Capital Power Halkirk 2 Wind Power Facility Connection

Functional Specification

(Project Number 1710)

Issued to

ATCO Electric Ltd. and AltaLink Management Ltd. (as the **legal owners** of the **transmission facility)**, and to
Capital Power L.P. (as the **market participant)**

November 30, 2016

Version V1

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Functional Specification Revision History

Revision	Description of Revision	By	Date
V1D1	• Draft for internal review	Henry Ng	October 17, 2016
V1D2	• Draft for external review	Henry Ng	November 7, 2016
V1	• For Issuance	Henry Ng	November 30, 2016

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1 PURPOSE

(1) The purpose of this document ("Functional Specification") is to set out the technical specifications and requirements and approved variances issued by the AESO to the **legal owners** of the **transmission facility**, ATCO Electric Ltd.("ATCO"), AltaLink Management Ltd., ("AltaLink"), and the **market participant**, Capital Power L.P., related to the design, construction, development and commissioning of certain new or modified facilities (the "Project") that have been proposed for or are related to a physical facilities connection with the **interconnected electric system** (the "Purpose").

(2) This Functional Specification is issued for the Purpose only, and the **legal owners** of the **transmission facility** and the **market participant** must comply with the Functional Specification provisions.

(3) The AESO is not responsible for any facilities designed by or for any third party, or installed on a third party's behalf, to accomplish the connection of the Project facilities.

(4) This Functional Specification includes:

(i) certain specific engineering, technical and functional requirements for the Project;

(ii) the requirements to comply with **ISO rules**, including OPPs, **reliability standards**, technical standards, and **ISO tariff** provisions (collectively called the "Authoritative Documents");

(iii) the electrical system environment in which the connecting facilities must be designed and operated; and

(iv) any approved variances from requirements set out in any applicable AESO Authoritative Documents.

2 INTERPRETATION AND VARIANCES

(1) Subject to subsection (2), any revision or variance to any of the Functional Specification provisions by the **legal owners** of the **transmission facility** or the **market participant** is prohibited.

(2) The **legal owners** of the **transmission facility** or the **market participant** may make application, jointly or individually, in writing to the AESO requesting a variance to this Functional Specification, and the AESO may in writing approve of the variance after the AESO has completed an analysis of the implications to the **interconnected electric system** with respect to the requested variance.

3 PROJECT OVERVIEW

The **market participant** has applied to the AESO for transmission system access to connect its proposed Halkirk 2 Wind Power Facility (Facility) in the Tinchebray area. Tinchebray is located in the AESO planning area of Alliance/Battle River (Area 36).

The **market participant**'s request includes a Rate STS, *Supply Transmission Service*, contract capacity of 150 MW and a Rate DTS, *Demand Transmission Service*, contract capacity of 1.8 MW.

The **market participant**'s Facility includes:

- A collector station, to be designated as Goldeye 620S substation.

The **market participant's** request can be met by the following transmission solution:

- Modify Tinchebray 972S substation, including adding a 240 kV circuit breaker and associated equipment.
- Add a 240 kV transmission line to connect Goldeye 620S substation to the existing Tinchebray 972S substation.

The scheduled in-service date (ISD) is February, 2018.

4 FORECAST OF FUTURE DEVELOPMENT IN THE PROJECT AREA

Proposed long term developments in Alliance/Battle River (Area 36) are described in the AESO 2015 Long-term Transmission Plan. Please refer to the AESO's website (www.aeso.ca) for more details of the long term transmission developments in the area.

5 SCOPE OF WORK

5.1 General

(1) The **legal owners** of the **transmission facility** and the **market participant** must complete all engineering, design, land or land-use acquisition, siting, public consultation, applicable regulatory approvals and permits, material procurement, construction, commissioning, and associated permitting requirements for the Project facilities.

(2) The **legal owners** of the **transmission facility** and the **market participant** must coordinate with each other as required on all Project facility design details, including protection and control, grounding, insulation, **point of connection**, site layout with proper consideration of maintenance coordination.

(3) The **legal owners** of the **transmission facility** and the **market participant** must develop joint operating procedures and any connection agreements as required such that all connecting **transmission facilities** will operate safely and reliably.

(4) The **legal owners** of the **transmission facility** and the **market participant** must deliver to the AESO all final design and as-built Project facility information and records in the format and content required by the AESO, to enable the AESO to update and maintain its transmission technical records and system models.

(5) The **legal owners** of the **transmission facility** and the **market participant** must submit the Project information and records referred to in subsection (4) above, under the professional stamp and signature of a registered professional engineer in Alberta who assumes responsibility for the preparation and accuracy of the content of the information and records.

(6) The **legal owners** of the **transmission facility** and the **market participant** must mutually agree on each party's roles and responsibilities regarding inspection of all facilities of the Project prior to energization of the facilities.

(7) The **legal owners** of the **transmission facility** and the **market participant** must ensure prior to energization of any or all of their respective Project facilities, that the facilities to be energized have been inspected by qualified personnel, so that the facilities are declared to be:

(a) safe for operation; and

(b) in compliance with this Functional Specification, Alberta Reliability Standards and any Authoritative Documents for which the Project must comply.

(8) No Project facilities are to be energized until an energization authorization has been issued by the AESO in accordance with the **ISO rules**.

5.2 Compliance with AESO Authoritative Documents

The **legal owners** of the **transmission facility** and the **market participant** must comply with the Authoritative Documents provisions which are applicable to the Project and which must be incorporated into the design, construction, commissioning and operation of the connecting facilities and other connection Project work, including but not limited to these provisions contained herein:

- AESO Operating Policies and Procedures
- Alberta Reliability Standards
- AESO Measurement System Standard Rev. 1 (dated September 18, 2007)[1];
- **ISO rules** including:
    - Section 502.1, *Wind Aggregated Generating Facilities Technical Requirements* (effective April 1, 2015);
    - Section 502.2, *Bulk Transmission Line Technical Requirements* (effective January 1, 2012);
    - Section 502.3, *Interconnected Electric System Protection Requirements* (effective August 30, 2016);
    - Section 502.4, *Automated Dispatch and Messaging System and Voice Communication Systems Requirements* (effective March 27, 2015);
    - Section 502.8, *SCADA Technical and Operating Requirements* (effective March 27, 2015);
    - Section 502.9, *Synchrophasor Measurement Unit Technical Requirements* (effective March 27, 2015);
    - Section 505.3, *Coordinating Synchronization, Commissioning, WECC Testing Activities* (effective December 31, 2012);
    - Section 505.4, *Coordinating Operational Testing* (effective December 31, 2012)
- AESO Generation and Load Interconnection Standard (dated September 19, 2006)[2] .

5.3 Modeling Data Requirements

All modeling data shall be provided as per the AESO Information Document ID# 2010-001R, *Facility Modelling Data* (issued July 26, 2016).

[1] The AESO considers this standard to remain in effect notwithstanding the statement in clause 1.5 in the standard. Efforts to revise the standard are currently underway.

[2] The AESO considers this standard to remain in effect notwithstanding the statement in clause 1.5 in the standard. Efforts to revise the standard are currently underway.

5.4 Wind Power Forecasting

All forecasting data shall be provided as per the AESO Information Document ID# 2011-007R, *Wind Power Forecasting* (dated September 28, 2016).

5.5 Substation Equipment Specifications

All new substation equipment[3] must meet the following minimum specifications:

- Temperature rating of -50ºC for all outdoor equipment.
- Equipment maximum and minimum continuous voltage ratings as indicated in Table 4.
- Minimum continuous equipment current ratings as indicated in Table 1.
- Equipment maximum fault duty: 40 kA for 240 kV.

