INTERCONNECTION PROTECTION SETTINGS & COMMISSIONING

LIMITATION OF LIABILITY AND DISCLAIMER

This document is not a replacement for electrical codes or other applicable standards.

This document is not intended or provided as a design specification or as an instruction manual.

The DER owner, employees or agents recognize that they are, at all times, solely responsible for the generator plant design, construction, operation and maintenance.

FortisAlberta Inc. (FAI), and any person employed on its behalf, makes no warranties or representations of any kind with respect to the DER requirements contained in this document, including, without limitation, its quality, accuracy, completeness or fitness for any particular purpose, and FAI will not be liable for any loss or damage arising from the use of this document, any conclusions a user derives from the information in this document or any reliance by the user on the information it contains. FAI reserves the right to amend any of the requirements at any time. Any person wishing to make a decision based on the content of this document should consult with FAI prior to making any such decision.

SECTION 1: Protection Settings Validation

Interconnection Protective Equipment Nameplate Information

Use a separate form for each piece of equipment providing interconnection protective functions. For system protection requirements, review FortisAlberta's *DER-02: Technical Interconnection Requirements Standard*
Note: Individual inverters only require certification

FortisAlberta Project #				**Date**			
FortisAlberta Feeder Number				**Facility Name**			
Facility Status	**New**	☐	**Upgrade**	☐	**Existing**	☐	
Aggregate Generation Capacity		**Generation Type**		**Facility Nominal Voltage (VAC)**			
Device Identifier (as per SLD)			**Associated Relay Identifier (as per SLD)**				
Relay Manufacturer			**Relay Model**				
DER certified to UL1741 SB or more recent	☐		**Machine certified to UL2200**	☐			

Overcurrent Trip Settings

Provide below the protection settings that have been implemented or are intended to be utilized for the interconnection protection. *Note: Always verify upstream coordination with FortisAlberta.*

(50/51) Overcurrent Trip Settings: Use 25kV / 14.4kV as the base

Current Pickup (Amps) (Must be between 600A and 5A)	**Phase**		**CT Ratio**	**Ground**		**CT Ratio**
Curve Type						
Time Dial/Modifier						
Instantaneous Trip (Amps)						

(67/67N/32R) Directional Overcurrent / Reverse Power Trip Settings: Use 25kV / 14.4kV as the base

Element Pickup (Amps or Watts)	**67P**		**67N**		**32R**	
Curve Type						
Time Dial/Modifier						
Instantaneous Trip (Amps)						
Trip Direction (FTS to DER) (DER to FTS)						

TCC coordination and description with FortisAlberta devices (To be completed by Fortis Alberta):

Assessment Completed By:		**Overcurrent Settings Approved:**	☐ Yes ☐ No

Required Protection Settings

The following are the **required** protection settings and maximum clearing times for any interconnection to FortisAlberta's distribution system. Any variance to the below settings must be approved by FortisAlberta. If settings cannot be met, please provide justification in the comments section.

Frequency Protection

(81U) Under-Frequency Trip		(81O) Over-Frequency Trip	
Required Setting	**Maximum Clearing time**	**Required Setting**	**Maximum Clearing time**
UF1 = 58.5 Hz	300sec	OF1 = 61.2 Hz	300sec
UF2 = 56.5 Hz	0.16sec	OF2 = 62.0 Hz	0.16sec

Voltage Protection

(59) Over-Voltage Trip	
Required Setting	**Maximum Clearing time**
OV1 = 106%	45sec
OV2 = 110%	2sec
OV3 = 120%	0.16sec

(27) Under-Voltage Trip			
Inverter-Based Generation		**Machine-Based Generation**	
Required Setting	**Maximum Clearing time**	**Required Setting**	**Maximum Clearing time**
UV1 = 88%	10sec	UV1 = 88%	2sec
UV2 = 45%	0.16sec	UV2 = 45%	0.16sec

Any variances to the required voltage settings shall be specified here:

e.g., if FortisAlberta mandates an OV4 setting of 106.5% at 0.5 seconds then it shall be specified in this box.

