Summary on

August 2015 – February 2016

WG Activities

[redacted] AESO

502.11 Workgroup (WG)

	Primary	Alternate
AltaLink	[redacted] Principal Engineer - Substations	[redacted] Principal Engineer - Major Equipment and HVDC/FACTS
ATCO	[redacted] Principle Engineer, Substation Engineering	[redacted] Senior Technical Supervisor, Innovation
EPCOR	[redacted] Senior Manager, Transmission Assets	[redacted] Substation Asset Manager
ENMAX	[redacted] Manager, Electrical Engineering	[redacted] Transmission Planning Engineer
FortiaAlberta	[redacted], Director, Engineering	

502.11 – History & Future

What happened

- June 2015 – AESO internal approval
- July 2015 – WG formed
- Aug 27 – 1st WG meeting @ AESO
- Sep 17 – 2nd WG meeting @ ATCO
- Oct 29 – 3rd WG meeting @ ENMAX
- Nov 16 – CANA as consultant
- Nov 19 – 4th WG meeting @ EPCOR
- Dec 17 – 5th WG meeting @ AltaLink
- Jan 21 – 6th WG meeting @ AESO

What will happen

- March
  - Recommendation paper
- April
  - Finalize recommendation paper
  - Start drafting 502.11 rule
- July – August
  - Circulating draft 502.11 to WG
- November
  - Finalize draft 502.11 rule
- December
  - File 502.11 rule with AUC

AESO Rules Consultation Process

Step 1.0	Identify need for new ISO Rule
Step 2.0	Invitation to stakeholders to participate in WG with draft T of R
Step 3.0	Finalize T of R. Hold workshops & tech sessions
Step 4.0	Recommendation Paper to stakeholders. Reply to stakeholders comments. Determine if further consultation is needed
Step 5.0	Draft Rule to industry. Reply to stakeholders comments. Determine if re-consultation is necessary
Step 6.0	Notice of Filing / Legal review / Filing with AUC

What Is Recommendation Paper All about?

- Executive Summary
- Introduction & Background
- Recommendations
  - Guiding Principles
  - Technical Requirements – Proposals & Options
  - Stakeholder Positions
- Implementation Considerations
- Next Steps
- Appendices (if any)

- Recommendations
  - Reliability and availability
  - Safety and security requirements
  - Service conditions
  - Grounding & insulation
  - Station power supply & control building
  - Bus layout
  - Power Transformers
  - Reactive compensation Devices
  - Other equipment

Mid November, 2015

CANA to provide consulting assistance

Two objectives:

- What are the minimum technical requirements of the comparable US/Canadian utilities?
- What are the extra technical considerations on substation rule when connecting new generation technologies?

August 27, 2015 – 1st WG Meeting
Major Topics to be Covered in 502.11

- Reliability and availability
- Safety and security requirements
- Service conditions
- Grounding & insulation coordination
- Bus layout
- Station power supply & control building
- Major equipment
- Other equipment

August 27, 2015 – 1st WG Meeting

- No participation from manufacturers for now
- 502.11 rule should cover ISD-owned substations which meet the criteria
- 69/72 kV and below be excluded
- Creation of “Major Substation” (later “Type 1 Substation”)
- Life expectancy not be specified
- Minimum reliability & availability be defined

September 17, 2015 – 2nd WG Meeting
Guiding Principles

- In line with ARS standards and other rules
- Allow for new technology to the maximum extent possible
- Reliability/availability be measurable as much as possible
- Limit the number of exceptions as much as possible
- Higher level of requirements for “Type 1” substations
- Definition of “element” (NERC / WECC / AIES)

September 17, 2015 – Applicability

Section 502.11 applies to

a) the **legal owner** of a **transmission facility** with at least one rated voltage equal to or greater than one hundred (100) kV; and

b) the **ISO**.