Table1. Minimum Continuous Equipment Current Ratings (A)

Component note 5	**240 kV**
Main Bus Note 1	2000
Cross Bus Note 2, 3	2000
Equipment or line terminal Note 4	2000

Notes for Table 1:

Note 1: Main bus includes all sections of ring bus scheme or single bus of simple bus or breaker and a half scheme except the portion of the bus connecting to a transformer.
Note 2: Cross bus includes diameter sections of breaker and a half or breaker and a third schemes.
Note 3: Cross bus can have higher minimum current rating based on bus configuration and equipment connectivity
Note 4: Line terminal includes all equipment and conductor from the transmission line to the line breakers.
Note 5: Current rating of the equipment below 69 kV within the substation shall be determined by the **legal owners** of the **transmission facility,** in consultation with **market participants**.

5.6 Specific Scope of Work for the Legal Owners of the Transmission Facility -ATCO

(1) General Requirements

- Coordinate with the **market participant** to develop necessary connection agreements and joint operating procedures.
- Ensure project safety is appropriately managed from design through energization.
- Undertake all required grounding studies, testing and mitigation as required for electrical safety and any mitigation for electrical effects on communication systems.
- Complete insulation coordination studies and coordinate with the **market participant** as required to establish appropriate insulation levels.

[3] Equipment includes such items as the power transformer, circuit breaker, capacitor bank, shunt reactor, high voltage current transformer, potential transformer, bus work, air break, and switchgear.

- All site preparation, fencing, foundations, grounding, support structures, termination structures, duct work, cabling, bus work, station service, control building, protection, controls, SCADA equipment, etc. as required.
- Any lines from one bus terminal to remote bus terminal should not have any terminal equipment that limits the line capacity below the minimum line capacity specified by the AESO.
- The **legal owner** of **transmission facility** shall provide access to the telecommunication system for communication services (SCADA, Operational Voice, Operational Data, and Synchrophasor Measurement Unit) if requested by the **market participant**, as required by the AESO for the operation of the AIES.

(2) Tinchebray 972S Substation – See Appendices 7.3 & 7.4

Substation Equipment

- Install one (1) 240 kV circuit breaker with associated disconnect switch(es).
- Install one (1) 240 kV motor operated disconnect switch.
- Re-terminate the existing 240 kV transmission line 9L16.
- Terminate the proposed 240 kV transmission line 9L177 to the bay previously occupied by the 240 kV transmission line 9L16.

Protection and Control

- Modify as required, the existing protection and control equipment as a result of the re-termination of the 240 kV line 9L16.
- Install protection and control equipment as required for the new 240 kV line 9L177.
- Complete system protection coordination studies and coordinate with the **legal owner** of the adjacent **transmission facility**, the **legal owner** of the **electric distribution system**, and **market participant** as required to establish settings appropriate for the facility additions and Alberta interconnected electric system (AIES) operations.
- For single phase-to-ground faults, the protection and control scheme for 240 kV transmission line 9L177 shall have single pole trip and reclose functionality fully operational. For multi-phase faults, the protection and control scheme for 240 kV transmission line 9L177 shall trip all three-poles without auto-reclose
- Install breaker failure protection functionality for the new 240 kV circuit breaker.
- Install synch check relays on the new 240 kV circuit breaker.

Telecommunication

- Install new or modify/upgrade the existing communication system as necessary to meet the project requirements for operation, control, protection and SCADA.
- Establish appropriate communication interface between the Tinchebray 972S substation and the Goldeye 620S substation such that tele-protection, SCADA, operational voice, and operational data requirements are met.

SCADA

- Establish communications interface point such that SCADA data can be transmitted back to the AESO's System Coordination Centre (SCC) and Backup Coordination Centre (BUCC).
- Any equipment required to implement the control schemes related to the Operational Constraints outlined in Section 6.
- Implement control center data mapping and verification of SCADA information for the proposed transmission facility modifications and additions and any associated changes required at other area substations as per Section 502.8 of the ISO rules. A complete listing of energy data requirements can be found in Appendices 7.6 & 7.7 of this document.

(3) Nevis 766S Substation

Substation Equipment

- Install equipment as required to implement the changes in RAS#139 as described in Section 6.5.

Telecommunication

- Install new or modify/upgrade the existing communication system as necessary to meet the project requirements for changes in RAS#139 as described in Section 6.5.

(4) 240 kV Transmission Line 9L177 – See Appendix 7.2

- Add a single circuit 240 kV transmission line, approximately 2 km in length[4], between the Tinchebray 972S substation and the Goldeye 620S substation. This circuit, to be designated 9L177, shall have a minimum summer/winter capacity of 500/600 MVA. OPGW shall be utilized to facilitate tele-communications. Appropriate demarcation points are to be established with adjacent facility owners.
- Ensure lightning protection design takes into account the lightning ground flash densities in the area.

5.7 Specific Scope of Work for the Legal Owner of the Transmission Facility -AltaLink

(1) General Requirements

- Ensure project safety is appropriately managed from design through energization.
- Undertake all required grounding studies, testing and mitigation as required for electrical safety and any mitigation for electrical effects on communication systems.
- All site preparation, fencing, foundations, grounding, support structures, termination structures, duct work, cabling, bus work, station service, control building, protection, controls, SCADA equipment, etc. as required.

(2) Buffalo Creek 526S Substation

Substation Equipment

[4] The line length provided herein is estimated value only and the actual distance will be identified in the Facility Proposal prepared by the **legal owner** of the **transmission facility**.

- Install equipment as required to implement the changes in RAS#138 as described in Section 6.5.

Telecommunication

- Install new or modify/upgrade the existing communication system as necessary to meet the project requirements for RAS#138 as described in Section 6.5.

(3) Edgerton 899S Substation

Substation Equipment

- Install equipment as required to implement the new RAS as described in Section 6.5.

Telecommunication

- Install new or modify/upgrade the existing communication system as necessary to meet the project requirements for the new RAS as described in Section 6.5.

5.8 Scope of Work for the Market Participant

(1) General Requirements

- The **market participant** and the **legal owner** of the **transmission facility** shall mutually agree on each party's scope regarding site preparation.
- For Wind aggregated generating facilities*:* The wind aggregated generating facility's ramp rate shall be set to 10%.
- The wind aggregated generating facility may not cause a phase-to-phase voltage unbalance greater than 1.0%.
- Any off-nominal frequency protection relays must function at 80% or greater rated voltage.
- Undertake all required grounding studies, testing, and mitigation to ensure the connecting transmission facilities are safe.
- Ensure connection project safety is appropriately managed from design through energization.

(2) Proposed Goldeye 620S Substation – See Appendix 7.5

General requirements

- Coordinate all alignments with the **legal owner** of the **transmission facility** as required to connect the **market participant**'s facility to the 240 kV connection point.
- Supply and install all risers or other connections as required to connect the connecting **transmission facility** to the 240 kV connection point.
- Provide a suitable visible open switch point on the 240 kV side of the transformer with a **transmission facility** switch number for "Guarantee of Isolation" purposes. The open point shall be able to accommodate a transmission facility owner lock and tag and all procedures related to the safe operation of this switch shall be included in the joint operating procedures.

- Complete insulation coordination studies and coordinate with the **legal owner** of the **transmission facility**, legal owner of the electric distribution system, and **market participant** as required to establish appropriate insulation levels.

Substation Equipment – The market participant will design, construct and operate Goldeye 620S substation and the associated WAGF. Substation equipment listed below are for the purpose of identifying the technical requirements on protection and control, metering, SCADA and Telecommunication.

- One (1) 240 kV circuit breaker with associated disconnect switches.
- One (1) 240 kV motor operated disconnect switch.
- One (1) 240/34.5 kV 100/133/167 MVA Generator Step-up transformer.
- Eight (8) 34.5 kV circuit breakers with associated disconnect switches for collector feeders.
- One (1) 34.5kV bus tie breaker with associated disconnect switches.

Protection and Control

- Complete protection coordination studies and coordinate with the **legal owner** of the **transmission facility** as required to establish settings appropriate for the **market participant** facility additions and AIES operations.
- Coordinate with both ATCO and AltaLink, install any equipment as required, to implement the RAS schemes as described in Section 6.5.
- Any frequency relays installed to protect equipment for off-nominal frequency operation must function at a transmission system voltage equal to or above 80% of the rated voltage.