Required Setting	Maximum Clearing time

System Synchronizing

(25) Synchronizing			
Requirements	**< 0.5 MVA**	**0.5 – 1.5 MVA**	**> 1.5 MVA**
Frequency Difference	0.3 Hz	0.2 Hz	0.1 Hz
Voltage Difference	10 %	5 %	3 %
Phase Angle Difference	20 Degrees	15 Degrees	10 Degrees

Use the comment section for any variance to the tables.

Anti-Islanding

Anti-Islanding			
Requirements			
Open Phase Detection	< 2 seconds		
Loss of Utility Voltage			
Unit Restart Delay after Utility Voltage Returns	≥ 5 minutes		
Dead Bus	No start		
Loss of Communication trip (Comms loss + Comms loss trip)	< 2 seconds		
DER Facility Method of Detection			
Active	☐	**Passive**	☐
Islanding Detection Method: (E.g., Sandia Frequency Shift, Active Frequency rift, or other)			
Anti-Islanding Scheme Description:			

Based on the criteria in DER-02, please indicate below the Anti-Islanding detection method and scheme.

Refer to DER-02 Annex A for islanding detection methods.

Voltage/Frequency Ride Through

Ride Through Requirements		
☐ Requirements outlined in Section 7.3 in Fortis Alberta's DER-02 have been met.		
Voltage Ride Through Settings (Machine Based)		
Voltage Range (%)	**Maximum Response Time**	**Minimum Ride Through**
V ≥ 120	0.16sec	N/A
117.5 < V < 120	N/A	0.2sec
115 < V ≤ 117.5	N/A	0.5sec
110 < V ≤ 115	N/A	1sec
88 ≤ V ≤ 110	N/A	Infinite
70 ≤ V < 88	N/A	$T_{VTR}(sec) = 0.7 + 4(V - 0.7pu)$
50 ≤ V < 70	N/A	0.16
V < 50	0.16	N/A
Frequency Ride Through Settings (Machine Based)		
Frequency Range (Hz)		**Minimum Ride Through**
f > 62		N/A
61.2 < f ≤ 62		299sec
58.8 ≤ f ≤ 61.2		Infinite
57 ≤ f < 58.8		299sec
F < 57		N/A

Ride through settings for inverter based DERs are confirmed by the manufacturer and certification. Machine based DERs are required to implement ride through settings.

NOTE: both ride through settings and maximum tripping times must be adhered to together.

Breaker Failure Protection

Breaker Failure (BF)	
Requirements	
FortisAlberta to Review BF Scheme	
Breaker Failure (upon detection of a BF condition)	≤ 0.3 second (pick-up)
	< 2 seconds (trip of secondary isolation point)
Breaker Failure (BF) Scheme Description:	

Breaker Failure protection shall be indicated on the *Electrical Single Line Diagram* with notes describing the protection philosophy.

Measurement Device Accuracy for Protection

Measurement Device Accuracy		
Requirements		
FortisAlberta to Review Measurement Device Accuracy for Protection		
Parameter	Minimum Accuracy	GFO Measurement Device Accuracy
Voltage (RMS)	± 1% V_{nom}	
Frequency	10mHz	
Active Power	± 5% rated apparent power	
Reactive Power	± 5% rated apparent power	
Time	± 1% of measured duration	
Additional notes on measurement device accuracy for protection:		

The measurement accuracy requirements for the PCC device shall be used.

Transformer Inrush/Rapid Voltage Change

Rapid Voltage Change	
Requirements	
FortisAlberta to Review DER site Rapid Voltage Change	
Rapid Voltage Change	RVC Study Complete and accepted by FortisAlberta: ☐
Rapid Voltage Change Mitigation Description (if applicable):	

Transformer inrush/RVC mitigation shall be indicated on the *Electrical Single Line Diagram* with notes describing the philosophy.

Transformer inrush/RVC results and graphs shall be included in the PQ Post-Energization Compliance report after the commissioning.

