services to any other person(s) in a manner which conflicts with the Contract.

21 CONFIDENTIALITY

The Contractor shall keep the Confidential Information confidential, using no less a standard than measures the Contractor uses to keep its own highly confidential information secret, but in any event not less than a reasonable standard of care.

Confidential Information may only be used by the Contractor for providing Services to the Purchaser and for no other purpose whatsoever.

The Contractor shall not, without the prior written consent of the Purchaser, disclose or otherwise make available any Confidential Information to any other Person, except to such directors, officers, and employees of the Contractor who have a need to access Confidential Information to perform their obligations to the Contractor for Hydro. The Contractor shall be responsible for any breach of the terms of this Section by it or any such Person.

The Contractor shall deliver Confidential Information to the Purchaser immediately on demand from the Purchaser and, on demand from Hydro, certify in writing to Hydro within ten (10) days of such demand that Confidential Information has been erased or destroyed.

The Contractor acknowledges that any failure to comply with the provisions of this Section hereof, shall cause irreparable harm to Hydro which cannot be adequately compensated for in damages, and accordingly acknowledges that Hydro shall be entitled, in addition to any other remedies available to it, interlocutory and permanent injunction relief to restrain any anticipated, present, or continuing breach of this Contract.

The Contractor's obligations pursuant to this Section hereof shall continue without limitation of time.

The Contractor shall

(a) have in place and utilize systems, media, policies, and procedures, for the storage of, security for, access to, handling of, transfer of, and destruction of, Personal Information that would satisfy the requirements of: (i) The Freedom of Information and Protection of Privacy Act (Manitoba) as if that Act applies to Contractor; and (ii) the <u>Personal Information Protection and Electronic Documents Act</u> (Canada) requirements for protection of Personal Information; and conform to ISO 27000;

(b) secure Personal Information against unauthorized and accidental access, disclosure or attack.

22 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 the type/sample/routine 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, at the Contractor's expense, 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 the USE OF FAULTY OR DEFECTIVE WORK Section of the General Conditions.

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. The Contractor shall be liable for all 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 invoice therefore certified correct by the Purchaser. The Purchaser may, at the Purchaser's option, apply moneys due or to become due from the Purchaser to the Contractor in or towards payment of such costs, charges and expenses, in which event the Contractor shall remain liable for any deficiency.

23 USE OF FAULTY OR DEFECTIVE WORK

Until all faulty or defective work has been made good or altered as provided by the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions, the Purchaser shall have the right to use any such faulty or defective work at the Contractor's sole risk, and without thereby in any way affecting the Purchaser's rights under the FAULTY OR DEFECTIVE WORK and USE OF FAULTY OR DEFECTIVE WORK Sections of the General Conditions 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.

24 CONTRACTOR'S LIABILITY

24.1 The Work

Unless otherwise specifically provided in the Contract, the Work shall be and remain at the risk of the Contractor and the Contractor shall make good loss thereof or damage thereto occurring between the effective date of the Contract and the date of the COMPLETION CERTIFICATE issued in respect thereof, or the date of final payment, whichever shall first occur.

24.2 Labour and Materials

The Contractor 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.

24.3 Injury to Persons or Property

If, at any time after the effective date of the Contract and before the date of the COMPLETION CERTIFICATE, or if at any time thereafter while the Contractor, its officers, servants, agents, employees or subcontractors are on the site for the purpose of making good any breakage, defect or failure in the Work pursuant to the WARRANTY Section of the General Conditions, there shall occur any injury (including loss of life), loss or damage to any person or property, other than property forming part of the Work, caused by or resulting from defective plant, material, workmanship, fabrication, or construction or by anything done, or omitted to be done, or permitted to be done by the Contractor, its officers, servants, agents, employees or subcontractors (but not otherwise), then the Contractor shall 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 by any person, firm or corporation for, or by reason, or on account of such injury, loss or damage, or anything relating thereto.

25 INTELLECTUAL PROPERTY

Drawings, reports, manuals, documents, and other and/or similar materials (herein "Drawings") produced/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 Drawings shall remain with the Contractor. The Contractor shall grant the Purchaser a perpetual, royalty free, non-transferable (save and except transferable to the Purchaser's affiliates or transferable to any entity created after the effective date of the Contract and to which the Purchaser assets are assigned or otherwise transferred) limited licence to use, copy, and to allow third parties to use, the Drawings and all proprietary information in the Drawings as may be required for the purpose of proposing, installing, operating, repairing, maintaining, modifying, replacing and/or upgrading the Work, or any part thereof.

26 PAYMENTS BY THE CONTRACTOR

The Contractor shall promptly pay all assessments, premiums, levies, taxes, permit and licence fees and shall promptly pay for all materials, labour, and services obtained or required by the Contractor in the execution of the Contract. If the Contractor fails to pay the same, or unduly delays payment, the Purchaser may, at the Purchaser's option, make such payment or payments for and on behalf of the Contractor, and thereafter the Contractor shall on demand, pay the Purchaser an amount equal to the aggregate of all the sums so paid by the Purchaser, plus interest on the sums so paid at an interest rate equal to the Prime Rate of interest charged by the Purchaser's bank plus 3% per annum calculated from the date of payment by the Purchaser to the date when moneys are next due and payable by the Purchaser to the Contractor under the Contract, plus the sum of $10.00 (CAD) as a service charge in respect of each cheque issued by the Purchaser for or on behalf of the Contractor pursuant to this Section of the General Conditions, or the Purchaser may, at its option, deduct the aforesaid sums, interest and service charge from any moneys due or to become due to the Contractor from the Purchaser, provided that no payment by the Purchaser as aforesaid shall be held to relieve the Contractor from the Contractor's liabilities and obligations under the Contract.

The Contractor shall keep a record of the pro rata share of accrued interest on holdbacks due all subcontractors.

27 WARRANTY

If, within 24 months from the date when the Work has been accepted by the Purchaser, the Work or any part thereof becomes broken or defective or fails due to faulty or improper design, material, workmanship, manufacture, fabrication, shipment or delivery, or fails to meet the requirements of the contract, then the Contractor, upon notification in writing from the Purchaser, shall forthwith make good every such breakage, defect or failure without cost (including without limitation, transportation costs to and from the place where the Work was delivered) to the Purchaser.

If, after such notification, 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 all costs, charges and expenses incurred by the Purchaser in connection therewith and shall forthwith pay to the Purchaser an amount equal to such costs, charges and expenses upon receipt of invoices therefore certified correct by the Purchaser.

The Contractor's liability under this Section of the General Conditions shall be in lieu of any warranty or condition implied by law as to the quality, design or fitness of the Work for any particular purpose, and save as in this Section of the General Conditions expressed the Contractor shall not be liable for defects in any work after the Work has been taken over by the Purchaser or for any injury or damage resulting from any such defects.

Provided the Contractor is not otherwise in default under the terms of the contract, and subject to the provisions of the CONTRACTOR'S LIABILITY and RESPONSIBILITY AS TO PATENTS Sections of the General Conditions, the Contractor's liability in respect of the Work, whether in contract, tort or otherwise, shall cease upon the fulfilment by the Contractor of the Contractor's obligations under this Section of the General Conditions; provided further that any part of the Work made good under this Section of the General Conditions shall be subject to all provisions of this Section of the General Conditions for a further period of 24 months from the date when the same has been made good as aforesaid.

Where more than one unit section of equipment is included in the Work, the said period of 24 months shall be deemed to commence when each unit section of the Work has been taken over by the Purchaser.

28 INSPECTION AND TESTING

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 or Inspector. Any special tests which the Purchaser requires are set forth in Request for Proposal 040314. The Contractor shall co-operate with the Engineer or Inspector and shall make available every facility which the Contractor possesses for inspecting and testing.

All work, materials and equipment condemned by the Engineer or Inspector shall be removed and rebuilt or replaced in accordance with the Contract at the Contractor's expense 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 work shall be promptly repaired and made good at the Contractor's own proper cost and expense.

If the Purchaser 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, proper operation 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 the USE OF FAULTY OR DEFECTIVE WORK, CONTRACTOR'S LIABILITY, CONTRACTOR'S DEFAULT, TERMINATION FOR BREACH, WARRANTY and INTERPRETATION OF THE CONTRACT Sections of the General Conditions.

29 COMPLETION CERTIFICATE

Subject to the provisions of the WARRANTY Section of the General Conditions, 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, the Purchaser will issue a COMPLETION CERTIFICATE (see SAMPLE ONLY COMPLETION CERTIFICATE included as Appendix F) to the Contractor, and from and after the date of said Certificate, the Purchaser shall be deemed to have accepted and taken over the Work, or the unit section thereof, as the case may be.

30 CONTRACTOR'S DEFAULT

If the Contractor:

(a) abandons the Work;

(b) fails to perform the Work in accordance with the terms and provisions specified in the Contract;

(c) fails to perform the Work within the time or times specified in the Contract;

(d) becomes bankrupt or insolvent, or makes an assignment for the general benefits of creditors;

(e) permits any execution to be levied on the Contractor's real or personal property or on any portion of the Work;

(f) assigns or sublets the Contract without the consent in writing of the Purchaser;

(g) loses control of the Work for any cause whatsoever, except by act of God, lawful orders of civil or military authorities, or the public enemy;

(h) refuses or neglects to follow the instructions of the Purchaser;

(i) fails to meet the Purchaser's requirements for material, plant, methods and/or labour within a reasonable time;

(j) refuses or neglects to use measures to protect the Work from damage;

(k) is guilty of carelessness or incompetence in the execution of the Work;

(l) delays the Work or any part thereof unnecessarily or unreasonably; or

(m) is in default of any other of its covenants or obligations in, or arising from, the Contract;

then the Purchaser may, at its option, and without prejudice to any other rights or remedies:

i) at the Contractor's expense, 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; and/or

ii) at the Contractor's risk and expense, remove unsuitable or inefficient material, plant and tools from the site; and/or

iii) at the Contractor's expense, take over and carry on the Work to the extent necessary to avoid loss or waste or damage to the Work already performed; and/or

iv) give notice of intention to terminate the Contract as provided in the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions.

31 TERMINATION FOR BREACH OF CONTRACT

If the Contractor makes default in any manner set forth in the CONTRACTOR'S DEFAULT Section paragraph (b), (c), (h), (i), (j), (k), (l), or (m) of the General Conditions, the Purchaser may give written notice to the Contractor of intention to terminate the Contract, stating the reasons therefore. If the Contractor does not remedy or take steps to remedy the default to the satisfaction of 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 the CONTRACTOR'S DEFAULT Section paragraph (a), (d), (e), (f) or (g) of the General Conditions, 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 thereafter. The Purchaser may, at its 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 may think fit, for the account and at the expense of the Contractor, and the Contractor shall be liable to the Purchaser for any excess cost occasioned the Purchaser.

At any time after the Purchaser has terminated the Contract, the Purchaser, with such assistance 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's material, plant, and tools at the site may be utilized by the Purchaser, without payment, for the purpose of completing the Work, and may be sold by the Purchaser by private sale or by public auction, either for cash or credit, and upon such terms and conditions as the Purchaser deems most advantageous, but without the Purchaser being liable for loss which may be occasioned thereby. The proceeds of such sale shall be applied in and towards the satisfaction of any money due or to become due to the Purchaser from the Contractor under the Contract.

Upon any termination of the Contract as provided herein, 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. 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 or due completion 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 moneys due or to become due to the Contractor. 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.

32 TERMINATION FOR CONVENIENCE

Notwithstanding the TERMINATION FOR BREACH OF CONTRACT Section of the General Conditions, the Purchaser may terminate the Contract (for whatever reason the Purchaser deems fit and at any time during the Work) on 30 days' written notice. The Purchaser shall pay for fees and expenses incurred to the date of the termination.

Without restricting its other remedies, the Purchaser may immediately terminate the Contract in writing if the equipment or services are unsatisfactory, inadequate, or improperly performed, the Contractor fails to comply with the Contract, or the Contractor becomes bankrupt or insolvent.

33 RESPONSIBILITY AS TO PATENTS

The Contractor shall pay all royalties payable under or in respect of, and shall fully 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 of, any and all letters patent, registered design, trade mark or copyright of any apparatus or component part thereof forming part of or used in or 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 this proposing document, but such indemnity shall not cover any use of the Work otherwise than for the purpose indicated by or reasonably to be inferred from this proposing document.