Revenue metering

- For **market participant** owned facilities, provide the description of the measurement point location for the point of delivery/point of supply, and the acceptable installation options for revenue metering in order to report on the measurement point.

SCADA

- Establish communications interface point such that SCADA data can be transmitted back to the **legal owner** of the **transmission facility** and AESO's System Coordination Centre (SCC) and Backup Coordination Centre (BUCC).
- Coordinate with the **legal owner** of the **transmission facility** for any equipment required to implement the control schemes related to the Operational Constraints outlined in Sections 6.4, 6.5, 6.6, and 6.7.
- Implement control center data mapping and verification of SCADA information for the proposed transmission facility modifications and additions and any associated changes required at other area substations as per Section 502.8 of the **ISO rules**. A complete listing of energy data requirements can be found in Appendices 7.6 & 7.7 of this document.

Telecommunication

- Coordinate with the **legal owner** of the **transmission facility** to install new communication system as necessary.

- Establish appropriate communication interface such that tele-protection, SCADA, operational voice, and operational data are met.

Synchrophasor Measurement Unit

- Install Synchrophasor Measurement Unit at the Goldeye 620S substation.

(3) Miscellaneous

- All site preparation, fencing, foundations, grounding, support structures, termination structures, duct work, cabling, bus work, station service, control building, protection, controls, SCADA equipment, etc. as required to complete the additions and/or modifications outlined above.

6 TRANSMISSION SYSTEM OPERATING CHARACTERISTICS

The **legal owners** of the **transmission facility** and the **market participant** must ensure all facilities are capable of operating in the following electrical environment.

6.1 Short Circuit Current Levels

(1) The short circuit current levels set out in Tables 2a, 2b, and 3 have been derived by the AESO based on information provided by the **legal owners** of the **transmission facility,** any connecting **generating units,** and adjacent operating areas. Available fault current levels will continue to increase as generation, transmission, and system inter-ties are added to the **interconnected electric system**. The **legal owner** of the **transmission facility** and **market participant** must continue to review the fault levels and their equipment ratings for adequacy.

(2) Any future equipment upgrades or protection system setting changes required due to increasing fault levels are the responsibility of the **legal owner** of the **transmission facility** or the **market participant**, as applicable.

(3) The following assumptions were incorporated into the AESO short circuit current models:

(i) All expected Alberta generation is dispatched.
(ii) All transmission elements are in service.
(iii) The proposed **Project** facility is connected as per this document.
(iv) $V_{base} = V_{bus}$, $MVA_{base} = 100$

Table 2a: Maximum Short Circuit Current Levels (2018 WP): Pre-Project

Substation	Base Voltage (kV)	Pre-fault Voltage (p.u.)	3-phase		Single-phase-to-ground	
			Positive Sequence Impedance (p.u.) 1	Current (kA)	Zero Sequence Impedance (p.u.) 1	Current (kA)
Hansman Lake 650S	138	1.0314	0.01514+j0.05172	8.2	0.00597+j0.05323	8.2
	240	1.0650	0.01019+j0.03887	6.5	0.00412+j0.03346	6.9
Paintearth 863S	240	1.0640	0.00641+j0.03286	7.8	0.01493+j0.06008	6.1

Tinchebray 972S	240	1.0631	0.00366+j0.02354	10.9	0.00447+j0.02843	10.2
Halkirk 615S	240	1.0613	0.00501+j0.03348	7.7	0.00457+j0.03741	7.4
Oakland 946S	240	1.0779	0.00243+j0.01903	14.1	0.00436+j0.02396	12.7
Sheerness 807S	240	1.0777	0.00218+j0.01739	15.4	0.00168+j0.01675	15.3
Anderson 801S	240	1.0775	0.00215+j0.01686	15.9	0.00156+j0.01549	16.0
	138	1.0852	0.00953+j0.09589	4.9	0.00406+j0.08060	5.2
Cordel 755S	240	1.0627	0.00317+j0.01980	12.9	0.00221+j0.01921	13.1

Table 2b: Maximum Short Circuit Current Levels (2018 WP): Post-Project

Substation	Base Voltage (kV)	Pre-fault Voltage (p.u.)	3-phase		Single-phase-to-ground	
			Positive Sequence Impedance (p.u.) 1	Current (kA)	Zero Sequence Impedance (p.u.) 1	Current (kA)
Hansman Lake 650S	138	1.0316	0.01494+j0.05125	8.3	0.00599+j0.05316	8.3
	240	1.0650	0.01001+j0.03824	6.6	0.00414+j0.03338	7.0
Paintearth 863S	240	1.0671	0.00618+j0.03158	8.1	0.01490+j0.05913	6.3
Tinchebray 972S	240	1.0679	0.00311+j0.02041	12.7	0.00279+j0.02029	12.7
Halkirk 615S	240	1.0661	0.00450+j0.03044	8.5	0.00425+j0.03327	8.3
Oakland 946S	240	1.0785	0.00241+j0.01813	14.8	0.00440+j0.02343	13.2
Goldeye 620S	240	1.0682	0.00330+j0.02167	12.0	0.00317+j0.02260	11.8
Sheerness 807S	240	1.0783	0.00215+j0.01645	16.3	0.00172+j0.01617	16.1
Anderson 801S	240	1.0781	0.00212+j0.01588	16.9	0.00158+j0.01482	16.9
	138	1.0861	0.00944+j0.09513	5.0	0.00406+j0.08025	5.2
Cordel 755S	240	1.0669	0.00291+j0.01819	14.2	0.00215+j0.01778	14.3

Table 3: Maximum Future Short Circuit Current Levels (2025 WP): Post-Project

Substation	Base Voltage (kV)	Pre-fault Voltage (p.u.)	3-phase		Single-phase-to-ground	
			Positive Sequence Impedance (p.u.) 1	Current (kA)	Zero Sequence Impedance (p.u.) 1	Current (kA)
Hansman Lake 650S	138	1.0635	0.01385+j0.04769	9.0	0.00374+j0.03706	9.8
	240	1.0650	0.00961+j0.03535	7.0	0.00239+j0.01841	8.3
Paintearth 863S	240	1.0609	0.00646+j0.03139	8.0	0.01472+j0.05582	6.3
Tinchebray 972S	240	1.0612	0.00329+j0.01897	13.3	0.00233+j0.01654	13.7
Halkirk 615S	240	1.0690	0.00477+j0.02933	8.7	0.00432+j0.03161	8.4
Oakland 946S	240	1.0619	0.00240+j0.01668	15.2	0.00180+j0.01116	16.6
Goldeye 620S	240	1.0614	0.00347+j0.02028	12.4	0.00291+j0.01949	12.5
Sheerness 807S	240	1.0599	0.00212+j0.01513	16.7	0.00148+j0.01092	17.8
Anderson 801S	240	1.0599	0.00207+j0.01449	17.4	0.00112+j0.00879	19.4
	138	1.0736	0.00956+j0.09380	4.8	0.00363+j0.07665	5.1
Cordel 755S	240	1.0590	0.00324+j0.01826	13.7	0.00195+j0.01527	14.4

6.2 Voltage Levels

Table 4 provides the steady state voltage range in the area of the proposed facility.

Table 4: Steady State Voltage Range (kV) during Normal and Contingency Events

Substation Name and Number	Nominal Voltage (kV)	Emergency Minimum Voltage (kV)	Desired Normal Minimum Voltage (kV)	Desired Normal Maximum Voltage (kV)	Emergency Maximum Voltage (kV)
Tinchebray 972S	240	216	234	252	264
Goldeye 620S	240	216	234	252	264

Notes:

1. The Desired Normal Operating Minimum and Desired Normal Operating Maximum are generally associated with Category A events and system normal.
2. The Emergency Minimum Voltage and Emergency Maximum Voltage are generally associated with Category B and C events and system abnormal.
3. The facilities must be capable of continuous operation at voltages up to and including the Emergency Maximum Voltage.