- ISD-owned HV substations are included
- Generators who own HV substations are also included

October 29, 2015 – 3rd WG Meeting
"Type 1" Substation

Definition

- Any 500 kV substations; or
- Any 240 kV substation having ≥6 source line and/or power transformer terminations; or
- Any substation designated by the AESO in its own discretion

* under above definition, about 23 substations in existing AIES system would have been called "Type 1" substations

October 29, 2015 – Grounding Requirements

- AIES is an effectively grounded system for ≥100 kV voltages
- A grounding study shall be conducted for each and every transmission substation project
- AESO shall provide 10-year short circuit levels

* Currently, for every substation project, all TFOs conduct a grounding study

October 29, 2015 – Insulation Coordination

- Agreed to
  - split BIL into LIL and SIL in 502.11
  - create a 260 kV nominal voltage class
  - use MCOV=150 kV for 138 kV class
- Recommended to include BIL levels for 13.8/25/34.5/69 kV equipment (inside substations) for insulation coordination purposes
- No need to specify a higher LIL/SIL for GIS equipment
- MTBF=1000 years for transformers, and MTBF=400 years for bus & other equipment, for lightning failure

October 29, 2015 – Voltage Class & MCOV

Nominal (kV)	Extreme Continuous Minimum (kV)	Normal Continuous Minimum (kV)	Normal Continuous Maximum (kV)	MCOV (kV)
138	124	135	145	150
144	130	137	151	155
240	216	234	252	264
260*	234	247	266	275
500	475	500	525	550

* For all 240 kV buses from Whitefish north and Sagitawah north

October 29, 2015 – Insulation Coordination

Air Insulated Substations

Nominal Voltage Classification (kV rms)	138/144		240/260		500	
	LIL	SIL	LIL	SIL	LIL	SIL
Post Insulators & Disconnect Switches	550	NA	900	750	1550	1175
Circuit Breakers	650	NA	1050	850	1800	1425
CTs & PTs	650	NA	1050	850	1800	1425
Xformer Windings (with surge arresters at both ends)	550	NA	850	750	1550	1175

Gas Insulated Switchgear

Disconnect switches, Buswork, Switchgear, CTs & PTs	750	N/A	1050	850	1550	1175

BIL levels for MV/LV Equipment in Substations

Nominal Voltage (kV rms)	13.8	25	34.5	69/72
Circuit breakers	110	150	200	350
Indoor switchgear, xformer & shunt reactor windings(with surge arresters)	95	125	170	350
Transformers, shunt reactors bushings (with surge arresters)	110	150	200	350
All other equipment (CTs, PTs, busbars, etc.)	110	150	200	350

October 29, 2015 – Service Conditions

- Recommend to create two temperature zones with -50°C and -40°C, demarcated at Edmonton and Cold Lake
- Maximum ambient temperature of +40°C for both zones
- Temperature change rate of 15°C per hour
- Use same wind map as for 502.2 rule

November 19 – 4th WG Meeting
AC/DC Station Power Supply & Control Building

- For all substations
  - 8 hours of discharge time from loss of AC station supply
  - 24 hours or less charging time (any need for spare charger?)
- For “Type 1” Substations
  - Dual independent AC sources required
  - If SST is directly connected to HV bus, protection be such that outage be limited to the SST (breaker is required)
  - Two independent battery banks with independent chargers, each with 4 hours of discharge time at full load (8 hrs of individual load). Common mode failure should be avoided
  - Control building be installed with temperature controlled area

November 19 – Circuit Breakers

- Point-on-wave required for cap banks and shunt reactors (the AESO may specify POW for other applications)
- Single pole circuit breakers required for 240/500 kV, unless the AESO specifies otherwise
- Minimum operating time for opening:

Nominal (kV)	34.5/69	138/144	240/260	500
Breakers/circuit switchers operating time (cycles)	5.0	3.0	2.5	2.0

December 17 – 5th WG Meeting

- Snow, Icing and Wind Limits
  - The ID presents minimum design parameters of TFOs in a table (Use AESO wind map for 50 year return period. Must use local environmental conditions)