In the event of any claim being made or action brought against the Purchaser arising out of the matters referred to in this Section of the General Conditions, the Contractor shall be promptly notified thereof and may at its own expense conduct 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 conduct by the Contractor of such negotiations or litigation shall be conditional upon the Contractor having first given to the Purchaser such reasonable security as shall from time to time be required by the Purchaser to cover the amount ascertained, or agreed, or estimated, as the case may be, of any compensation, damages, expenses, and costs for which the Purchaser may become liable in respect of such infringement or alleged infringement as aforesaid. The Purchaser shall, at the request of the Contractor, afford all available 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, replace such work with a non-infringing work or modify it so that it becomes non-infringing or remove the said enjoined work and refund the sums paid therefor.

34 OWNERSHIP OF EQUIPMENT AND SUPPLIES

Any equipment and supplies provided by Manitoba Hydro to the Contractor for use pursuant to the Contract shall remain the property of Manitoba Hydro and shall be returned to Manitoba Hydro upon request.

35 ENUREMENT

The Contract shall enure and be binding upon the parties and their executors, administrators, heirs, successors and permitted assigns.

36 ASSIGNMENT OF RIGHTS AND OBLIGATIONS

The Contractor shall not assign any of its rights or obligations arising under the contract without the written consent of the Purchaser, which consent may be arbitrarily withheld.

37 SURVIVAL OF TERMS

Sections RECORDS, CONFIDENTIALITY, LIABILITY, ENUREMENT, INTELLECTUAL PROPERTY, OWNERSHIP OF EQUIPMENT AND SUPPLIES of the General Conditions shall survive the termination or expiration of the Contract.

38 INTERPRETATION OF THE CONTRACT

The Purchaser's decision shall govern 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 the Purchaser shall be the sole judge of the quality, quantity, suitability and efficiency of labour, workmanship, materials, plant, apparatus, equipment, appliances and methods used, furnished or supplied by the Contractor pursuant to the Contract.

The Contract shall be interpreted according to the laws of the Province of Manitoba, Canada.

39 OBSERVANCE OF LAWS AND REGULATIONS

Until the Work shall have been fully completed and accepted by the Purchaser, the Contractor shall be liable for the due and proper observance, both by itself, and by its servants, agents, employees and subcontractors, of all statutes, by-laws, rules and regulations in any way affecting or relating to the Work, which are lawfully imposed by any federal, provincial or municipal authority.

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 statutes, by-laws, rules and regulations by the Contractor, its servants, agents, employees and subcontractors.

40 APPLICABLE LAWS

The Contract shall be governed by the laws of the Province of Manitoba, Canada.

41 NOTICES

Every notice or communication required or permitted to be given or served pursuant to the Contract shall be in writing, and shall be delivered personally or by fax:

To the Purchaser:
TBD

To the Contractor:
TBD

To the Engineer:
TBD

In addition to forgoing, the Purchaser may effectually give notice to the Contractor:

(a) by giving same on the Superintendent, whether personally, or by fax to the Superintendent's designated Manitoba office; or

(b) by giving same to Contractors address and contact particulars included in the Contract.

Notice given or served by personal service shall be deemed effectually given and received upon such personal service, and notice given or served by fax shall be deemed effectually given and received on the first (1st) calendar day after the day of transmission.

The Contractor acknowledges and agrees that the Engineer is an employee of the Purchaser.

42 ARBITRATION

42.1 Notice of Dissatisfaction Concerning Engineer Determinations

A party shall be conclusively deemed to have accepted a determination by the Engineer issued under any provision of the Contract, 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 seven (7) 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.

42.2 Amicable Settlement of Disputes

The Purchaser and the Contractor shall make all reasonable efforts to resolve any 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 Engineer and Contractor's representative fail to resolve the dispute, 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 a Vice President for the Purchaser and the equivalent senior executive of the Contractor.

42.3 Final and Binding Arbitration

If the dispute has not been resolved within a reasonable time, 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, together with a concise statement of the matters in dispute.

42.4 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.

42.5 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.

42.6 Venue

Arbitration proceedings shall be conducted at Winnipeg, Manitoba.

42.7 Work to Continue

The Contractor shall not suspend, delay or interfere with 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 above, nor during arbitration proceedings.

END OF GENERAL CONDITIONS

Manitoba Hydro

TECHNICAL REQUIREMENTS

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040314

TECHNICAL REQUIREMENTS

1 DESCRIPTION OF THE WORK

The Technical Requirements set out the Purchaser's requirements with respect to the design, material procurement, manufacture, supervision, labour, equipment, quality control, testing, packaging, shipping and delivery of conductor hardware assemblies, including suspension, dead-end and jumper string assemblies, to be installed on the Manitoba-Minnesota 500 kV AC Transmission Line from Dorsey Substation to the USA border.

The following items are excluded from the Work:

(a) Insulators,
(b) Spacer-dampers and vibration dampers,
(c) Conductor compression fittings,
(d) OPGW/shield wire hardware, and
(e) OPGW/shield wire vibration dampers.

2 REFERENCE STANDARDS

The latest revisions of the following standards, current at the time and the date of the execution of the Contract, shall apply. In the case where conflict between several referenced documents exists, the more stringent requirements shall be followed.

If a conflict exists among the Technical Requirements or its referenced standards and the Design Requirements Drawings, the Design Requirements Drawings shall take precedence.

Canadian Standards Association (CSA):

CSA C83	Communication and Power Line Hardware
CSA C108.3.1	Limits and Measurement Methods of Electromagnetic Noise from AC Power Systems, 0.15-30 MHz
CSA G40.20/40.21	General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel
CSA G164	Hot Dip Galvanizing of Irregularly Shaped Articles
CSA C411.1	AC Suspension Insulators

American Society of Mechanical Engineers (ASME):

ASME B18.2.1	Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)
ASME B18.2.2	Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.21.1	Washers: Helical Spring Lock, Tooth Lock, and Plain Washers (Inch Series)

American Society for Testing and Materials (ASTM):

ASTM A143	Standard Practice for Safeguarding Against Embrittlement of Hot Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A275	Standard Practice for Magnetic Particle Examination of Steel Forgings
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength
ASTM A370	Standard Test Methods and Definitions for Mechanical Testing of Steel Products
ASTM A563	Standard Specification for Carbon and Alloy Steel Nuts
ASTM B26	Standard Specification for Aluminum-Alloy Sand Castings
ASTM B108	Standard Specification for Aluminum-Alloy Permanent Mold Castings
ASTM B247	Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings
ASTM E23	Standard Test Methods for Notched Bar Impact Testing of Metallic Materials
ASTM E94	Standard Guide for Radiographic Examination
ASTM F436	Standard Specification for Hardened Steel Washers

International Electrotechnical Commission (IEC):

IEC 61284	Overhead lines – Requirements and tests for fittings

International Organization for Standardization (ISO):

ISO 9001	Quality Management Systems –Requirements

Manitoba Hydro Drawing Standard:

Minimum Standards for Drawings Produced and Submitted by Fabricators, Manufacturers and Construction Companies.
Transmission and Civil Design Department Autocad Drawings Standards.

3 SYSTEM PARAMETERS

3.1 Operating System Parameters

All conductor hardware assemblies shall be suitable for operation under system parameters and environmental conditions as listed in Table 1 and Table 2.

Table 1
Operating System Parameters

Parameter	Specified Value
Nominal Line-Line Voltage	500 kV
Maximum Continuous Operating Voltage	575 kV
System Configuration	AC 3-phase
Nominal Line Load	2,000 Amps
Emergency Line Load	2,500 Amps
Maximum Conductor Operating Temperature	70 ˚C
Maximum Sub-Conductor Surface Gradient	19 kV/cm
Single-Line-Ground Fault Current	23.1 kA
Fault clearing time	500 ms

Table 2
Environmental Conditions

Condition	Specified Value
Ambient Air Temperature: Minimum Maximum	 -50ºC 40ºC
Altitude	Less than 500 m
Environment type	Rural and agricultural
Terrain Type	Mainly flat and open with

Condition	Specified Value
	few trees or buildings, snow-covered during winter
Lightning Stroke Density	1.61/km^2/yr

3.2 Conductor Characteristics

Conductor Type:	Aluminum Conductor Steel Reinforced (ACSR)
Conductor Designation:	Bunting
Conductor Size:	1192.5 kcmil
Aluminum Type:	1350-H19
Outside Diameter:	33.1 mm
Number of Strands:	45/7
Strand Diameter(Al):	4.14 mm
Strand Diameter (Steel):	2.76 mm
Outer Layer:	Right hand lay
Linear Density:	1.997 kg/m
Rated Tensile Strength (RTS):	142.3 kN
Bundle Configuration:	Triple – see Figure 1

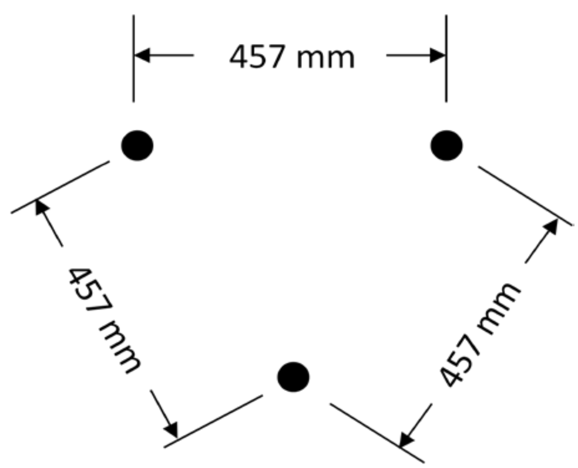

Figure 1, Conductor Symmetric Bundle Configuration

3.3 Line Design Parameters

Manitoba-Minnesota Transmission Line design parameters are as shown below:

Design Span:	470 m
Minimum Span:	200 m

Maximum Span: 540.5 m

Max. Wind Load: 95 - 100 km/h (10 min average)
Max. Ice Load: 16 mm, radial glazed (8829 N/m³ ice density)

Conductor tension values are as shown in Table 3.

Table 3
Conductor Tensions

Condition Tension Value

Condition	**Tension Value**
Aeolian Vibration (1)	32.4 - 35.7 kN (Initial) 24.9 – 32.2 kN (Final)
Sub-span Oscillation (2)	27.5 – 34.2 kN (Initial) 21.6 – 31.0 kN (Final)

Notes:
(1) Aeolian vibration tension values are at -20°C which is the average temperature of the coldest month.
(2) Sub-span oscillation tensions are at 0°C which is the annual average temperature.

4 DESIGN REQUIREMENTS

4.1 Functional Requirements

Conductor hardware assemblies shall be designed to perform the following functions:

(a) Provide the specified strength and function under the stated operating and environmental conditions,
(b) Maintain sub-conductors in required configuration,
(c) Avoid damage to the conductor,
(d) Provide corona free operation,
(e) Ensure that individual components are secured against becoming loose,
(f) Allow for energized replacement of insulators.

4.2 General Requirements

Design of all conductor hardware assemblies shall be the responsibility of the Contractor.

All conductor hardware assemblies shall be designed based on the parameters listed in the Technical Requirements. Design of all components shall meet the requirements of CSA C83 unless otherwise specified.

Design of all conductor hardware assemblies shall take into account regular wear and tear from movement of individual hardware components.

4.3 Purchaser's Drawings

All conductor hardware assemblies shall be designed within configurations and to the strength requirements as specified in the Design Requirements Drawings shown in Table 4.

Table 4
Design Requirements Drawings

Drawing Number	Title
1-36070-DD-51210-0001 0001	177 kN Tangent Suspension Single "I" String Assembly Design Requirements Drawing
1-36070-DD-51210-0002 0001	177 kN Tangent Suspension Single "V" String Assembly Design Requirements Drawing
1-36070-DD-51210-0003 0001	243 kN 10˚ Angle Suspension Double "I" String Assembly Design Requirements Drawing
1-36070-DD-51210-0004 0001	243 kN 10˚ Angle Suspension Double "V" String Assembly Design Requirements Drawing
1-36070-DD-51210-0005 0001	Jumper String Assembly Design Requirements Drawing
1-36070-DC-51210-0006 0001	Deadend String Assembly Design Requirements Drawing

4.4 Corona Performance

Complete conductor hardware assemblies shall be designed to perform corona free operation at the maximum continues operating voltage as specified in Table 1 of the Technical Requirements.