6.3 Insulation Levels

(1) Table 5 provides the required basic insulation levels for the **transmission facilities**. Station equipment with lower insulation levels may be used provided that protection and coordination can be maintained with judicious insulation design and use of appropriate surge arresting equipment.

(2) For 25 kV circuit breakers where there is a grounded wye transformer and surge arrestors are installed a basic insulation level of 125 kV is acceptable.

Table 5: Basic Impulse Levels (kV)

Nominal Voltage Classification (kV rms)	**240**
Station Post Insulators and Airbreaks	900
Circuit Breakers	1050
Current and Potential Transformers	1050
Transformer Windings (protected by surge arresters)	850

6.4 Specific Project Operational or Transmission Constraints

6.5 Remedial Action Scheme (RAS)

The RAS requirements defined in this section are issued only for cost estimates. The final RAS specifications will depend on the ISDs of different generation connection projects and transmission developments in the Central and South Regions.

AESO Connection studies for this project includes other new generation connection projects in the study area. Study observed that this connection project exacerbate system constraints observed in connection studies of other existing and future projects. The functional specification requirements for the RAS to alleviate thermal violations are detailed in Table 1; based on study assumptions and results for this project. As the different connection and system projects move forward to the construction stage, AESO operations planning studies would be performed for each project to determine mitigation measures; RAS or procedure; one year ahead of the energization date of the Project so that appropriate RAS mitigation can be in place by ISD of the specific connection. The AESO would consult with the customers before specifying revised and/or new mitigation measures.

Table 1: Remedial Action Schemes for Halkirk 2 (P1710) WAGF

Scheme Number: 139		
Scheme Name: 901T-766S Nevis overload mitigation scheme		
Scheme Location: 766S Nevis		
Scheme Classification: LAPS		
Scheme Long Term Status: Temporary		
Scheme Redundancy: No		
Scheme Remote Enable Yes/No: Yes		
FS Design Notes: 1. This RAS functional specification is issued only for project cost estimate for RAS requirements 2. While estimating costs, TFO should consider all new equipment would be required, other than telecommunication tower, to implement this RAS. 3. RAS to have SCADA Enable/Disable control at 766S 4. Coordinate sequential trip of LV Breakers with referenced wind farm owner. Wind Farm owner to implement runback alarm and 6 trip signal receives and assign all 6 digitally coded signals to different contacts. Wind Farm owner then must assign each trip signal received to trip one set of LV breakers ensuring 6 trip signals received from TFO will remove all MW of the wind farm by tripping LV breakers. 5. All RAS components (relays/SCADA, enabled/disabled status and telecommunication) must be monitored and alarmed. 6. Telecommunications failure will not cause automatic tripping of wind farm LV breakers. 7. Consultation and coordination with other Wind Projects affected by RAS Number 139 would be required to implement this scheme.		
FS Defined Terms: • DTT = Direct Transfer Trip. • 9L20 LTO is defined as when its breakers open 2-pole or its MOD A/B open at its either terminal.		
Scheme Monitoring	Scheme Settings	Scheme Actions

901T 240kV/144kV Transformer on 144kV side at Nevis 766S • 901T current flow in the direction from 144kV to 240kV at 766S • 9L20 LTO at Nevis 766S and Cordel 755S	Mitigation of Overload due to 9L20 Open Condition: Runback/Trip Settings: • 901T Loading >= 100% of transformer rating in MVA (converted to current using 144 kV base voltage) for 10 sec with direction from 144 kV to 240 kV; AND • 9L20 LTO either end = True Reset Runback/Trip Setting Logic: • The RAS relay contact once pick up for the above condition should reset for 901T Loading <= 98% of transformer rating for 1 sec Tripping Settings: • 901T Loading >= 110% of transformer rating in MVA (converted to current using 144 kV base voltage) for 10 sec with direction from 144 kV to 240 kV; AND • 9L20 LTO either end = True Reset Trip Setting Logic : • The RAS relay contact once pick up for the above condition should reset for 901T Loading < 100% of transformer rating for 1 sec RAS Failure: • Communication and other RAS Failure	Runback/Trip Setting Actions: • Send runback alarm signal to Halkirk 2 WAGF for up to 9 minutes • If overload continues after 9 minutes, Send DTT to Halkirk 2 WAGF to sequentially trip LV breakers in groupings after waiting 3.5 sec after each trip, maximum 6 trip steps to remove all MW of Halkirk 2 WAGF. Trip Setting Actions: • Send DTT to Halkirk 2 WAGF to sequentially trip LV breakers in groupings after waiting 3.5 sec after each trip, maximum 6 trip steps to remove all MW of Halkirk 2 WAGF. RAS Failure: Send alarm to ATCO Electric SOC and AESO SCC

Scheme Number: 138
Scheme Name: 7L50 -526S Buffalo Creek overload mitigation scheme
Scheme Location: 526S Buffalo Creek
Scheme Classification: LAPS
Scheme Long Term Status: Temporary
Scheme Redundancy: No
Scheme Remote Enable Yes/No: Yes
FS Design Notes: 1. This RAS functional specification is issued only for project cost estimate for RAS requirements 2. While estimating costs, TFO should consider all new equipment would be required, other than telecommunication tower, to implement this RAS. 3. 7L50-526S RAS must be coordinated with 7L50-757S RAS number 32 to ensure the 526S RAS operates first and completes its function before RAS number 32 operates. 4. RAS to have SCADA Enable/Disable control at 526S 5. Coordinate sequential trip of LV Breakers with referenced wind farm owner. Wind Farm owner to implement runback alarm and 6 trip signal receives and assign all 6 digitally coded signals to different contacts. Wind Farm owner then must assign each trip signal received to trip one set of LV breakers ensuring 6 trip signals received from TFO will remove all MW of the wind farm by tripping LV breakers. 6. All RAS components (relays/SCADA, enabled/disabled status and telecommunication) must be

monitored and alarmed.
7. Telecommunications failure will not cause automatic tripping of wind farm LV breakers.
8. Consultation and coordination with other Wind Projects affected by RAS Number 138 would be required to implement this scheme.

FS Defined Terms:
- DTT = Direct Transfer Trip

Scheme Monitoring	Scheme Settings	Scheme Actions
At 526S Buffalo Creek: • 7L50 Flow in current and its direction into 526S	Runback/Trip Settings: • Line Loading >= 114 MVA in summer and 146 MVA in winter (converted to current using 144 kV base voltage) for 5 sec with direction from Jarrow Tap to 526S. Reset Runback/Trip Setting Logic: • The RAS relay contact once pick up for the above condition should reset for Line Loading <= 98% of seasonal line rating (converted to current using 144 kV base voltage) for 1 sec. Trip Settings: • Line Loading > 129 MVA in summer and 157 MVA in winter (converted to current using 144 kV base) for 10 sec with direction from Jarrow Tap to 526S. Reset Trip Setting Logic: • The RAS relay contact once pick up for the above condition should reset for Line Loading <100% of seasonal line rating (converted to current using 144 kV base voltage) for 1 sec. RAS Failure: • Communication and other RAS Failure.	Runback/Trip Setting Actions: • Send DTT to Jarrow 252S to trip 704L breaker 252S2. • If overload continues, Send runback alarm signal to Halkirk 2 WAGF for up to 9 minutes. • If overload continues after 9 minutes, Send DTT to Halkirk 2 WAGF to sequentially trip LV breakers in groupings after waiting 3.5 sec after each trip, maximum 6 trip steps to remove all MW of Halkirk 2 WAGF. Trip Setting Actions: • Send DTT to Halkirk 2 WAGF to sequentially trip LV breakers in groupings after waiting 3.5 sec after each trip, maximum 6 trip steps to remove all MW of Halkirk 2 WAGF. RAS Failure: • Send alarm to ATCO Electric SOC and AESO SCC.