Power Plant Controller

DER Power Plant Controller (PPC) Verification	
Is a PPC being used? (it is recommended that a PPC be used at the PCC for any DERs greater than 249kVA)	☐ YES ☐ NO
Power Plant Controller Field Verification Plan complete?	☐ YES ☐ NO
FortisAlberta currently requires constant power factor control for DERs. Power Plant Controllers shall be able to accommodate all control requirements (e.g., Volt-Var control, Volt-Watt, etc.) outlined in DER-02 should another control mode be requested.	

Power plant controllers are recommended but not required. If a PPC does not exist at the DER site and there are system related issues, FortisAlberta may, at its sole discretion require a PPC to be installed.

Additional Comments / Protection Variances:

The following items must be attached/completed with this submission:

Electrical Single Line Diagram: Please ensure the most up to date issue for construction (IFC) Electrical SLD of the facility corresponds to this submitted IPSC document, meeting *Section 5.1* of FortisAlberta's DER-02. The SLD shall indicate the required protection elements and clearly outline the breaker failure scheme as indicated in *Section 7.6* in Fortis Alberta's DER-02.

All responsible individuals signing and stamping results for the DER owner/facility certify that the design of electrical protection and control systems for this generating facility complies with all applicable standards, including FortisAlberta DER-02, FortisAlberta PQ-SPEC-01 and applicable interconnection standards.

☐ **Description of anti-islanding detection method and scheme**

Please provide the manufacturer datasheet for the anti-islanding scheme. See *Section 7.4* in Fortis Alberta's DER-02 for required information.

☐ **Description Ride-through Settings**

Please provide the ride-through settings with submission as per *Section 7.3* in Fortis Alberta's DER-02.

Provided by:	**Reviewed by:**
Power Producer (Name / Company)	FortisAlberta
Title (P.Eng. Required with stamp)	Title
Signature	Signature
Date	Date

FORTIS ALBERTA

SECTION 2: Load Protection Performance and Equipment Commissioning

Load Protection Settings and Testing

Please provide in the table below the current settings of each of the system protection elements (section outlined in red). If an element differs from FortisAlberta's requirement provide justification to the variance in the additional comments section. If the element is not applicable to the system indicate in the table as nonapplicable and provide a comment stating why it is not required.

Interconnection Protection Validation: Refers to the testing of the protection elements / schemes and system equipment during start-up commissioning or maintenance activities. Indicate in the table below the period at which the interconnection protection settings have been tested. **All commissioning validation testing reports and procedures must be made available upon request from FortisAlberta.**

Results given in Section 2 shall be the actual load test results and not the settings proposed.

Please refer to FortisAlberta's *DER-02: Technical Interconnection Requirements Standard* for system requirements.

FortisAlberta Project #		Facility Name		Date

Interconnection Protection Validation					
New Commissioning	☐	Testing Completed ≤ 3 Years	☐	Testing Completed > 3 Years	☐

System Protection Elements and Validation			
Protection Elements		Settings	
		FortisAlberta Requirement	Facility Interconnection Settings
Overcurrent (non-directional)			
51	Phase Time Overcurrent	Unique to System Configuration	Fill out Separate Overcurrent Trip Table FortisAlberta DER-02, *Section 7.5*
50	Phase Instantaneous		
Directional (non-export)			
67	Phase Directional Overcurrent	10% of Total Generation Capacity	Fill out Separate Table
67N	Ground / Neutral Directional Overcurrent	10% of Total Generation Capacity	Fill out Separate Table
32R	Reverse Power	1% of Total Generation Capacity	Fill out Separate Table