4.5 Compatibility with Insulators

All conductor hardware assemblies shall be compatible with insulators of the same string in accordance with CSA C411.1 Annex C and as shown on Design Requirements Drawings.

4.6 Design of Suspension Assemblies

4.6.1 General Requirements

Suspension assemblies shall include all the hardware components between the attachment hole of the tower and the conductor bundle, excluding insulators.

Suspension assemblies shall be designed such that line contact occurs between coupled components. Point contact between components shall be avoided.

4.6.2 Suspension Assembly Length

The preferred lengths of Suspension Assemblies shall be as shown on Design Requirements Drawings. Shorter assembly lengths may be considered in the Engineer's sole discretion.

4.6.3 Suspension Assembly Swing

Design of all Suspension Assemblies shall allow for the suspension assembly swing-out angle of 75° from vertical in the transverse direction.

4.6.4 Strength Requirements

All suspension assemblies shall be designed to withstand loads as specified on Design Requirements Drawings.

4.6.5 Suspension Clamp Fit

Suspension clamps shall be designed so that conductors seat firmly and smoothly on the clamps without causing any damage to or deformation of the conductor which would impair its function or strength. In all positions, the seat and the keeper shall be in intimate and uniform contact with the conductor.

All surfaces of the clamp assembly shall be smooth and without sharp edges.

The clamps shall be designed to facilitate installation and removal with standard hot line tools.

4.6.6 Articulation of Suspension Clamp

Design of all suspension assemblies shall provide for articulation of the suspension clamps.

Suspension clamps shall be free to rotate with respect to the clamp support up to 75° (degrees) measured to the horizontal line in the longitudinal direction. In addition, the suspension clamp shall be free to swing transversely relative to the yoke plate, up to an angle of 45 ° (degrees) from vertical.

4.6.7 Suspension Clamp Angle

Bolted type suspension clamp design shall provide for the conductor exit angle of not less than 20° at each end. The flair at the clamp exit shall have a minimum radius of 90 mm at the end. The lip of the clamp shall have a minimum 3.5 mm radius.

Cushion type suspension clamp design shall provide for the conductor exit angle of not less than 15° at each end.

4.6.8 Suspension Clamp Slip Strength

The clamps shall have minimum slip strength as specified on the Design Requirements Drawings when the clamping bolts are torqued to the installation torque specified for the clamp.

4.6.9 Suspension Clamp Fasteners

All clamping fasteners on vertically split clamps shall be made captive and shall have acceptable locking devices.

The Contractor shall state the torque which is to be applied to the clamping bolts on the clamp casting.

4.6.10 Clearance to Insulators

For suspension assemblies and jumper assemblies, a minimum distance of 38 mm of clearance shall be maintained between the bottom of the insulator and any part of the assembly.

4.6.11 Grading Rings

The Purchaser has a preference for suspension hardware assemblies without grading rings to operate within the requirements of the Technical Requirements. However, should grading rings be required, they shall be removable by use of hot sticks if they are expected to interfere with hot line maintenance operations.

The grading rings, if required, shall be designed to support a vertical load of 2,000N without permanent deformations which would impair the function of reusability of any component.

Addition of a grading ring may reduce the strike distance of the insulator string. In such case, re-design of the suspension assembly may be required to allow foraddition of an insulator unit while maintaining the preferred length of the suspension assembly.

4.7 Design of Dead-End Assemblies

4.7.1 General Requirements

Dead-end assemblies shall include all the hardware components between the attachment hole of the tower and the conductor bundle, excluding insulators and conductor dead-end fittings.

Dead-end assemblies shall be designed in such a way that the load is evenly distributed among the three insulator strings at all times.

Dead-end assemblies shall be designed such that line contact occurs between coupled components. Point contact between components shall be avoided.

4.7.2 Dead-End Assembly Length

Proposed Dead-end Assembly length shall be within limits as specified on the Design Requirements Drawings.

4.7.3 Strength Requirements

Dead-end Assemblies shall be designed to withstand loads as specified on Design Requirements Drawings.

4.7.4 Rotation of Sub-Conductor

Design of Dead-end Assembly shall not allow rotation of individual sub-conductors.

4.7.5 Failure of Sub-Conductor

Dead-end assembly shall be designed so that the failure of any individual sub-conductor will cause minimum damage to components of the assembly. The assembly shall remain operable mechanically after the failure of any sub-conductor.

4.7.6 Failure of Insulator String

Dead-end assembly shall be designed so that after the failure of any one insulator string the assembly and the conductor bundle shall remain operable.

4.7.7 Dead-End Assembly Articulation

Dead-end assembly shall be designed to accommodate the following maximum articulations:

(a) Vertical: +30° to -30° (degrees)
(b) Horizontal: +50° to -50° (degrees)

All angles refer to a line horizontal and normal to a tower crossarm.

4.7.8 Sag Adjustment Devices

Sag adjustment turnbuckles or similar devices shall be provided between the compression deadend of each conductor and the spacing device or the combination of triangular yoke plates. These adjustment devices shall be completely independent of one another to allow for adjustment of an individual sub-conductor position up to 350 mm horizontally. The yield strength of turnbuckles or similar devices shall be no less than 170 kN based on the methodology recommended in Appendix H of CSA C83 standard

4.8 Grading Rings

Grading rings shall be provided where required to meet corona free operation. These grading rings shall be removable by use of hot sticks if they are expected to interfere with hot line maintenance operations.

Grading rings shall be identical and interchangeable where possible.

The grading rings shall be designed to support a vertical load of 2,000 N without permanent deformations which would impair the function of reusability of any component.

4.9 Design of Fasteners

Design of all conductor hardware assemblies shall provide for ease of installation of all fasteners without a need to use specialized tools to achieve required installation torque.

All bolts shall include a nut and a cotter pin. The thread length of the bolt and the position of the cotter pin with the bolt bearing as under applied load and the bolt head in contact with the side of the fitting shall be such that:

(a) The nut will not contact the side of the fitting when run to the end of the threads,

(b) There shall be not more than 6 mm between the nut and the side of the fitting for bolts up to an including 22 mm in diameter. For bolts with diameter greater than 22 mm, the space requirement shall be not more than 10 mm,

(c) The cotter pin must be positioned so that it can be freely installed.

4.10 Welding

Welds shall not be used in the design and manufacture of any component of Hardware Assembly, with the exception of grading rings.

4.11 Yoke Plates

The yoke plate connecting to the ball of the bottom insulator unit through socket clevis shall be designed and manufactured in such a way that the bottom insulator unit of the slack string shall not rotate to such an extent as to contact the yoke plate when the bottom insulator unit on a slack string is swung to its extreme downward position relative to the yoke plate.

Provisions shall be made for rigging holes. Number, diameter and location shall be subjected to approval by the Purchaser.

4.12 Bolts and Nuts

All bolts and nuts shall conform to the general requirements of CSA C83.

All bolts shall include a nut and a cotter pin unless agreed otherwise by the Purchaser.

All bolts shall be positively locked. Bolt heads and locking devices shall be accessible from the tower.

All fasteners shall be of imperial sizes in accordance with ASME B18.2.1 and ASME B18.2.2. Metric substitutions will not be allowed.

4.13 Construction and Maintenance Requirements

All conductor hardware assembly parts shall be suitable to be joined or separated using standard hot line tools.

Provisions shall be made on both sides of each insulator string to allow for energized maintenance and insulator replacement.

Rigging holes shall be provided to allow for energized installation of the conductor and part replacements during maintenance operations. Allowable loads for these rigging holes shall be specified on Contractor's final conductor hardware assembly drawings.

4.14 Design Drawings

The Proponent shall submit preliminary design drawings for each of the conductor hardware assemblies for the Work as set out in the Technical Requirements. These drawings shall identify:

(a) All components of the assembly,
(b) Overall physical dimension,
(c) Strength of all components,
(d) Types of materials used, and
(e) Method of manufacture.

Upon award of the Contract, the Contractor shall produce detailed assembly and individual component drawings. These drawings shall include:

i) All physical dimensions including dimensions of mating surface and tolerance,
ii) Weights,
iii) Dimensional tolerances,
iv) Short circuit ratings
v) Corona rating,
vi) Strength ratings (yield and failure),
vii) Types of material used,
viii) Method of manufacture,
ix) Reference standard used,
x) Coupling type,
xi) Location and size of rigging holes,
xii) Drawing and revision number,
xiii) Project name,
xiv) Drawing scale.

All drawings should meet the "Manitoba Hydro Minimum Standards for Drawings Produced and Submitted by Fabricators, Manufacturers and Construction Companies" (Appendix C) along with the "Transmission and Civil Design Department AutoCAD Drawing Standards" (Appendix D). All drawings shall be set up in the Manitoba Hydro drawing borders format with the title blocks provided and shall be validated prior to submission. Final drawings shall be eSealed by a Professional Engineer registered in Manitoba in PDF/A format along with a computer generated AutoCAD .dwg version of the drawing.

No fabrication shall commence until detailed assembly and individual component drawings are reviewed and accepted by the Purchaser.

4.15 Units of Measure and Language

All drawings shall be only in English language and in SI (metric) system except for bolts and nuts.

5 MATERIALS AND MANUFACTURING

5.1 General

Only new manufactured materials shall be used.

All aluminum material shall be manufactured from primary ingot.

In general, ferrous components fabricated by casting are not acceptable and forged components are preferred. Where a proposed part is cast, this shall be clearly identified on Contractor's drawings.

It is preferred that forming and bending is performed hot. Where cold forming and bending must be used, hardware component shall be stress relief heat treated after the product has assumed its final shape. Stress relief shall be done prior to galvanizing.

Embrittlement or loss of ductility due to stress concentration, strength hardening and quenching shall be avoided.

5.2 Governing Standards

All materials shall conform to the general requirements of CSA C83 unless otherwise specified by the Technical Requirements.

In addition:

(a) Material and manufacturing used for the production of aluminum castings shall meet the requirements of ASTM B108 and ASTM B26,
(b) Material and manufacturing used for the production of aluminum forgings shall meet the requirements of ASTM B247.

5.3 Corrosion Resistance

All material shall be resistant to atmospheric corrosion. If dissimilar metals are used, suitable precautions shall be taken to minimize electrolytic corrosion.

5.4 Energy Absorption/Toughness

All ferrous materials subjected to tension loads, excluding nuts, washers and unstressed components, shall have Level 1 energy absorption properties (20 Joules at -20°C) as specified by CSA C83.

5.5 Finish

All surfaces shall be free from burrs, sharp edges, forging flashes or other imperfections that may cause hand injury or conductor damage. These imperfections shall be removed before galvanizing.

5.6 Galvanizing

All hardware must achieve its final shape before galvanizing.

All ferrous materials shall be galvanized in accordance with CSA G164.

For malleable and ductile iron casting, the requirements of Clause A2.1.4 of CSA G164 shall be mandatory.

All nuts shall be tapped oversize after galvanizing in accordance with CSA G164, Clause B9.

5.7 Structural Steel

Hardware manufactured from structural steel shall use material in accordance with CSA G40.20/G40.21. These components shall have Level 1 energy absorption properties (20 Joules at -20C) as specified in CSA C83.

5.8 Stainless Steel

All stainless steel components shall meet the requirements of ASTM A276 or its equivalent.

5.9 Grading Rings

All grading rings shall be made of aluminum.

5.10 Bolts and Nuts

Bolts shall meet the requirements of ASTM A307, Grade A or equivalent.

Nuts shall meet the requirements of ASTM A563, Grade A or equivalent.

All bolts shall have level 1 energy absorption of 20 Joules at -20C, in accordance with CSA C83.

5.11 Washers

Round washers shall meet the requirements of ASTM F436 or equivalent.

Helical spring washers shall meet the requirements of ASME B18.21.1 or equivalent.

5.12 Balls and Sockets

All balls and sockets shall be compatible with dimensional requirements of the insulators from the same string and they shall be in accordance with CSA C411.1 Annex A and B.

All sockets shall be provided with cotter keys meeting the requirements of CSA C83 – Style 1.

5.13 Holes

All holes shall be oversized as per Table 1 of CSA C83.

All holes shall be drilled in materials thicker than 13 mm.

6 TESTING REQUIREMENTS

6.1 General

The Contractor shall be responsible for all testing as required by the Technical Requirements.

All type tests, routine tests and sample tests shall be done in accordance with CSA C83 and IEC 61284 unless otherwise specified by the Technical Requirements.