Scheme Number: New

Scheme Name: 749L-899S Edgerton overload mitigation scheme

Scheme Location: 899S Edgerton

Scheme Classification: LAPS

Scheme Long Term Status: Temporary

Scheme Redundancy: No

Scheme Remote Enable Yes/No: Yes

FS Design Notes:
1. This RAS functional specification is issued only for project cost estimate for RAS requirements
2. While estimating costs, TFO should consider all new equipment would be required, other than telecommunication tower, to implement this RAS.
3. RAS to have SCADA Enable/Disable control at 899S
4. Coordinate sequential trip of LV Breakers with referenced wind farm owner. Wind Farm owner to implement runback alarm and 6 trip signal receives and assign all 6 digitally coded signals to different contacts. Wind Farm owner then must assign each trip signal received to trip one set of LV breakers ensuring 6 trip signals received from TFO will remove all MW of the wind farm by tripping LV

breakers.
5. All RAS components (relays/SCADA, enabled/disabled status and telecommunication) must be monitored and alarmed.
6. Telecommunications failure will not cause automatic tripping of wind farm LV breakers.

FS Defined Terms:
- DTT = Direct Transfer Trip

Scheme Monitoring	Scheme Settings	Scheme Actions
At 899S Edgerton: • 749L (749AL Tap to 899S) Flow in current and its direction into 899S	Runback/Trip Settings: • Line Loading >= 88 MVA in summer and 96 MVA in winter (converted to current using 138 kV base voltage) for 5 sec with direction from 749AL Tap to 899S. Reset Runback/Trip Setting Logic: • The RAS relay contact once pick up for the above condition should reset for Line Loading <= 98% of seasonal line rating (converted to current using 138 kV base voltage) for 1 sec. Trip Settings: • Line Loading > 97 MVA in summer and 140 MVA in winter (converted to current using 138 kV base) for 10 sec with direction from 749AL Tap to 899S. Reset Trip Setting Logic: • The RAS relay contact once pick up for the above condition should reset for Line Loading <100% of seasonal line rating (converted to current using 138 kV base voltage) for 1 sec. RAS Failure: • Communication and other RAS Failure.	Runback/Trip Setting Actions: • Send runback alarm signal to Halkirk 2 WAGF for up to 9 minutes. • If overload continues after 9 minutes, Send DTT to Halkirk 2 WAGF to sequentially trip LV breakers in groupings after waiting 3.5 sec after each trip, maximum 6 trip steps to remove all MW of Halkirk 2 WAGF. Trip Setting Actions: • Send DTT to Halkirk 2 WAGF to sequentially trip LV breakers in groupings after waiting 3.5 sec after each trip, maximum 6 trip steps to remove all MW of Halkirk 2 WAGF. RAS Failure: • Send alarm to AltaLink ACC and AESO SCC.

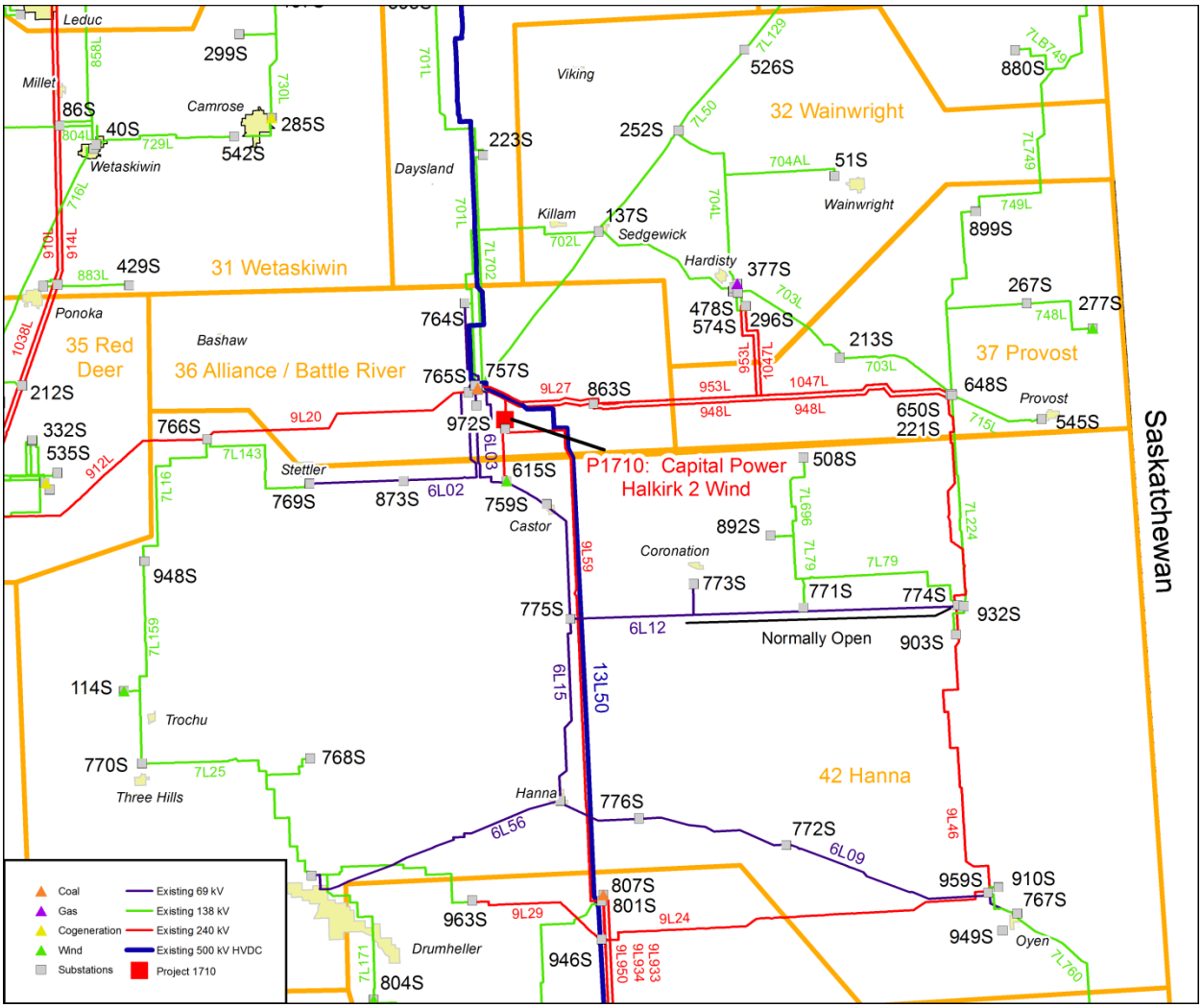
6.6 Meteorological Data Requirements

The required meteorological data shall be measured at the following heights:
- The wind turbine generator hub height, and
- 35 meters above ground level.