Voltage			
59	**Over Voltage**	**OV1** = 106 % **Max. Clear Time** = 45 sec	**OV1 (%)** = **Actual Clear Time (sec)** =
		OV2 = 110 % **Max. Clear Time** = 2 sec	**OV2 (%) =** **Actual Clear Time (sec) =**
		OV3 = 120 % **Max. Clear Time** = 0.16 sec	**OV3 (%)** = **Actual Clear Time (sec)** =
		Alternate OV (if applicable) = **Max. Clear Time (sec)** =	**Alternate OV (%)** = **Actual Clear Time (sec)** =
27	**Under Voltage** *Inverter-Based (I)* *Machine-Based (M)*	**UV1** = 88% **Max. Clear Time** = (I) 10 sec (M) 2 sec	**UV1 (%)** = **Actual Clear Time (sec)** =
		UV2 = 45 % **Max. Clear Time** = 0.16 sec	**UV2 (%)** = **Actual Clear Time (sec)** =
Frequency			
81O	**Over Frequency**	**OF1** = 61.2 Hz **Max. Clear Time** = 300 sec	**OF1** (Hz) = **Actual Clear Time (sec)** =
		OF2 = 62.0 Hz **Max. Clear Time** = 0.16 sec	**OF2** (Hz) = **Actual Clear Time (sec)** =
81U	**Under Frequency**	**UF1** = 58.5 Hz **Max. Clear Time** = 300 sec	**UF1** (Hz) = **Actual Clear Time (sec)** =
		UF2 = 56.5 Hz **Max. Clear Time** = 0.16 sec	**UF2 (Hz)** = **Actual Clear Time (sec)** =

System Synchronizing (Not required for inverters certified to UL1741 or equivalent) (Required in Section 2 if performing system sync. at the PCC)			
25	**Frequency Difference**	0.1 - 0.3 Hz	**FD** =
	Voltage Difference	3 - 10 %	**VD** =
	Phase Angle Difference	10 - 20 Degrees	**AD** =
Anti-Islanding (Not required for inverters certified to UL1741 or equivalent)			
Loss of Utility Voltage		**Max. Clear Time** ≤ 2 sec	**Actual Clear Time (sec)** =
Open Phase			**Actual Clear Time (sec)** =
Transfer-Trip			**Actual Clear Time (sec)** =
Dead Bus		**No Start**	
Loss of Communication trip (Comms loss + Comms loss trip)		**Max. Clear Time** ≤ 2 sec	**Actual Clear Time (sec)** =
Breaker Failure (required in Section 3 if using inverter shut down for breaker failure)			
BF Detection		**Pickup** ≤ 0.3 sec	**Pickup** =
Secondary Isolation		**Clear Time** ≤ 2 sec	**Actual Clear Time** =

(50/51) Overcurrent Trip: Use 25kV / 14.4kV as the base

Current Pickup (Amps)	Phase		Ground	
Curve Type				
Time Dial/Modifier				
Instantaneous Trip (Amps)				
CT Ratio				

(67/67N/32R) Directional Overcurrent / Reverse Power Trip: Use 25kV / 14.4kV as the base

Element Pickup (Amps)	67P		67N	
Curve Type				
Time Dial/Modifier				
Instantaneous Trip (Amps)				
Element Pickup (Watts)	32R			
Time Delay				

Interconnection Equipment Testing

The DER Owner is responsible for the inspection, testing, and calibration of its equipment, at the PCC / PoC. Testing shall be conducted prior to the initial energization of the facility and on a periodic basis for maintenance purposes. Review DER-02, *Section 9.0* for inspection and testing requirements.

The following interconnection equipment at the PCC / PoC shall be included in all testing, but not limited to:

- Interrupting / Isolation devices (i.e. Breaker, Recloser, Disconnect Switch)
- Instrumentation (i.e. Current / Voltage Transformers, Sensing Devices)
- Control Wiring
- Underground Cabling
- Main Power Transformers
- Protection Function Testing
- Interconnection SCADA DNP3 Mapping: Refer to DER-02, *Annex 'A'* for requirements and mapping

All commissioning validation testing reports and procedures must be made available upon request from FortisAlberta.

Refer to manufacturer guidelines for equipment testing and expected values. In the absence of the manufacturer's information, use the latest industry standards for testing equipment. Indicate below the testing period and the standard(s) used for testing.