- Bus Layout

  A good bus layout should

  - support & promote safety and reliability of AIES
  - provide maximum maintenance and operating flexibility
  - be cost effective for current needs and future expansions

December 17 – Bus Layout for All Substations

- A faulted element must not result in loosing another transformer element
- No additional elements be taken out of service to accommodate maintenance of an element
- Ampacity of all terminal components connecting a transmission line or power transformer be NO less than the rating of the line or the transformer
- Breaker failure should not trip all the circuits which terminate at the same remote substation, or the same generating station
- Bus tie breaker or disconnect switch to be based on the reliability requirement

December 17 – Bus Layout for All Substations

- In an incomplete 1.5/1.3 breaker diameter, DSs close to bus should be installed to minimize outage time during the installation of the remaining breakers in the future
- A ring configuration is acceptable with up to six (6) nodes. A ring bus with >6 nodes will be approved case-by-case
- A disconnect device at the line side be installed for each transmission line, power transformer and/or generator connection
- If all 3 transmission voltage levels (500/240/138 kV) are present, failure of an autotransformer shall not result in tripping more than 4 circuit breakers

December 17, 2015 – Bus Layout

Minimum Bus Continuous Current Ratings (A)

Component	138/144 kV	240/260 kV	500 kV
Main Bus	1,200	3,000	4,000
Cross Bus	600	2,000	3,000
Feeder or Line terminal	600	2,000	3,000

December 17 – Bus Layout (cont'd)

- AESO to provide the ultimate number of terminations and voltage compensation devices in the FS
- In the ID Document
  - examples be included to show typical bus layouts
  - pros and cons of each bus configuration
- For "Type 1" Substations
  - A faulted element not result in the loss of any other elements
  - If initially designed with a simple bus or ring bus, the design must be such that it can be converted into the ultimate layout without having to relocate any existing equipment
  - In ring bus, positioning of equipment be such that lines are not terminated in positions which will ultimately be buses

January 17 – Power Transformers

- Transformer life should be comparable to other apparatus

  Yes ☐ No ☑

- Single-phase transformers for large GSU or base load transformers

  Yes ☐ No ☑

- Transformer terminals be equipped with SAs except enclosed cable termination boxes in which case SA be placed at switchgear end of feeders

  Yes ☑ No ☐

- SAs be installed as close as possible to the transformer bushings taking arrester clearance requirement into account

  Yes ☑ No ☐

January 17 – Power Transformers (cont'd)

- Transformer rating be based on CSA C88 M90 or later versions

  Yes ☑ No ☐

- Overloading capability of large power transformers will be AESO's responsibility

  Yes ☑ No ☐

- Minimum average temperature rise is 65°C. However, TFOs can use 55°C rise in special applications

  Yes ☑ No ☐

- "Full Capacity Below Normal" for all 240/138 and 500/240 kV autotransformers

  Yes ☑ No ☑

January 17 – Power Transformers (cont'd)

- All power transformers have LTC (except GSUs and 500 kV transformers)

  Yes ☑ No ☐

- LTC be always placed at the primary winding (or the wye winding)

  Yes ☐ No ☑

- Minimum average temperature rise is 65°C. However, TFOs can use 55°C rise in special applications

  Yes ☑ No ☐

- Minimum voltage range is ±5% with 2.5% for each step

  Yes ☑ No ☐

January 17 – Power Transformers (cont'd)

- Transformer loss evaluation be conducted for all voltage level transformers based on IEEE C57.120. The AESO to provide loading levels data & economic factors.

  Yes ☑ No ☐

- Transformer impedance is a TFO responsibility. However, AESO may specify uncommon impedance for certain transformers in the FS

  Yes ☑ No ☐

- For system transformers, consideration be given to the design and control such that parallel operation is capable. For load transformers, parallel operation is up to TFO & load customers

  Yes ☑ No ☐