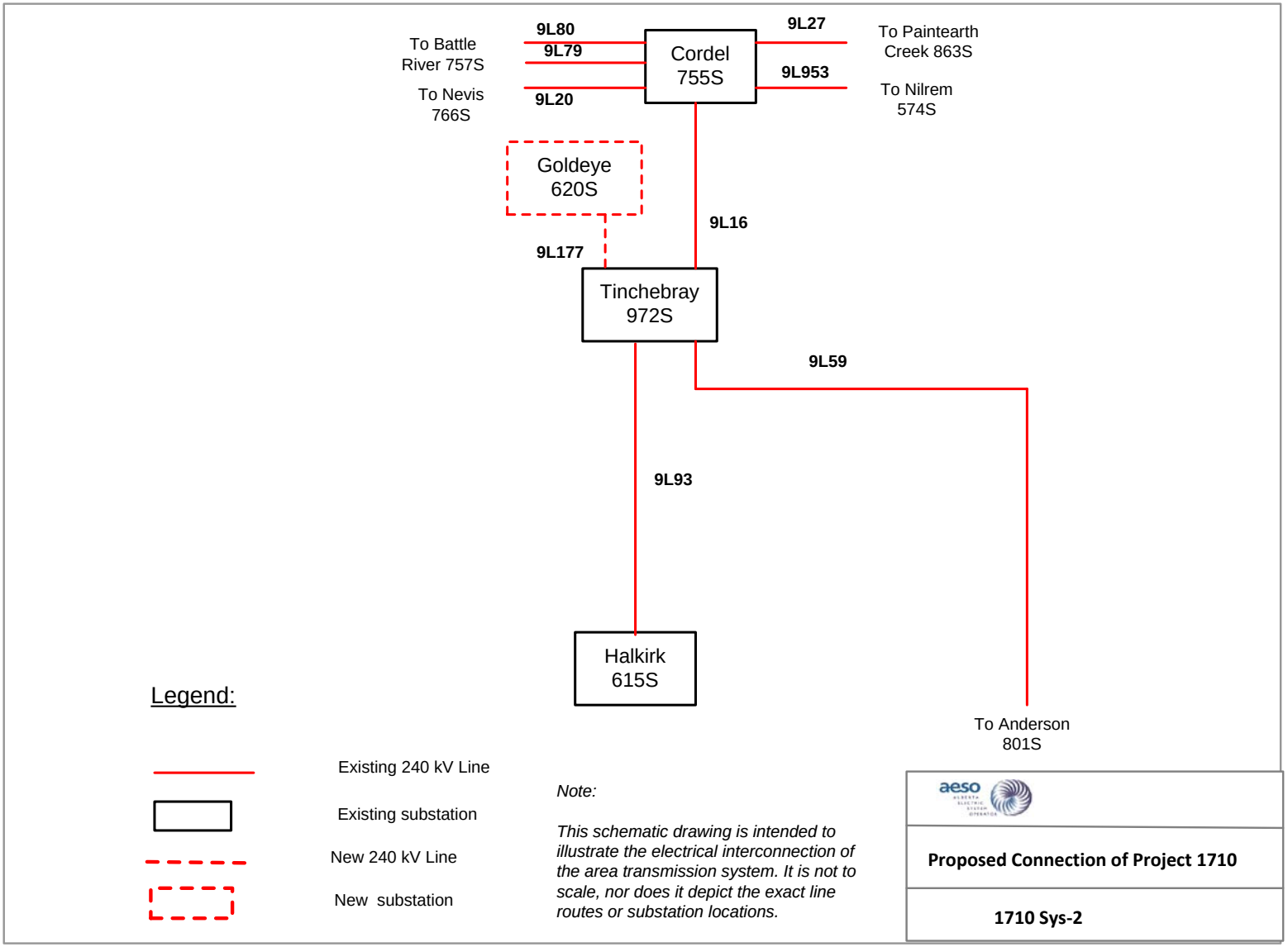
It is the **market participant**'s responsibility to provide all meteorological data to the AESO as specified in the *AESO's Information Document Wind Power Forecasting ID# 2011-007R.*

7 APPENDICES

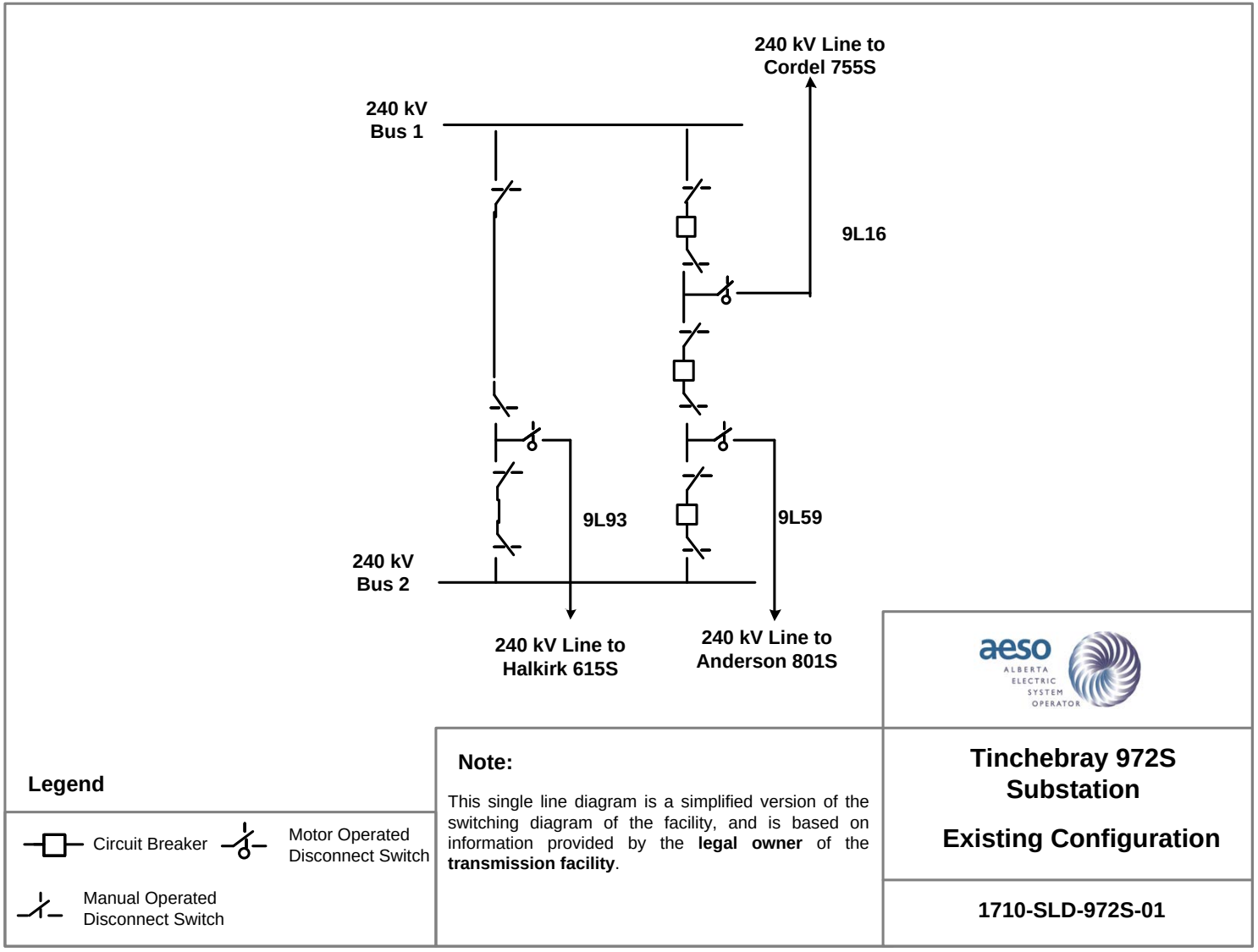
7.1 System Interconnection – Pre-Project Area Transmission System with Proposed Project Location