All the required tests shall be made on the finished hardware components.

6.2 Classification of Tests

All hardware components and assemblies shall be subjected to testing in accordance with Table 5 of the Technical Requirements.

Table 5
Test Requirements

Item	Test	Reference Clause	Insulator String Assemblies			Suspension Clamps		
			Type	Sample	Routine	Type	Sample	Routine
1	Visual examination	IEC 61284 Clause 7	x	x	x	x	x	x
2	Dimensional and material verification	IEC 61284 Clause 8	x	x	x	x	x	x
3	Hot dip galvanizing	CSA G164 Clause 6	x	x		x	x	
4	Impact energy absorption	Clause 6.11.4 of the Technical Requirements	x	x		x	x	
5	Mechanical damage and failure load	Clause 6.11.5 of the Technical Requirements	x	x		x	x	
6	Clamp slip strength	Clause 6.11.6 of the Technical Requirements				x	x	
7	Clamp bolt tightening	IEC 61284 Clause 11.4.5				x	x	
8	Visual corona	Clause 6.11.7 of the Technical Requirements	x			x (1)		
9	Radio influence voltage	Clause 6.11.8 of the Technical Requirements	x			x (1)		
10	Chemical analysis of aluminum castings	Clause 6.11.9 (a) of the Technical Requirements				x	x	
11	Mechanical properties of aluminum castings	Clause 6.11.9 (b) of the Technical Requirements				x	x	
12	Aluminum casting radiographic inspection	Clause 6.11.9 (c) of the Technical Requirements				x	x	
13	Grading Ring Loading	Clause 4.8 of the Technical Requirements and the test procedure to be proposed by contractor	x					
14	Cotter Pin	CSA Item Standard C83.42 and the test procedure to be proposed by contractor	x					

Notes:
(1) In connection with the complete insulator string and including grading rings where required.

6.3 Access and Notification

The Contractor shall allow the Purchaser or its representative access to all tests for the Work as set out in the Technical Requirements. The Contractor shall give notice to the Engineer of such testing a minimum of 30 days in advance.

6.4 Test Setups

The hardware under test shall be arranged and the loads shall be applied to simulate service loads as close as possible and in accordance with CSA C83 and IEC 61284.

6.5 Supply of Conductor and Insulators for Testing

The Purchaser will supply conductor and insulators required for testing of the conductor hardware assemblies.

6.6 Type Tests

6.6.1 General

Type tests are intended to demonstrate conformance of electrical and mechanical characteristics of the proposed conductor hardware assemblies with all the requirements of the Technical Requirements. All hardware components shall be subjected to type tests listed in Table 5 of the Technical Requirements.

All type tests shall be performed on three complete sets of each of the conductor hardware assemblies.

Type Test Reports shall be certified by a qualified person and submitted electronically to the Engineer for approval.

The Purchaser shall not accept any material deliveries until all Type Test Reports have been approved by the Engineer.

6.7 Validity of Existing Type Tests

The Engineer may accept the existing type test reports offered by the Contractor in the Contractor's Proposal, provided that:

(a) All the type tests were made of the same type of conductor hardware assemblies with same dimension as required by the Technical Requirements;
(b) A complete set of tests were performed on the required number of conductor hardware assemblies as prescribed by the Technical Requirements;
(c) Testing was performed in accordance with all the requirements of the Technical Requirements;
(d) Testing was performed within the last ten (10) years;
(e) Testing was performed on conductor hardware assemblies manufactured at the same facility; and

(f) The Contractor's manufacturing process has not changed since the time of the type tests performed.

The Engineer shall advise the Contractor in writing as to whether the above criteria have been satisfied, at the Engineer's sole discretion.

6.8 Sample Tests

6.8.1 General

All components of the conductor hardware assemblies are subject to sample tests listed in Table 5 of the Technical Requirements. Samples shall be selected at random from the lot offered for acceptance.

All sample tests and inspections shall be made at the place of manufacture prior to shipment, in accordance with the Inspection and Test Plan.

All Sample Test Reports shall be issued by a qualified person and submitted electronically to the Engineer for approval.

The Contractor shall not ship any materials without a written approval by the Engineer.

6.8.2 Lot Size Definition

Production lots are defined as components batch processed at the same time, under identical conditions and using the same setup. If no rational basis for establishing a lot size can be determined, then a lot size shall be defined and marked as that material produced within an eight (8) hour shift.

6.8.3 Sampling Plans and Acceptance Criteria

All hardware components shall be tested using a single sample plan for normal inspection, as defined by CSA C83 standard.

Sample size and acceptance numbers shall be:

(a) Sampling inspection by attributes: as per Table A1 of CSA C83 standard, and
(b) Sampling inspection by variables: as per Table B1 of CSA C83 standard

except for:

i) For component strength: the sample size shall be 5 samples per 1,000 pieces,
ii) For surface defects: 100% sampling,

iii) For energy absorption/toughness: the sample size shall be 1 sample per heat lot,

iv) For adherence of coating: the sample size shall be 5 samples per galvanizing lot.

Alternate sampling plan and acceptance criteria may be acceptable subject to approval by the Engineer.

6.8.4 Classification of Defects

The following Acceptable Quality Levels shall be used:

Class B:
(a) Dimensional and material verification
(b) Impact energy absorption
(c) Mechanical damage and failure load
(d) Clamp slip strength
(e) Clamp bolt tightening
(f) Chemical analysis of aluminum castings
(g) Mechanical properties of aluminum castings
(h) Aluminum casting radiographic inspection

Class C:
(a) Cotter pin insertion and disengagement force
(b) Grading ring load

Class D:
(a) Visual examination
(b) Hot dip galvanizing

Definitions of Acceptable Quality Levels shall be as per Table 3 of CSA C83 standard.

6.8.5 Mill Certificates and Chemical Analysis Reports

The Contractor shall provide mill certificates from the raw material supplier for each heat number. The certificates shall provide heat chemical analysis, yield and ultimate tensile strength and elongation.

If mill certificates are not available, the Contractor shall provide the Engineer with test results from both mechanical and chemical analysis performed by a test laboratory acceptable to both the Engineer and the Contractor.

6.9 Identification of Lots

The Contractor shall provide the Engineer with correlation between the production lots and the mill certificates.

6.10 Routine Tests

The Contractor shall be responsible for all routine and sample tests. Hardware components shall be subjected to sample and routine tests listed in Table 5 of the Technical Requirements.

6.11 Individual Test Requirements

6.11.1 Visual Examination Test

All hardware components shall be subjected to visual examination test to ensure conformity of manufacturing process, shape, coating and surface finish with the detailed design drawings. Testing shall be in accordance with IEC 61284 – Clause 7.

6.11.2 Dimensional Verification Test

All hardware components shall be subjected to dimensional verification test to ensure conformity with the detailed design drawings. Testing shall be in accordance with IEC 61284 - Clause 8.

6.11.3 Hot Dip Galvanizing Test

Hot dip galvanized hardware components shall be subjected to galvanizing test dimensional verification test to ensure conformity with the detailed design drawings. Testing shall be in accordance with CSA G164 – Clause 6.

6.11.4 Impact Energy Absorption Test

Charpy V-Notch impact tests shall be performed on specimens from sample forgings or castings in accordance with the requirements of ASTM A370 and ASTM E23. If test samples are made from the basic forging material then they shall have the identical heat treatment processing as used for the finished component.

Materials shall all have Level 1 impact properties as specified in CSA C83 (minimum energy absorption of 20 Joules at -20 degrees Celsius for three Charpy V-Notch bars tested in accordance with ASTM A370).

6.11.5 Mechanical Damage and Failure Load Tests

All load tests shall confirm the capability of the conductor hardware assembly to successfully carry the Minimum Mechanical Damage Load equal to the Yield Strength as defined in the Design Requirements Drawings for the assembly under test.

Components may be tested individually given that test apparatus accurately recreates the support and loading that the component will experience under service.

Each test load shall be gradually raised from zero to the Minimum Mechanical Damage Load then held at this value for a period of five (5) minutes. The assembly shall show no evidence of mechanical damage or permanent deformation of any of its components after the load has been released.

After initial load application and examination for damage, the test shall be repeated by applying the Minimum Mechanical Damage Load and holding it for one (1) minute. The load must then be increased at a rate not to exceed 5,000 N per minute until failure occurs.

The maximum load prior to failure shall be reported as the Failure Load of the component under test.

6.11.6 Clamp Slip Strength Test

Each clamp must be separately tested. A load shall be applied parallel to the axis of the conductor to test longitudinal slip strength.

Prior to testing, the clamp shall be installed on the conductor sample while it is under required slip strength as specified on the Design Requirements Drawings, with the Contractor’s recommended bolt torques (where applicable). Loading must not be conducted until one half hour after this installation.

The clamps of the suspension assembly must withstand the longitudinal load specified on Design Requirements Drawings without exceeding 6 mm initial slip. Initial slip shall be defined as the permanent displacement between the conductor and the clamp, measured after removal of the load.

After the initial loading test, the load shall be increased until continuous slip occurs, and this load is to be reported.

6.11.7 Clamp Bolt Tightning Test

Conductor clamps shall be subject to a bolt tightening test in accordance with IEC 61284 – Clause 11.4.5.

6.11.8 Visual Corona Test

Corona tests shall be performed with and without voltage grading rings installed (if applicable).

The assembly shall be configured using the same insulator units specified for the project.

Visual corona test shall be performed in accordance with CSA C83, Appendix E. The test shall be conducted three times, and the value for corona extinction considered for qualification shall be the arithmetic mean of the three voltage gradients.

The visual corona test shall be considered successful, if no visual corona is observed on any part of the tested assembly when the extinction test voltage gradient on the conductor surface for the tested assembly is less than and equal to the value specified in the Technical Requirements.

6.11.9 Radio Influence Voltage Test

RIV tests shall be performed with and without voltage grading rings installed (if applicable). The assembly shall be configured using the insulator units and conductor bundle specified on the Design Requirements Drawings. The measurements of RIV shall be made in accordance with CSA C108.3.1.

RIV limits must be in accordance with CSA C108.3.1 at the voltage gradient specified in the Technical Requirements for the RIV testing.

For both series of measurements the RIV vs. conductor surface voltage gradient is to be plotted and reported.

After the conductor bundle measurements, the suspension assembly shall be installed on the conductors. Then, the measurements shall be repeated and similarly reported.

6.11.10 Aluminum Castings Tests

(a) Chemical Analysis
Chemical analysis shall be carried out on samples from each production lot. The results shall conform to the composition specified in ASTM B26 or ASTM B108, for the alloy used.

One sample for chemical analysis per 8 hour shift from each furnace being used will be required. Any deviation from this requirement will be cause for rejection.

(b) Mechanical Properties
Separately cast test bars shall be cast each 8 hour shift for tensile testing. The tensile strength and elongation must meet the requirements of ASTM B26 or B108, or the lot is rejected.

(c) Radiographic Inspection
Radiographic inspection shall be performed, in accordance with ASTM E94, on each type of component casting, e.g. body and keeper of clamps, at the start of production and any time a change has been made in the casting process. Three consecutive samples shall be inspected and meet the requirements of Grade C of ASTM B26 or B108 with no failures.

6.12 Notice of Tests

If additional testing, as permitted by applicable sections of the Technical Requirements, is required to satisfy requirements of the Technical Requirements, the Contractor shall give notice of such testing of a minimum of 30 days to the Engineer.

6.13 Submission of Test Reports

Upon completion of all testing as specified in the Technical Requirements, all test reports shall be submitted electronically to the Engineer to confirm that all requirements of the Technical Requirements have been met.

Test reports shall be sent to:
Chen Wang, P. Eng. – Transmission Line Engineer
Manitoba Hydro
Transmission & Civil Design Department
820 Taylor Avenue (4)
Winnipeg, Manitoba, Canada R3M 3T1
Email: cwang@hydro.mb.ca

6.14 Third Party Testing

The Purchaser reserves the right to select and test samples from conductor hardware assembly lots fabricated by the Contractor using a qualified third party using the same tests as outlined in the Technical Requirements. If this tested lot fails any of the acceptance criteria set out in the Technical Requirements, then the lot will be refused and returned at the Contractor's expense. A replacement lot will be provided by the Contractor in accordance with all requirements of the Contract, at no additional expense or cost to the Purchaser.