Interconnection Equipment Testing					
New Commissioning	☐	**Testing Completed ≤ 3 Years**	☐	**Testing Completed > 3 Years**	☐
Testing Standard(s) Applied (i.e. NETA ATS 2017, CSA C22.3 No 9, IEEE 1547.1)					

Additional Comments / Variances:

Testing Certification

Your signature below indicates that the information that has been provided is accurate and the testing of the protection and facility equipment aligns with the requirements in FortisAlberta's DER-02 standard. It also indicates that all testing results have been documented and are available upon request by FortisAlberta.

All responsible individuals signing and stamping results for the DER owner/facility certify that the electrical protection and control system for this generating facility complies with the design and all applicable performance standards, including FortisAlberta DER-02, FortisAlberta PQ-SPEC-01 and applicable interconnection standards.

Certified by:	**Reviewed by (P&C):**
Power Producer (name / company)	FortisAlberta
Title (P.Eng. Required with stamp)	Title
Signature	Signature
Date	Date

SCADA APPROVALS & SITE WITNESSING

Device Approvals		
FAI SCADA department has put the DER PCC device into production.	☐ YES ☐ NO ☐ N/A	Device ID:
FAI SCADA department has put the FAI PCC device into production.	☐ YES ☐ NO ☐ N/A	Device ID:

Completed by (SCADA):	**Site witnessed by (Field Technical Services):**
FortisAlberta Responsible Party	FortisAlberta Responsible Party
Title	Title
Date	Date

SECTION 3: Generation Protection Performance and Equipment Commissioning

Generation Protection Settings and Testing

Please provide in the table below the current settings of each of the system protection elements (section outlined in red). If an element differs from FortisAlberta's requirement provide justification to the variance in the additional comments section. If the element is not applicable to the system indicate in the table as nonapplicable and provide a comment stating why it is not required.

Interconnection Protection Validation: Refers to the testing of the protection elements / schemes and system equipment during start-up commissioning or maintenance activities. Indicate in the table below the period at which the interconnection protection settings have been tested. **All commissioning validation testing reports and procedures must be made available upon request from FortisAlberta.**

Results given in Section 3 shall be the actual test results and not the settings proposed.

Please refer to FortisAlberta's *DER-02: Technical Interconnection Requirements Standard* for system requirements.

FortisAlberta Project #		Facility Name		Date	
Interconnection Protection Validation					
New Commissioning	☐	**Testing Completed ≤ 3 Years**	☐	**Testing Completed > 3 Years**	☐
System Protection Elements and Validation					
Protection Elements		**Settings**			
		FortisAlberta Requirement		**Facility Interconnection Settings**	
System Synchronizing (Not required for inverters certified to UL1741 or equivalent) (Required in Section 3 if not performing the system sync. at the PCC)					
25	**Frequency Difference**	0.1 - 0.3 Hz		**FD** =	
	Voltage Difference	3 - 10 %		**VD** =	
	Phase Angle Difference	10 - 20 Degrees		**AD** =	
Effective Grounding – Transient Overvoltage (TOV)					
Load Rejection Overvoltage (LROV)		Review Reference Material		**Compliant with DER-02B** ☐ *PQ Report Required	