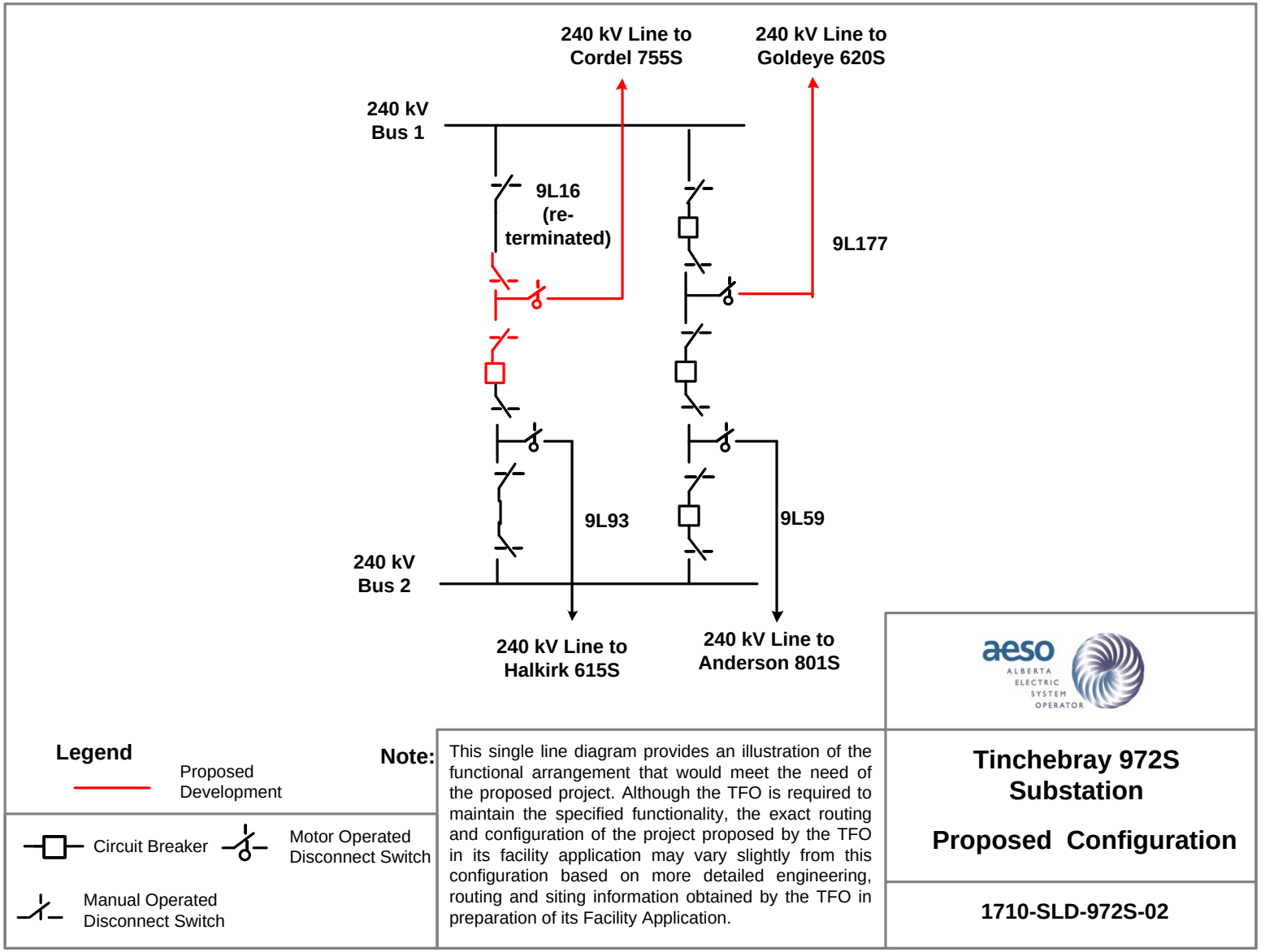
7.2 System Interconnection - Proposed



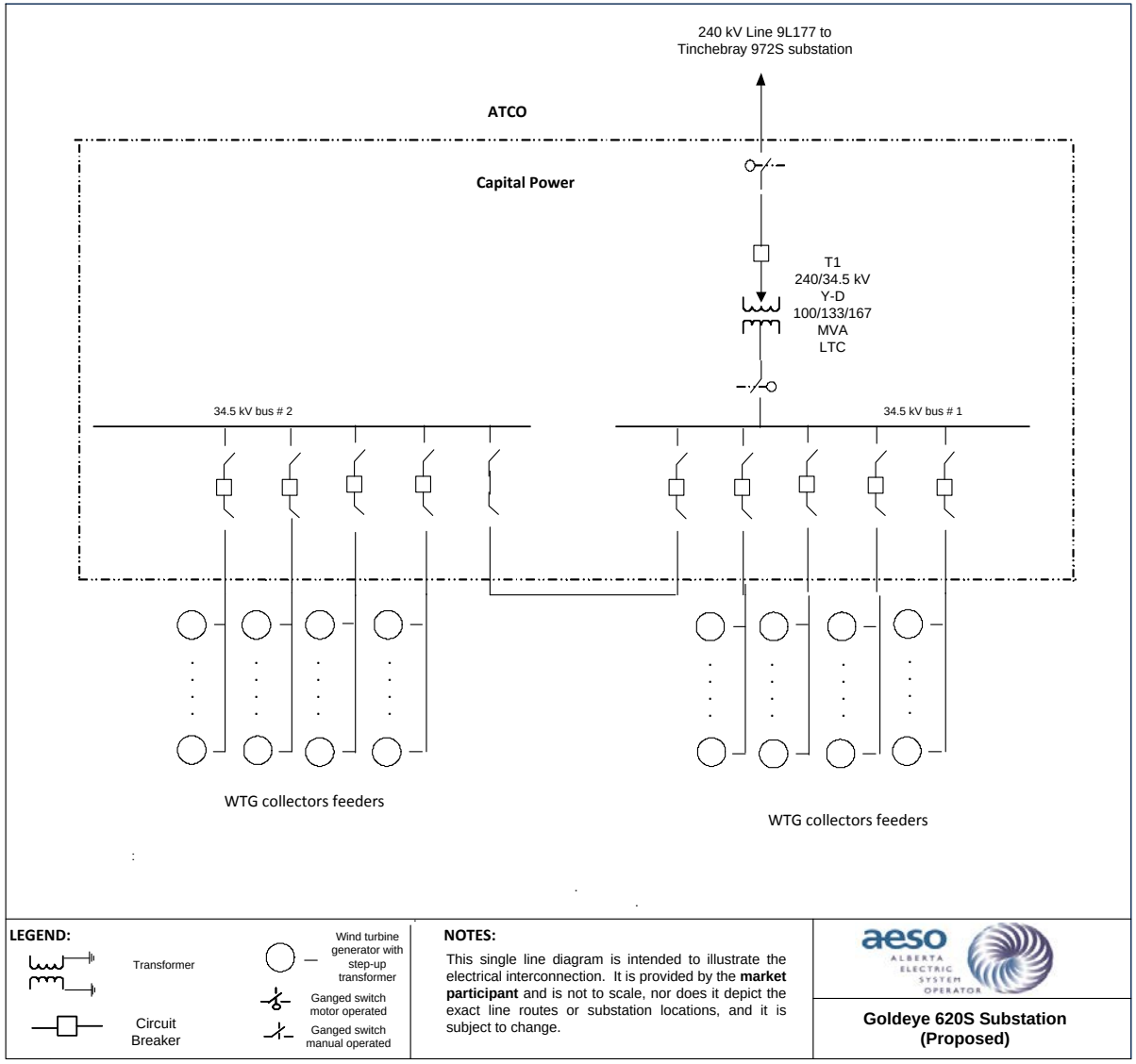
7.3 Single Line Drawing – Tinchebray 972S Substation – Pre-Project