7 QUALITY ASSURANCE

7.1 General

The Contractor shall comply with the quality assurance program requirements of ISO 9001 standard or its equivalent in the performance of the Work, the Contract, and the Contractor's obligations in respect of both. If the Contractor’s proposed program is not based on ISO 9001 series of standards, the Contractor shall submit evidence, satisfactory to the Engineer that the proposed program conforms fully to the spirit and intent of ISO 9001.

The Engineer may, in his sole discretion, reject Work that is not produced under the Quality requirements specified in this Section.

The Contractor is responsible to identify in its Quality Plan the specific activities it will undertake to perform:

(a) Quality Assurance: The process of auditing the quality requirements and the results from Quality Control measurements to ensure quality standards are being met.

(b) Quality Control: The process of monitoring and recording results of Quality activities to assess performance and recommend necessary changes.

7.2 Quality Documentation

All quality documentation shall be in the English language. Where the original document is in a single language other than English, the Contractor is responsible to have the document translated into English without causing delays to the documentation process.

7.3 Access to Contractor’s Facilities

The Purchaser reserves the right to audit the Contractor’s Quality Management System program at any time during the Work.

The Purchaser or its representative shall be granted unescorted access to the Contractor's facilities and to the facilities of all of its Subcontractors, at any time during the Contractor’s or Subcontractors’ normal business hours to verify that the Contractor and its Subcontractors are satisfactorily carrying out the Work and that the Work complies with the requirements of this Section of the Technical Requirements. The Purchaser or its representative shall be allowed at any time and under any circumstance to take photographs of any portion of the Work he deems necessary.

While attending at the Contractor's facilities, the Purchaser or its representative will comply with the reasonable policies of the Contractor concerning confidentiality (and with respect to matters not related to the Work and the Contract) which have been disclosed in writing to the Purchaser prior to attendance and for which no objection has been made; provided further however that nothing in the Contract is altered or diminished by reason of any such policy or compliance with same. While attending at Contractor's facilities, the Purchaser or its representative will use best efforts to limit disruption of other activities at such facilities.

7.4 Tools and Equipment

All tools and equipment used to carry out inspection activities by the Contractor shall have been calibrated within the one (1) year proceeding of the date of inspection by accredited third party inspection company. Calibration records shall be provided to the Purchaser or its representative upon request. If it is discovered that tools and equipment that were used for the Work have not been calibrated within one (1) year of the inspection date, the inspections shall be repeated, at the sole risk of the Contractor, with tools and equipment that are properly calibrated.

7.5 Inspection and Test Plan

At least 30 days after execution of the contract, the Contractor shall submit the Inspection and Test Plan for approval by the Engineer. The ITP document shall identify in detail:

(a) Production process and associated test,
(b) Parameter to be controlled,
(c) Sampling and frequency,
(d) Acceptance criteria,
(e) Reference standard or document,
(f) Control equipment,
(g) Testing location,
(h) Person/position responsible for the test, and
(i) Quality Control record form.

The Engineer will determine the Purchaser's level of involvement in testing. This will be reflected in the ITP document.

7.6 Non-Conformance Reports

The Contractor shall provide the Purchaser or its representative, within 7 days of such request, information related to any present non-conformance reports regarding conductor hardware assembly quality and manufacturing, testing, shipping, internal and external QA audits, including corrective and preventative actions in accordance with CAN/CSA-ISO 9001.

8 MARKING, PACKAGING AND SHIPPING

8.1 Marking

Marking is required to ensure traceability for each of the component of the conductor hardware assembly.

All hardware components shall be marked permanently with the manufacturer's identification and component rated strength as a minimum.

The letters and numerals shall be distinct, durable, and conspicuous. All marking requirements shall be in accordance with CSA C83. Markings may be raised or depressed but must be clearly legible after galvanizing.

8.1.1 Suspension Clamps

Suspension clamp marking shall include conductor diameter range and catalogue number.

8.1.2 Installation Torque

All components with critical installation torques shall have the torque value permanently marked on the component.

8.1.3 Bolts

The heads of bolts shall be marked with the grade identification symbol.

8.2 Packaging and Shipping

8.2.1 General

The Contractor shall prepare the conductor hardware assemblies for shipment in such manner as to protect them from dust and dirt, damages during transportation, handling and outdoor storage. The Contractor shall be responsible for and make good any and all damage resulting in loading and transportation.

8.2.2 Packaging

The packaging arrangements shall be optimized to allow for an ease of field handling and installation.

Aluminum components, such as clamps and grading rings, shall be packaged into wooden crates or boxes separately from the steel parts and protected against movements during transportation.

Proper protection shall be provided to prevent movement of the components inside the crates or boxes during transportation. These crates or boxes shall be grouped into pallets in such manner that they can be easily lifted by a forklift. Shrink wrap or other appropriate packaging option shall be used to protect the pallets from weather elements.

The loaded pallets shall be capable of withstanding environmental conditions as listed in Table 2 for at least 24 months without loss of characteristic properties of all the hardware components in the pallet.

8.2.3 Approval of Packaging

The Contractor shall provide the packaging details to the Engineer for approval within six (6) weeks of Contract award. No packaging shall proceed without Engineer's approval.

8.2.4 Marking of Crates or Boxes

Each box shall be clearly marked with the following information:

(a) Project name specified on the Purchase Order
(b) Purchase Order number
(c) Contractor's name
(d) Name of item, including conductor size and assembly type
(e) Destination
(f) Weight, in kilograms
(g) Date of manufacture
(h) Quantity of items
(i) Production lot number

All markings shall be legible and made of stamped metal tag securely attached to the box. All identification marks shall appear on the side and on the top of each box.

8.2.5 Shipping Reports

The Contractor shall, within 24 hours of each shipment, provide Purchaser with the shipping report, which shall include:

(a) Project name specified on the Purchase Order
(b) Purchase Order number
(c) Items and quantities shipped

(d) Net and gross mass of each box
(e) Carrier
(f) Bill of Lading number
(g) Shipping date
(h) Expected delivery date

The Contractor shall be responsible for tracking and expediting all shipments and for obtaining all required permits.

8.2.6 Delivering

The Contractor shall deliver all shipments on an open flatbed trucks for offloading using a forklift.

Minimum 4" thick wood blocking on bottom of wood crate shall be used to allow lifting by a forklift.

Deliveries using sea containers will not be accepted.

END OF TECHNICAL REQUIREMENTS

TERMS AND CONDITIONS OF PAYMENT

DESIGN, MANUFACTURE AND SUPPLY OF 500kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES	DECEMBER 2016

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES 500kV AC TRANSMISSION LINES REQUEST FOR PROPOSAL 040314

TERMS AND CONDITIONS OF PAYMENT

1 ITEMS 1 TO 7

Subject always to satisfactory performance of the Work by the Contractor in accordance with the Contract, the Purchaser shall pay the Contractor the cost of the Work and all services of the Contractor in connection therewith, in Canadian currency, whichever currency was proposed, as follows:

1.1 Major Payment

An amount equal to 92.5% of the cost of the Work shall be paid 30 days after receipt of the Contractor's invoice following the completion of the Work.

Prior to payment of 92.5% of the cost of the Work to the Contractor as aforesaid, the Purchaser may require the Contractor to furnish the Purchaser with an Affidavit sworn by the Contractor in the form set out in Schedule 'A' (see SAMPLE ONLY) to these Terms and Conditions of Payment.

1.2 Performance Holdback

The 7.5% Performance Holdback balance of the cost of the Work shall be paid 30 days after the date of the COMPLETION CERTIFICATE issued in respect thereof.

END OF TERMS AND CONDITIONS OF PAYMENT

Terms and Conditions of Payment Schedule 'A'

CANADA) I, ______________________________
)
PROVINCE OF MANITOBA) of the __________ of ____________ in the
)
TO WIT: 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__

FORM OF PROPOSAL

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

Important: Macro Security level to Medium

1. The first field to be completed in the Form of Proposal is your full legal company name. Once your proposal is complete and converted to pdf, your full legal company name will automatically appear inside the header of every page.

2 Continue preparing your proposal by completing the gray shaded fields on each page.

3. 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.

4. Certain fields which contain the drop-down selection feature will allow you to make a selection from a list. For checkboxes, click inside the applicable YES or NO box to make a selection. To deselect, click inside the YES or NO box you wish to deselect.

5. After you are satisfied with your electronic completion of the Form of Proposal, save the document and convert it to pdf.

6. Print and sign the signing page manually. Scan the signed page and insert it into the Form of Proposal pdf. Delete the unsigned page.

7. Certain fields have been limited to a maximum number of rows or characters that you can type. If the space provided is insufficient, you can use the document provided titled “Additional Form of Proposal.docx”.

8. If the “Additional Form of Proposal.docx” document has been utilized, convert it to pdf.

9. Submit the Form of Proposal, Additional Form of Proposal (if used) and any other applicable documents that you wish to accompany your proposal.

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

DESIGN, MANUFACTURE AND SUPPLY OF 500 kV AC CONDUCTOR HARDWARE ASSEMBLIES
500kV AC TRANSMISSION LINES
REQUEST FOR PROPOSAL 040314

FORM OF PROPOSAL 040314

COMPANY INFORMATION

This proposal is submitted by: ______________________________
(legal company name)
hereinafter called the "Proponent", a company duly incorporated under the laws of:

____

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

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

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

The Proponent's principal office dealing with this Form of Proposal is at:

____
(number, street)

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

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

THE WORK

The Proponent shall provide its proposed price for the Work by completing the following information below:

Indicate if you're a Non-Resident Importer into Canada:

YES ☐ NO ☐

If YES please indicate your GST Registration # below:

ITEM	DESCRIPTION	QTY	EXW UNIT PRICE $ CAD	DDP UNIT PRICE $ CAD
1	**DEADEND STRING HARDWARE ASSEMBLY**	325		
	Packaging option A "by like pieces"			
	Packaging option B "by hot/cold end"			
	Packaging option C "by tower type"			
2	**177 KN I-STRING HARDWARE ASSEMBLY**	904		
	Packaging option A "by like pieces"			
	Packaging option B "by hot/cold end"			
	Packaging option C "by tower type"			
3	**177 KN V-STRING HARDWARE ASSEMBLY**	489		
	Packaging option A "by like pieces"			
	Packaging option B "by hot/cold end"			
	Packaging option C "by tower type"			
4	**243 KN I-STRING HARDWARE ASSEMBLY**	1		
	Packaging option A "by like pieces"			
	Packaging option B "by hot/cold end"			
	Packaging option C "by tower type"			
5	**243 KN V-STRING HARDWARE ASSEMBLY**	81		
	Packaging option A "by like pieces"			
	Packaging option B "by hot/cold end"			
	Packaging option C "by tower type"			
6	**JUMPER STRING HARDWARE ASSEMBLY**	208		
	Packaging option A "by like pieces"			

ITEM	DESCRIPTION	QTY	EXW UNIT PRICE $ CAD	DDP UNIT PRICE $ CAD
	Packaging option B “by hot/cold end”			
	Packaging option C “by tower type”			

(GST) and Manitoba provincial retail sales tax (PST) are not included in the proposed price. GST and PST shall be shown as “extra” on each invoice. All other applicable taxes shall be included.

ITEM 7 – TYPE TEST OF ITEMS 1 TO 6

....$__________**LUMP SUM**

(GST) and Manitoba provincial retail sales tax (PST) are not included in the proposed price. GST and PST shall be shown as “extra” on each invoice. All other applicable taxes shall be included.

COMMERCIAL COMPLIANCE

Below are proposed changes to the commercial terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

TECHNICAL COMPLIANCE

The Proponent's product offering full confirms with all the requirements of Technical Requirement in accordance with Manitoba Hydro Request for Proposal 040314:

YES ☐ NO ☐

If no, below are proposed changes to the technical terms contained in the RFP that the Proponent requests be considered during negotiation, if any, of its Proposal.

RFP SECTION	TITLE / DESCRIPTION	PROPOSED CHANGE	RATIONALE FOR CHANGE	COST AND SCHEDULE IMPACT

DELIVERY DATE(S)

The Proponent offers to deliver the ITEMS of the Work on the Purchaser's specified date:

YES ☐ NO ☐

If the above answer was NO or if the Proponent can deliver the Work earlier than the Purchaser's preferred date, the Proponent indicates below its earliest dates upon which the ITEMS of the Work could be delivered:

ITEM 1	,	20
ITEM 2	,	20
ITEM 3	,	20
ITEM 4	,	20
ITEM 5	,	20
ITEM 6	,	20

SHIPMENT/TRANSPORTATION DETAILS

Delivery of the Work

The Purchaser requires the Proponent to provide the following information regarding shipment/transportation of the Work:

The total shipment weight is ___________lb or ___________ kg.