Anti-Islanding (Not required for inverters certified to UL1741 or equivalent)		
Generator Start after Voltage Restoration	**Block Start** ≥ 300 sec	**Start** =
Voltage Ride Through (Only applicable to machine based DERs)		
V (%) > 120	**Clear Time** ≤ 0.16 sec	**Actual Clear Time (sec)** =
117.5 < V (%) ≤ 120	**Clear Time** ≥ 0.2 sec	**Actual Clear Time (sec)** =
115 < V (%) ≤ 117.5	**Clear Time** ≥ 0.5 sec	**Actual Clear Time (sec)** =
110 < V (%) ≤ 115	**Clear Time** ≥ 1 sec	**Actual Clear Time (sec)** =
88 ≤ V (%) ≤ 110	**NO TRIP**	
70 ≤ V (%) < 88	**Clear Time** ≥ $0.7 + 4(V - 0.7pu)$	**Actual Clear Time (sec)** =
50 ≤ V (%) < 70	**Clear Time** ≥ 0.16 sec	**Actual Clear Time (sec)** =
V (%) < 50	**Clear Time** ≤ 0.16 sec	**Actual Clear Time (sec)** =
Frequency Ride Through (Only applicable to machine based DERs)		
f > 62	**Clear Time** ≤ 0.16 sec	**Actual Clear Time (sec)** =
61.2 < f ≤ 62	**Clear Time** ≥ 299 sec	**Actual Clear Time (sec)** =
58.8 ≤ f ≤ 61.2	**NO TRIP**	
57 ≤ f < 58	**Clear Time** ≥ 299 sec	**Actual Clear Time (sec)** =
F < 57	**Clear Time** ≤ 0.16 sec	**Actual Clear Time (sec)** =
Breaker Failure (required in Section 3 if using inverter shut down for breaker failure)		
BF Detection	**Pickup** ≤ 0.3 sec	**Pickup** =
Secondary Isolation	**Clear Time** ≤ 2 sec	**Actual Clear Time (sec)** =
Facility Start Up RVC		
Transformer Inrush	**RVC Measured (%)** =	
Facility RVC	**RVC Measured (%)** =	

Power Plant Controller (PPC)	
DER certifies that the power plant controller and all equipment in the measurement equipment, communications / signal equipment in the control loop have been tested individually and as a system.	☐
DER certifies system level tests performed include all required active / reactive control modes of DER-02 / IEEE 1547-2018 at the RPA, with all generating units included and in service.	☐
DER certifies that the facility has been left in power factor control mode set at the appropriate power factor setpoint. The DER confirms that the power factor specified by the PPC is the same as what was measured at the PCC relay.	☐

Interconnection Equipment Testing

The DER Owner is responsible for the inspection, testing, and calibration of its equipment, at the PCC / PoC. Testing shall be conducted prior to the initial energization of the facility and on a periodic basis for maintenance purposes. Review DER-02, *Section 9.0* and IEEE 1547-2018 for inspection and testing requirements.

The following interconnection equipment at the PCC / PoC shall be included in all testing, but not limited to:

- Interrupting / Isolation devices (i.e. Breaker, Recloser, Disconnect Switch)
- Instrumentation (i.e. Current / Voltage Transformers, Sensing Devices)
- Control Wiring
- Underground Cabling
- Main Power Transformers
- Protection Function Testing
- Interconnection SCADA DNP3 Mapping: Refer to DER-02, *Annex 'C'* for requirements and mapping

All commissioning validation testing reports and procedures must be made available upon request from FortisAlberta.

Refer to manufacturer guidelines for equipment testing and expected values. In the absence of the manufacturer's information, use the latest industry standards for testing equipment. Indicate below the testing period and the standard(s) used for testing

Interconnection Equipment Testing					
New Commissioning	☐	**Testing Completed ≤ 3 Years**	☐	**Testing Completed > 3 Years**	☐
Testing Standard(s) Applied (i.e. NETA ATS 2017, IEEE 1547.1)					

Additional Comments / Variances:

Testing Certification

Your signature below indicates that the information that has been provided is accurate and the testing of the protection and facility equipment aligns with the requirements in FortisAlberta's DER-02 standard. It also indicates that all testing results have been documented and are available upon request by FortisAlberta.

All responsible individuals signing and stamping results for the DER owner/facility certify that the electrical protection and control system for this generating facility complies with the design and all applicable performance standards, including FortisAlberta DER-02, FortisAlberta PQ-SPEC-01 and applicable interconnection standards.

Certified by:	**Reviewed by (P&C):**
Power Producer (name / company)	FortisAlberta
Title (P.Eng. Required with stamp)	Title
Signature	Signature
Date	Date

Site witnessed by (Field Technical Services):

FortisAlberta Responsible Party	
Title	Date

REFERENCE MATERIAL

Inspections and Tests

The following are the minimum expectations for each type of inspection and test. Refer to the equipment manufacturer for recommended routine maintenance tests, if not available use the latest NETA Acceptance Testing Standard (ATS) as a reference for applicable inspections, test procedures and expected results.