The total shipment volume is __________ ft^3 or ___________m^3.

The shipment's dimensions are:
length ___________ ft x width ___________ ft x height ___________ ft, or
length ___________ m x width___________ m x height ___________ m.

The total shipment quantity is _________ (No. of cartons / No. of pallets, etc.)

The shipment will be transported via:

Road:
___________(qty) ___________ (length in ft) enclosed van(s), or
___________ (qty) ___________ (length in ft) flatdeck trailer(s).

OR
Rail:
___________ (qty) ___________ (length in ft) boxcar(s), or
__________ (qty) ___________ (length in ft) flatcar(s), or
___________ (qty) ___________ (length in ft) gondola car(s).

SHIPMENT/TRANSPORTATION DETAILS (CONTINUED)

Loading of the Work

The following is the location of the Proponent's shipping facility or factory where the ITEMS of the Work will be loaded, blocked, braced and secured for transportation by the Proponent or the Proponent's designated carrier:

Street Name and Number: ______________________________
City Province/State: ______________________________
Postal Code/Zip Code: ____________

The estimated travel time from the Proponent's shipping facility or factory to the Purchaser's designated arrival destination is day(s).

The Proponent intends to load the ITEMS of the Work in containers weighing:
______(kg) approximately and measuring _____ (m) x ______ (m) x _____ (m).

The Proponent indicates below any special equipment and requirements necessary for the transportation of the Work:

PRODUCTION SCHEDULE

The Proponent shall provide a detailed production schedule.

Include a GANTT chart, proposed schedule from ordering raw materials, manufacturing, shipping and delivery of products to final destination.

PLANT CAPACITY

The following is the Proponent's plant capacity which identifies the total plant capacity by month which details what portion of the capacity has been allocated to other orders.

Identify work arrangements by days/week and shifts/day.

MANITOBA CONTENT

The Proponent shall provide the estimated percentage of total proposed price that they consider to be Manitoba Content: ____________%

The Proponent shall provide a detailed breakdown of Manitoba Content that would be incorporated into the Work substantiating the above percentages (inputs originating from the Province of Manitoba such as labour, materials, transportation, etc):

NOTE: **Upon request, the Contractor shall provide to Manitoba Hydro records substantiating the percentage of Manitoba Content.**

a) Labour by Own Workforce

COMPONENT OF THE WORK	TYPE OF LABOUR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

b) Manitoba Subcontractors

TYPE OF WORK TO BE SUBCONTRACTED	NAME AND ADDRESS OF SUBCONTRACTOR	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

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

Manitoba Business Involvement (continued)

c) Purchase of Goods from Manitoba Companies

TYPE OF GOODS	NAME AND ADDRESS OF SUPPLIER	PORTION OF THE PROPOSED PRICE %
		%
		%
		%

d) Purchase of Equipment from Manitoba Companies

TYPE OF EQUIPMENT	NAME AND ADDRESS OF SUPPLIER	TOTAL VALUE OF PURCHASE PRICE $

e) Leased Equipment/Facility from Manitoba Companies

TYPE OF EQUIPMENT	OWNER	TOTAL VALUE OF LEASE $

Provide information regarding any lease agreements such as the following:

- Length of lease
- Lease payment
- Maintenance
- Residual value

Manitoba Business Involvement (continued)

f) Other Manitoba Content:

OTHER INPUTS	OWNER	TOTAL VALUE OF LEASE $

ALTERNATIVE METHODS, PROCEDURES, SCHEDULES, SEQUENCES OR ENVIRONMENTALLY PREFERABLE PRODUCTS/SERVICES

The following is a list of all of the Proponent's proposed alternative methods, procedures, schedules, sequences or environmentally preferable products/services that affect the Work:

EQUAL ARTICLES, MATERIALS OR EQUIPMENT

The following is a list of the equal articles, materials or equipment that the Proponent proposes to substitute for those specified:

Article, Material, or Equipment		Price Change $	
Specified	Proposed	Increase	Decrease

NOTE: Names of manufacturers of equals and catalogue numbers are stated, if applicable. All technical data and literature are appended to this proposal. No equal articles, materials, or equipment will be permitted unless listed above and approved by the Purchaser.

JOINT VENTURES

The extent and nature of Manitoba business participation in a joint venture is detailed below.

A Band Council Resolution authorizing the provision of the Form of Proposal on behalf of the First Nation Band is submitted with this proposal:

YES ☐ NO ☐

PROPONENT'S TECHNICAL AND NON-TECHNICAL CONTACT PERSONS

All enquiries concerning the technical aspects of this proposal should be directed to:

(please print name and title of Proponent's Representative)
whose telephone number is: ( ) -
FAX number is: ( ) -
Internet e-mail address is: @ .
and World Wide Web is: http://www. .

All enquiries concerning the non-technical aspects of this proposal should be directed to:

(please print name and title of Proponent's Representative)
whose telephone number is: ( ) -
FAX number is: ( ) -
Internet e-mail address is: @ .
and World Wide Web is: http://www. .

SIGNING PAGE

The words used in this Proposal have the meanings ascribed to them in RFP 040314.

We/I the undersigned, having examined all of RFP 040314 together with all addenda issued prior to the Closing Date, and having attended all mandatory meetings and mandatory site visits, hereby submit this proposal with all necessary enclosures.

The Proponent agrees that RFP 040314, and any proposal submitted in respect of same, is not a legal offer. By signing below, the Proponent certifies that the information submitted herein is true and correct as of the date set out below to the best of the Proponent's knowledge, and that the Proponent agrees to the terms and conditions set out in the RFP.

______________________________ [Insert legal name(s) of Proponent]

Per ______________________________ Name ______________________________
Authorized signing officer Print Name

I have authority to bind the Proponent

Dated ___________________________ ________________________
Title

DESIGN, MANUFACTURE AND SUPPLY OF 500KV IMPLOSIVE CONNECTORS
500kV AC TRANSMISSION LINES
REQUEST FOR PROPOSAL 040432

ADDENDUM 1

In proposing on Manitoba Hydro Request for Proposal 040432 which will close on **March 8, 2017**, the Proponent shall comply with this addendum which shall form part of Request for Proposal 040432.

....

TECHNICAL REQUIREMENTS
Page 9, Section 6.6 Type Tests

Item (b) in Subsection 6.6.1 General shall be revised as follows:

> Type tests are intended to demonstrate conformance of electrical and mechanical characteristics of the proposed Implosive Connectors with all the requirements of these Technical Requirements. All Implosive Connectors shall be subject to type tests listed in Table 1.
>
> All type tests shall be performed on three Implosive Connector samples except for:
>
> a) Tensile load test shall be done on three sets, each including two terminal dead-ends and one joint.
>
> b) Electrical current cycling test shall be done on ~~three~~ ***one*** sets~~s~~, ***this set shall*** ~~each~~ inclu***de***~~ding~~ four terminal dead-ends, four joints and four jumper terminal jumpers.

....

Marlon Watts
Manitoba Hydro
Purchasing Department
360 Portage Avenue
Winnipeg, Manitoba, R3C 0G8,
Canada.

February 21, 2017

NOTE:	Deletions are shown as ~~strikethrough text~~ and replacements/additions are shown as ***large bold italicized text***.

H501A/f Rev 98 09

Manitoba Hydro

REQUEST FOR QUOTATION

RFQ number
040259

Date (Year/Month/Day)
2016/09/07

IMPORTANT NOTE:
The above Document number **MUST** appear on **ALL** correspondence and formal communications with Manitoba Hydro.

Vendor:110595 / 6000151631

QUOTATIONS DEPARTMENT
COMPANY NAME: ______________________
PH:________________________________
FAX:_______________________________
CONTACT NAME:_______________________

CLOSING DATE: 2016/10/13
16:00 HOURS MANITOBA LOCAL TIME

Quotations shall be submitted not later than the Closing Date.

Purchasing Enquiries: Greg Lebans
Telephone: 204-360-5231
Email: glebans@hydro.mb.ca

DELIVERY DATE : 2017/03/31

RFQ 040259
TOWER TESTING
GUYED AND SELF SUPPORTING - MMTP

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QUOTATIONS DEPARTMENT FAX:______________________________ CONTACT NAME:_____________________	RFQ number / Date (Year/Month/Day) **040259** / 2016/09/07	Page 2

SUBMISSION OF TENDER:

Electronic Submissions
Tenders shall be submitted electronically by MERX (www.merx.com) not later than the Closing Date. Tenders submitted through Merx are, preferably, made in a word searchable.pdf format. Tenders not submitted through MERX will not be accepted.

Delivery and Receipt of Documents and Submissions
Manitoba Hydro assumes no risk, makes no guarantee, warranty or representation whatsoever, and shall have no responsibility or liability, including in contract or in tort, whatsoever, for or in connection with:
(a) the timely delivery of any information or documentation, including, without limitation, the RFQ;
(b) the timely receipt of any tenders, revisions, amendments, notice of withdrawals, or any other information or documentation from any Respondent or potential Respondent, or;
(c) the working order, functioning or malfunctioning, of any electronic information system (including Merx).

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QUOTATIONS DEPARTMENT
FAX:______________________________
CONTACT NAME:_____________________

RFQ number / Date (Year/Month/Day) Page
040259 / 2016/09/07 3

DEFINITIONS

"Confidential Information" means all information concerning Manitoba Hydro and the Work that is supplied by Hydro or otherwise comes into the possession of the Contractor during the course of performance of the Work, regardless of format or medium, and the Work.

"Contract" shall mean the agreement to be entered into between the Purchaser and the Contractor for work to be done and/or material and equipment to be furnished in accordance with this Request for Quotation (RFQ).

"Contractor" shall mean the party or parties named as such in the Contract and the legal personal representatives, successors and assigns of the Contractor.

"Plant" shall mean items which are brought on to or constructed upon the Site by the Contractor for the performance of the Work, including, but not limited to, tools, equipment and vehicles.

"Purchase Order" shall mean the document(s) by which the Purchaser accepts a tender, and shall include all change orders and work orders amending, deleting and/or adding to the Work.

"Purchaser" shall mean Manitoba Hydro, its successors and assigns, including any duly appointed representative(s).

"Site" shall mean the place(s) where the Work is to be carried out and the immediate vicinity.

"Subcontractor" shall mean a person, firm or corporation having a contract with the Contractor for part of the Work, including without limitation the furnishing of labour, material, equipment or apparatus.

"Respondent" or "Bidder" shall mean any party tendering on one or more of the various classes of work covered by this Request for Quotation.

"Work" shall mean all of the various classes of work to be done, executed and performed, whether temporary or permanent, and all equipment, apparatus, machinery and materials to be furnished and supplied by the Contractor pursuant to the Contract.

Next Page:4

QUOTATIONS DEPARTMENT
FAX:______________________________
CONTACT NAME:_____________________

RFQ number /	Date (Year/Month/Day)	Page
040259 /	2016/09/07	4

INSTRUCTIONS TO RESPONDENTS

ENQUIRIES
Enquiries should be submitted early to permit evaluation and potential response. A Respondent shall not be entitled to rely on any response or interpretation received in respect of an enquiry unless that response or interpretation was provided via an addendum to the RFQ.

FORM OF TENDER
The Respondent is required to use the Form of Tender. The Respondent is encouraged to include in their tender thorough and sufficient information concerning matters under consideration.

If any discrepancy exists between a Form of Tender issued by Manitoba Hydro and the Form of Tender submitted by a Respondent, Manitoba Hydro reserves the right, in its sole unfettered discretion, to not accept the tender.

ADDENDA
The Purchaser may, at any time prior to the date and time of closing, issue addenda changing this RFQ, and such addenda shall be an integral part of this RFQ.

SIGNING OF TENDERS
A tender submitted shall be signed by an authorized signing officer of the Respondent. If a tender is submitted by more than one legal entity, the tender shall be signed by an authorized signing officer of each legal entity. Manitoba Hydro may require evidence of the authority of any person purporting to sign a tender on behalf of a person, firm or corporation, whether as principal, agent or attorney.

PRIVILEGE/DISCRETION
Manitoba Hydro reserves the right to cancel this RFQ in its entirety, re-issue or tender all or any part of the Work referred to in this RFQ, at any time, regardless of whether or not any tenders have been received, for any reason whatsoever, in Manitoba Hydro's sole and unfettered discretion.

If any tender is accepted, in whole or in part, Manitoba Hydro shall notify the successful Respondent in writing. The successful Respondent cannot rely upon oral acceptance.

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 tender, accept the lowest tender, or be precluded from accepting any tender or other offer further in respect of any tender submitted. Manitoba Hydro reserves the right, and the Respondent acknowledges that Manitoba Hydro has the right, to reject any, or all, tenders, for any reason, or to accept any tender which Manitoba Hydro in its sole unfettered discretion deems advantageous to itself.

Manitoba Hydro reserves the right in its sole unfettered discretion to 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 tender process and/or the requirements of this RFQ.

WITHDRAWAL/AMENDMENT OF TENDER
A Respondent may withdraw or amend its tender on MERX any time prior to the time and date of closing.

RESPONDENT'S EXPENSES
The Respondent shall be responsible for all expenses concerning or related to the preparation of its tender and any subsequent discussions.

DIVISION OF ITEMS
The Work has been divided into items which may be purchased separately or collectively. Also, the Purchaser may award Purchase Order(s) to one or more contractors.

TENDERED PRICES

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Tendered prices shall include all customs duties, surcharges, insurance premiums, permit and licence fees, Workers Compensation and vacation pay assessments, and all other payroll benefits. Canadian Goods and Services Tax (GST) and Manitoba provincial retail sales tax (PST) shall be treated as specified for each item. All other applicable taxes shall be included and shall not be subject to any adjustment.

No payment shall be made to the Contractor for sales tax (if any) which may be imposed by Canada or Manitoba in respect of the Contractor's plant, tools and any other items not included in the Work.

Prices in the accepted tender, if any, shall be firm and not subject to adjustment for changes or unexpected contingencies of any kind whatsoever, including without restricting the generality of the foregoing, changes in wages, material costs, or taxes which may in future be imposed by lawful authority within or outside of Canada.

Should a discrepancy between any unit price and its extension be identified, the unit price will be considered the tendered amount.

EVIDENCE OF RESPONDENT'S ABILITY, EXPERIENCE, CAPITAL AND PLANT
The Purchaser may require the Respondent to furnish evidence, in addition to any provided by the Respondent in a tender, satisfactory to the Purchaser, that the Respondent has the ability, experience, capital and plant required to undertake and perform the Work successfully, and complete it within the time specified.

The Purchaser may inspect any Plant and /or facilities that the Respondent proposes to use for doing the Work.

ENVIRONMENTALLY PREFERABLE PRODUCTS OR SERVICES
It is the desire of Manitoba Hydro to use environmentally preferable products and/or services, if practicable. Respondents able to supply products and/or services that are environmentally preferable, and that meet performance requirements, are encouraged to propose them as an alternative within their tender.

MANITOBA CONTENT EVALUATION
All things being reasonably equal, preference shall be given to tenders which maximize Manitoba content in the Work. Manitoba Hydro will take into consideration the amount of Northern Manitoba and Northern Manitoba Aboriginal content when analyzing tenders.

QUALITY ASSURANCE PROGRAM
The Respondent will provide particulars of the quality assurance program that would apply to the Work. If the Respondent's program is not based on ISO 9001-2008, the Respondent will submit evidence, satisfactory to the Purchaser, that the program conforms fully with the spirit and intent of ISO 9001-2008. Manitoba Hydro shall have sole and final discretion in determining whether a quality assurance program is the equivalent of ISO 9001-2008.

TENDER EVALUATION CRITERIA
Mandatory Submission Requirements
(PASS/FAIL)
1. Quality Assurance Program & Quality Control Procedure Document and/ or ISO Certificates
2. Preliminary test procedure for A-550 and A-551 towers

In order to determine overall best value to Manitoba Hydro, tenders received will be evaluated in accordance with the following criteria (in no particular order of preference):
a) Price
b) Demonstrated track record and previous experience in similar work requested in this RFQ including subcontractors.
c) Schedule

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CORRUPT OR FRAUDULENT PRACTICES

Manitoba Hydro has the right at any time to reject any tender submitted if, in Manitoba Hydro's determination, the Respondent has engaged in any Corrupt, Fraudulent, Collusive, Coercive or Obstructive Practice or has breached any laws regarding corruption or fraud. For these purposes the following defined terms shall apply:

a) "Coercive Practice" means impairing or harming, or threatening to impair or harm, directly or indirectly, persons or their property to influence improperly the actions of Manitoba Hydro, a Respondent, or any other person, in the procurement process, or in entering of the Contract.

b) "Collusive Practice" means an arrangement between two or more persons (including, without limitation, a Respondent and any other person) designed to achieve an improper purpose, including but not limited to the establishment of prices for the Work at artificial, non-competitive levels in the procurement process or in entering of the Contract.

c) "Corrupt Practice" means the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of Manitoba Hydro, a Respondent, or any other person, in the procurement process, or in the entering of the Contract.

d) "Fraudulent Practice" means any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, Manitoba Hydro, a Respondent, or any other person, to obtain a financial or other benefit or to avoid an obligation in the procurement process, or entering of the Contract.

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GENERAL REQUIREMENTS

DESCRIPTION OF THE WORK
ITEM 1 - Fabrication and Supply Tower Testing of A-550-0+9m extension Tangent Tower in accordance to MB Hydro Drawing # 1-36070-DE-25112-0001 sht 0001 rev 00

ITEM 2 - Fabrication and Supply Tower Testing of C-550-0+9m extension Angle Tower in accordance to MB Hydro Drawing # 1-36070-DE-25132-0001 sht 0001 rev 00

ITEM 3 - Fabrication and Supply Tower Testing of A-551-0+6m extension Tangent Tower in accordance to MB Hydro Drawing # 1-36070-DE-25111-0001 sht 0001 rev 00

ITEM 4 - Fabrication and Supply Tower Testing of B-551-0+6m extension Angle Tower in accordance to MB Hydro Drawing # 1-36070-DE-25121-0001 sht 0001 rev 00

ITEM 5 - Fabrication and Supply Tower Testing of D-550-0+9m extension Angle Tower in accordance to MB Hydro Drawing # 1-36070-DE-25142-0001 sht 0001 rev 00

ITEM 6 - Fabrication and Supply Tower Testing of B-550-0+9m extension Angle Tower in accordance to MB Hydro Drawing # 1-36070-DE-25122-0001 sht 0001 rev 00

ITEM 7 - Retesting of Towers (PURCHASER'S OPTION)
7.1 - Retest of A-550-0+9m
7.2 - Retest of C-550-0+9m
7.3 - Retest of A-551-0+6m
7.4 - Retest of B-551-0+6m
7.5 - Retest of D-550-0+9m
7.6 - Retest of B-550-0+9m

Standard Material Specifications
Fabrication and Supply of Tower Testing for ITEMs 1 - 7, shall be in REFERENCE to MB Hydro Tower Testing Technical Specification and STANDARD MATERIAL SPECIFICATION 30-3M latest revision (Supply of Steel Towers), and 30-7M latest revision (Supply of Bolts, Nuts, and Washers).

PURCHASER'S OPTION
The Purchaser has the option, but not the obligation, to purchase ITEMS of the Work identified in Section 1 - SCOPE OF THE WORK as a "Purchaser's Option" and set out in the Form of Tender (the "Option") as follows:

(a) the term for the Purchaser's acceptance of an Option shall be 6 months from the Effective Date (the "Option Period"),
(b) the Purchaser may exercise an Option with respect to any of the said ITEMS individually, severally, or in any combination, at any time during the Option Period, and
(c) the Purchaser shall exercise an Option by written notice to the Contractor in the form of an Extra Work Order informing of its election to do so with respect to an ITEM within the Option Period. Such notice from the Purchaser exercising an Option shall constitute a binding agreement of purchase and sale and the Contract shall be deemed amended thereby and all terms and conditions of the Contract shall apply mutatis mutandis to the exercised Option.

SCHEDULE OF THE WORK
Tower Testing to be completed in the following order; A-550, A-551, B550, C-550. D-550, B-551. All testing shall be completed by March 31, 2017

TRANSPORTATION, TRAVEL, MEALS AND ACCOMMODATIONS
The Contractor shall be responsible for the transportation of its equipment and personnel to, from and around the sites as required to complete the Work, as well as for all meals and accommodations.

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FOREIGN NATIONALS WORKING IN CANADA
The following provisions apply to all workers employed by the Contractor or under the Contractor's control or for who the Contractor is otherwise responsible under the Contract, who are NOT citizens of Canada or 'permanent residents' of Canada (as defined in the Immigration and Refugee Protection Act). Such persons are defined, collectively, in the Immigration and Refugee Protection Act as 'foreign nationals', which term is used below and has the same meaning.

The Contractor shall ensure that all workers who are foreign nationals and who perform services under the Contract in Canada are legally authorized to work in Canada. The Contractor shall obtain and maintain all necessary work permits, visas and documentation for such foreign nationals, and shall comply with all conditions imposed on the Contractor, as 'employer' of the foreign nationals, under the Immigration and Refugee Protection Act and regulations.

Before permitting any foreign nationals to perform services under the Contract in Canada, the Contractor shall, by notice in writing to the Contract Administrator,
(a) list all such foreign nationals by name;
(b) certify that the said foreign nationals are legally authorized to perform services under the Contract in Canada; and
(c) provide copies of their respective work permits, and visas or other documentation if applicable.

Furthermore, the Contractor shall provide copies of work permit or visa renewals to the Project Manager if applicable, so that at no time is any foreign national performing services under the Contract in Canada without the requisite legal authority.

CONFLICT OF INTEREST
The Contractor warrants that to the best of its knowledge the Contractor, its directors, officers, employees, and subcontractors, have and shall continue to have no conflict of interest that may be detrimental to the performance of the Work or to the Purchaser. The Contractor shall provide notice to the Purchaser of any actual, potential, or apparent conflict of interest immediately upon awareness of same.

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GENERAL CONDITIONS

CORRUPTION AND FRAUD
The Contractor declares and undertakes in relation to the Contract that it:
a) has not acted and will not act unfairly or dishonestly so as to cause loss to the Purchaser or deprive the Purchaser of its rights;
b) has not offered, given, demanded or accepted any bribe or other improper benefit or advantage to any person and will not do so;
c) has not provided false, inaccurate or misleading information to any person and will not do so;
d) has not authorized, acquiesced or turned a blind eye to any form of corruption and will not do so;
e) did not collaborate, directly or indirectly, with any person in competition for this or other contracts with the Purchaser during the procurement process;
f) will not, in respect of any design services to be provided under the Contract, deliberately, knowingly, with willful blindness or recklessness, provide or approve a design which will provide an improper benefit or advantage to any person or which is in excess of the Purchaser's requirements and has not been fully disclosed and approved by the Purchaser;
g) will not deliberately, knowingly or with willful blindness or recklessness, carry out, instruct, authorize, condone or be a party to provision of work, materials, equipment or services not of a quality and quantity required under the Contract; or
h) will not conceal defective work, material, equipment or services.

INTENT
The Contractor shall fully and completely perform the Work described herein, in every detail within the timeframe(s) and for the purpose(s) designated in this Contract, and the Contractor shall do or cause to be done any and every thing necessary for such purpose, all in accordance with this Contract; and the Contractor shall fully and completely perform all of its covenants and obligations in, from, or in respect of, this Contract.

SUBCONTRACTS
The contracts pertaining to the Work subcontracted shall be subject to all the terms and conditions of this Contract. The Contractor shall not subcontract any of the Work or change any accepted subcontractors without prior express written consent from Manitoba Hydro.

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 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.

INVOICES
The invoices to be submitted by the Contractor shall be satisfactory to Manitoba Hydro in both form and content. The Contractor shall also provide supporting documents and receipts if requested by Manitoba Hydro.

LIABILITY
The Contractor shall use due care in the performance of the Contract to ensure that no person is injured, no property damaged or lost and no rights are infringed.

Manitoba Hydro shall not be liable for any injury, property loss or damage suffered by the Contractor arising out of the Contract, unless caused by wrongful or negligent acts or omissions by Manitoba Hydro.