End-to-End Wire Checks:

- Verify tightness of accessible bolted connections by use of a calibrated torque wrench. Use manufacturer specifications for required torque levels.
- Inspect, tug test and tighten all loose circuit wiring connections.
- Confirm each wire is terminated as indicated in vendor / engineered drawings.
- Verify end-to-end continuity.
- Verify single point grounding.
- Ensure proper phasing.

Insulation-Resistance & Dielectric Withstand Testing:

- One-minute insulation resistance on each phase. Shall include both phase-to-phase and phase-to-ground tests.
- Insulation-resistance tests shall be conducted when the breaker or isolation switch is in the closed position.
- For required test voltages and expected values refer to manufacturer data, Table 100.1 or Table 100.5 (Transformers) in NETA ATS.
- Isolation switches requiring dielectric withstand tests shall be conducted with the switch in the closed position, testing each phase, phase-to-phase and phase-to-ground. Refer to manufacturer recommendations.
- Breakers requiring dielectric withstand testing (for vacuum bottle integrity) shall be conducted across the vacuum bottle when the breaker is in the open position.

Contact Resistance Tests:

- Tests to be conducted across switchblades, fuse holders and breaker contacts in the closed position. Each phase shall be tested and compared. A low-ohm meter shall be used for each test.
- Comparing each phase, at a maximum, test values shall not differ by more than 50 percent of the lowest phase.

Breaker Timing Tests:

- Verification of when the breaker receives an open / close signal to the actual mechanical open / close of the breaker contacts.
- Test values shall reflect manufacturers specification. In the absence of manufacturer data values times shall be recorded for maintenance purposes.

Breaker / Isolation Switch Function Tests:

- Verify that breaker functions electrically via protection controller (inter-tie relay).
- Breaker open and close functions shall be verified manually by push button and/or mechanical lever.
- When applicable both the undervoltage and anti-pump functions of the breaker shall be tested.
- Manually operate switches to verify proper engagement of switchblades.

Inspections and Tests Cont'd

Analog Inputs / Configuration:

- Inject voltage and current into meter inputs to ensure accuracy.
- Confirm voltage and current ratios configured directly reflect instrument ratios and system parameters.
- Verify / configure meter for event capturing that complies to 'Annex B' of FortisAlberta's *Technical Interconnection Requirements Standard* (DER-02).

Transformers

Ratio / Polarity:

- (Power) Perform turns ratio test on the nominal operating tap and for each winding.
  (Instrument) Perform turns ratio test on each PT and CT at the PCC.
- (Power) Ratios shall not differ by more than 0.5% on each winding pair.
- (Instrument) Ratio errors shall conform to ANSI/IEEE C57.13

Winding Resistance:

- (Power) Resistance shall be measured on both the high and low voltage windings at the operating tap.
- (Power) Temperature corrected winding resistance shall be compared within one percent of factory or previously obtained results.

Excitation Current:

- (Power) Excitation current shall be measured on both the high and low voltage windings at the nominal operating tap.
- (Power) Excitation current pattern for a 2-winding transformer shall have two similar readings and one lower current reading.
- (Instrumentation - CT) Testing shall be in accordance to ANSI/IEEE C57.13.1.
- (Instrumentation - CT) Excitation results shall match the curve supplied by the manufacturer or be in accordance with ANSI/IEEE C57.13.1.

Power Factor:

- (Power) Insulation Power Factor tests shall be performed on all windings of the transformer as per testing equipment manufacturers recommendation.
- (Power) Expected CHL values shall be less than:
  Oil (Power) = 0.5%
  Dry (Power) = 2.0%
  Dry (Distribution) = 5.0%
- (Power) Insulation Power Factor tests shall be performed on all windings of the transformer as per testing equipment manufacturers recommendation.

Burden:

- (Instrumentation) Measured transformer burdens shall not exceed instrument transformer name-plate rating.