The Contractor shall indemnify and save harmless Manitoba Hydro against all claims and suits by third parties resulting from breach of the Contract or wrongful or negligent acts or omissions by the Contractor or its agents.

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CONFIDENTIALITY
The Contractor may only use Confidential Information for the purpose of providing the Work to Manitoba Hydro and not for any other purpose. The Contractor may share Confidential Information with an employee or sub-contractor who has a need to know for the purpose of the Work. The Contractor shall not disclose Confidential Information to any other person without Manitoba Hydro's prior written consent. At Manitoba Hydro's request, the Contractor shall immediately return Confidential Information to Manitoba Hydro, or certify in writing that it has been destroyed.

INTELLECTUAL PROPERTY
Drawings, reports, manuals, documents, and other and/or similar materials (herein "Drawings") produced/provided by the Contractor or on behalf of the Contractor in the course of the Work shall become the exclusive property of Manitoba Hydro. Ownership of any proprietary information or intellectual property contained in the Drawings shall remain with the Contractor. The Contractor shall grant Manitoba Hydro a perpetual, royalty free, non-transferable (save and except transferable to Manitoba Hydro's affiliates or transferable to any entity created after the effective date of the Contract and to which Manitoba Hydro assets are assigned or otherwise transferred) limited licence to use, copy, and to allow third parties to use the Drawings and all proprietary information in the Drawings as may be required.

TERMINATION OF THE CONTRACT
Manitoba Hydro may terminate the Contract (for whatever reason Manitoba Hydro deems fit and at any time during the Work) on 30 days' written notice. Manitoba Hydro shall pay for fees and expenses incurred to the date of the termination.

Without restricting its other remedies, Manitoba Hydro may immediately terminate the Contract in writing if the equipment or services are unsatisfactory, inadequate, or improperly performed, the Contractor fails to comply with the Contract, or the Contractor becomes bankrupt or insolvent.

INTERPRETATION OF THE CONTRACT
Manitoba Hydro's decision shall govern 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 Manitoba Hydro shall be the sole judge of the quality, quantity, suitability and efficiency of labour, workmanship, materials, plant, apparatus, equipment, appliances and methods used, furnished or supplied by the Contractor pursuant to the Contract.

The Contract shall be interpreted and governed according to the laws of the Province of Manitoba, Canada.

ENUREMENT
The Contract shall enure and be binding upon the parties and their executors, administrators, heirs, successors and permitted assigns.

ASSIGNMENT OF RIGHTS AND OBLIGATIONS
The Contractor shall not assign any of its rights or obligations arising under the Contract without the written consent of Manitoba Hydro, which consent may be arbitrarily withheld.

EMPLOYEES OF CONTRACTOR OR EMPLOYEES OF SUBCONTRACTORS
All individuals performing the Work shall be skilled in their work assignments. The Contractor shall not retain an individual for Work whose skill or fitness is unsatisfactory to Manitoba Hydro.

WORK SAFETY
The Contractor shall comply with all applicable laws, including without limitation all laws, regulations, licensing requirements, and by-laws duly enacted by federal, provincial and/or municipal authorities.

The Contractor shall at all times follow safe working practices, and shall take all necessary measures to protect the safety of workers and all others persons who may be in the vicinity of the work site. At a

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minimum the contractor shall comply with the requirements of The Workplace Safety and Health Act, C.C.S.M. c. W210 and with all reasonable requests and directions of Manitoba Hydro.

WORKER'S COMPENSATION
If the Contractor is required to be registered under The Workers Compensation Act, R.S.M. 1987, c. W200, then the Contractor shall at all times pay, or cause to be paid, any assessment or compensation required to be paid pursuant to the Act. Upon failure to do so, Manitoba Hydro may pay such assessment or compensation to The Workers Compensation Board, and deduct the amount thereof from monies due to the Contractor. Manitoba Hydro may 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.

INDEPENDENT CONTRACTOR
The Contractor is an independent Contractor. This Contract shall not create, nor shall it be deemed to create, the relationship of employer and employee, principal and agent, partnership, or joint venture between Manitoba Hydro and the Contractor, or between Manitoba Hydro and any officer, employee, subcontractor or agent of the Contractor.

The Contractor is responsible for any deductions or remittances which are, or which may hereafter, be required by law.

INSURANCE
The Contractor shall provide, maintain and pay for General Liability Insurance, and shall provide limits of not less than $2 000 000 (Cdn) inclusive, per occurrence, for bodily injury, death, and damage to property including loss of use thereof.

The General Liability Insurance shall include insurance coverage for the following:
a) Premises Property and Operations
b) Products and Completed Operations
c) Blanket Contractual Liability
d) Cross Liability
e) Non-owned Automobile Liability
f) Occurrence Property Damage
g) Manitoba Hydro named as Additional Insured, endorsed to provide no less than 30 days' written notice of cancellation, change or amendment restricting coverage

The Contractor shall supply Manitoba Hydro with a certified copy of the required policy of insurance and all renewals thereof. A Certificate of Insurance may be submitted in place of the policy provided that all terms and conditions of required coverage are specified therein. All documentation must be submitted to Manitoba Hydro prior to the commencement of the Work.

The Contractor shall be responsible for any deductible amounts under the policy except where such amounts may be excluded from the Contractor's responsibility. Should a loss be sustained, the Contractor shall act on behalf of both Manitoba Hydro and the Contractor for the purpose of adjusting the amount of loss with the insurance companies.

TERMS OF PAYMENT
Subject to satisfactory performance of work and the Contractor's obligations hereunder, Manitoba Hydro shall pay the Contractor the cost of the Work and all services in Canadian currency 30 days after the date of the Contractor's invoice.

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TECHNICAL REQUIREMENTS

PURPOSE
The purpose of full scale testing is to confirm a tower's ability to withstand 100% of design loads.

The Contractor shall furnish all materials, including, but not limited to, foundations, tower steel, tower bolts, guy wire, and guy hardware, necessary to fabricate, assemble and erect the test tower.

GENERAL TEST CRITERIA
The material(s) and the manufacturing processes used in the fabrication of the test tower shall be to the same specifications as those used during the fabrication of the production towers. These specifications shall include the member sectional properties, connection details, e.g. bolt or weld sizes, material grades and fabrication processes.

TEST PROGRAM
The Contractor shall submit a comprehensive test program for approval by the Purchaser's Engineer at least three (3) weeks prior to testing.

The test program shall include, but not be limited to, the following information:

1. The expected test date.
2. A description of the proposed foundations for the test support.
3. The method of load application.
4. A drawing of the test rigging arrangement and attachment details.
5. The position of the dynamometers and/or load cells and the position of angle transducers in the case of resultant load applications.
6. The position of deflection measurement points.
7. The position and orientation of strain gauges if appropriate.
8. The tolerances (loads, resultant angles, deflections, strain gauges).
9. Details of applied loads for each test load case, load increment and holding period.
10. Holding period for the final level.
11. Loading rate for elastic-plastic materials and creep-sensitive materials.

ASSEMBLY OF TEST TOWER
The test tower shall be supported by footings and anchors (as required) that simulate the design assumptions.

The contractor shall proceed with the assembly of the test tower in accordance with the instructions provided by the Purchaser.

In the case where the contractor encounters a difficulty in the assembly or erection of the tower, the Purchaser shall be informed and shall decide on the modifications required.

A report of assembly shall be prepared by the contractor and submitted to the Purchaser. This report should include photographs of the different phases of the assembly and any particular difficulty encountered.

MATERIAL SPECIFICATION
The selection of materials, manufacturing tolerances and engineering properties (i.e. geometrical and mechanical characteristics) for the tower are the responsibility of the Purchaser.

The materials used for the fabrication of a test tower shall be representative of the materials used for the fabrication of the production towers and within the appropriate industry specification. Prior to fabricating the test tower, the contractor shall provide all material test reports and mill certificates to purchaser for review.

On completion of the test series, the Contractor shall take samples from the test tower in order to verify

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the compliance of the material with the specifications.

The number and location of samples are the responsibility of the Purchaser. If the components of the support do not fulfil the requirements of the applicable industry standards, the Purchaser may declare the test invalid and retest the tower at the Contractor's expense.

LOAD CASES AND TESTING SEQUENCE
Prototype towers shall be tested under load cases selected by the Purchaser's Engineer. Test loads shall be calculated as follows:

Test load = Limit Load / Strength Factor

Test loads will be provided by the Purchaser's Engineer. Strength factors used in determining the test loads can be found in Table 1.

	Reliability	Security
Tangent Towers	0.9	1.0
Running Angle Towers	0.85	0.95
Heavy Angle Dead End Towers	0.8	0.9

Table 1: Tower Structure Component Reduction Factors

The Purchaser's Engineer shall identify towers and their extensions requiring full scale testing.

Each tower shall be tested for 8 to 10 load cases based on the critical loads. All load cases shall be determined by the Purchaser's Engineer. One destruction test shall be required for the most critical loading case, as selected by the Purchaser's Engineer.

LOAD MEASURING DEVICES
Load measuring devices shall be placed at all load application points. In addition, load measuring devices shall be placed at all guy anchor attachment points, where applicable.

Calibration of all load cells shall be done within one week of tower testing commencement.

APPLICATION OF LOADS
After each increment of load is applied, there shall be a "hold" period of at least two minutes for reading deflection and observing the tower to check for signs of structural distress. At the 100% level of test load application, the "hold" period shall be increased to five minutes for each load case.

After each increment of applied load, tower deflection shall be observed and recorded at a sufficient number of points (minimum two) to fully assess the behaviour of the tower under load.

TOLERANCES ON APPLIED LOADS
For each load level, the applied load measurements shall be considered acceptable if they are within the limits shown in Table 2:

Load Level %	Acceptable Range %
50	49 to 51
75	74 to 76
90	89 to 91
95	94 to 96
100	100 to 102

Table 2: Tolerances on Applied Loads

WIND MEASUREMENTS
The Contractor shall use anemometers to measure wind speed and wind direction at the conductor

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level. Wind readings shall be recorded every 30 minutes during tower testing. Recorded values shall be included in the Tower Test Report, as detailed in Section 1.16 below.

DEFLECTION MEASUREMENTS
Deflections shall be measured and recorded in the transverse and longitudinal directions. Deflection measurements shall be taken under the "no load" condition both before and after testing.

LOCAL MEMBER FAILURE
If localized failure occurs below the design capacity level, the Contractor shall have provisions to repair the damaged member within four (4) working days. Repaired towers shall be tested immediately after repair.

CATASTROPHIC TOWER FAILURE
If catastrophic failure occurs below the design capacity level, the Contractor shall make all necessary provisions to re-fabricate and retest the tower within 6 weeks. The modified tower shall be re-tested for the load combination under which the failure occurred and any other load cases not yet tested.

Details of the tower failure shall be included in the Tower Test Report.

RE-USE OF FAILED TOWERS
No members of the failed tower shall be re-used unless approved by the Purchaser's Engineer.

TEST TOWER DISPOSAL
After successful completion of all tests, the Contractor shall dispose of the test tower at his own expense.

TOWER TEST REPORTS
The Contractor shall collect and document all the data obtained during tower testing.

The Contractor shall submit three (3) hard copies and one (1) electronic copy of each Draft Tower Test Report for approval by the Purchaser's Engineer, not later than four weeks following completion of the tower testing.

The following information shall be included in the test reports:

(a) Dates and location of the test,
(b) Description of all abnormalities and difficulties encountered during the assembly, as well as the corrective measures adopted,
(c) Rigging drawings used to apply the test loads,
(d) Loads required at the various points on the support and at each load level
(e) Holding period for the final load
(f) Instrument calibration records
(g) Deflection measurements
(h) Wind speed and direction

For each tower failure, the following information shall be recorded:

(i) Maximum loads applied to the tower prior to failure,
(j) Description of the failure,
(k) Engineering properties of failed members,
(l) Photographs and video recordings,
(m) Engineering properties of component samples taken from the tower and tested.

Details of all tower failures shall be included in the Tower Test Report.
Once approved by the Purchaser's Engineer, the Contractor shall submit one (1) hard copy and one (1) electronic copy of each Final Test Report.

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All reports shall bear certification and signatures of authorized representatives of the Contractor.

TOWER MODELS
The following files are available upon request and will be distrubted via email or CD:
- A-550+9m.bak
- C-550+9m.bak
- A-551+6m.bak
- B-551+6m.bak
- D-550+9m.bak
- B-550+9m.bak

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