7.4 Single Line Drawing – Tinchebray 972S Substation – Proposed

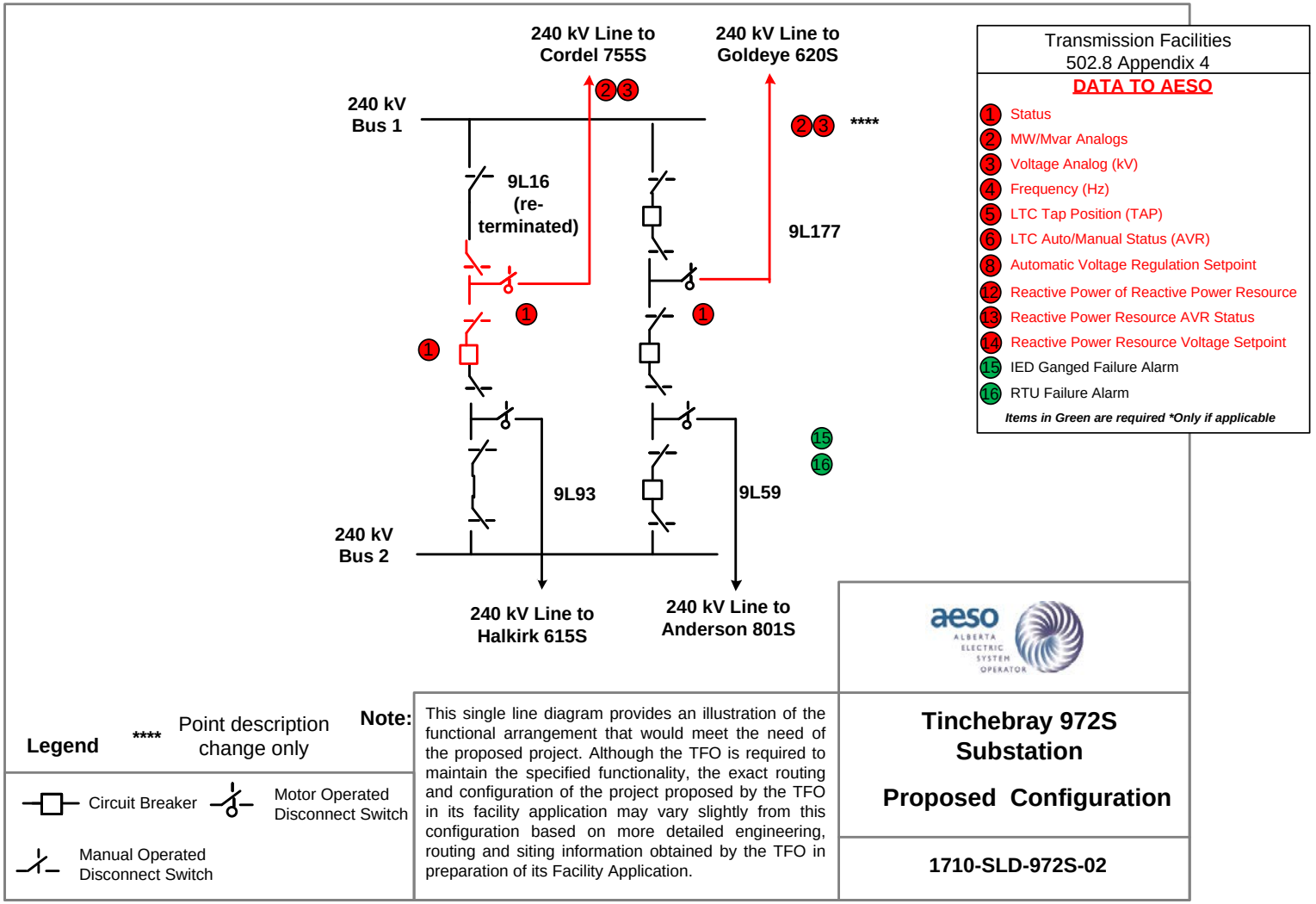


7.5 Single Line Drawing – Goldeye 620S Substation – Proposed

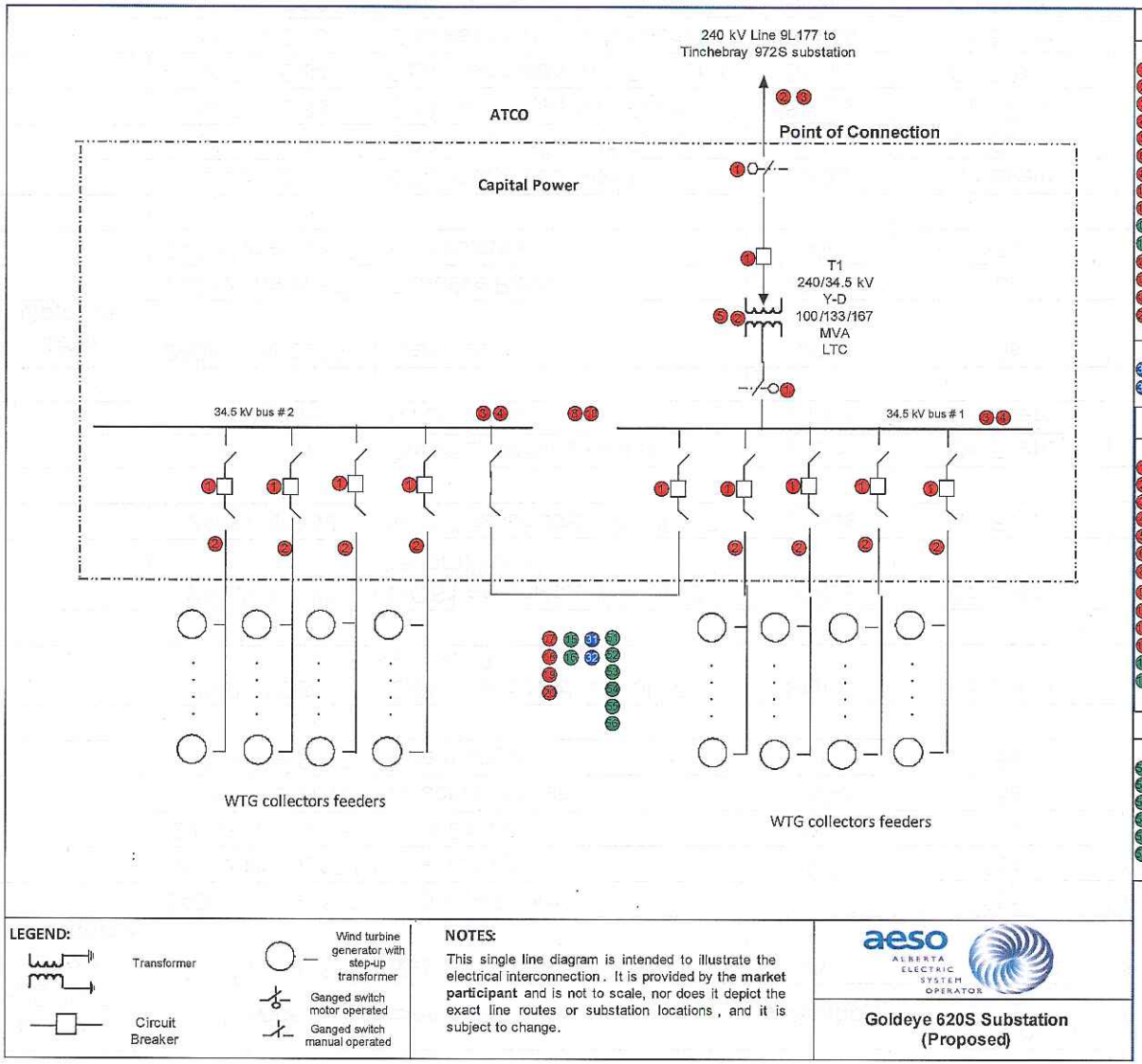


7.6 SCADA Requirements

7.6.1 SCADA Point Requirements- Tinchebray 972S Substation



7.6.2 SCADA POINT REQUIREMENTS- GOLDEYE 620SS SUBSTATION



Wind Aggregated Generating Facilities
502.8 Appendix 2

DATA TO AESO

1. Status
2. MW/Mvar Analogs
3. Voltage Analog (kV)
4. Frequency (Hz)
5. LTC Tap Position (TAP)
6. LTC Auto/Manual Status (AVR)
8. Automatic Voltage Regulation Setpoint
10. Automatic Voltage Regulation Status (AVR)
12. Reactive Power of Reactive Power Resource
15. IED Ganged Failure Alarm
16. RTU Failure Alarm
17. Potential Real Power Capability (MW)
18. Active Real Power Limit (MW)
19. Wind Power Limiting Control System Status
20. Wind Speed/Direction from MET tower

*Items in Green are required *Only if applicable*

DATA FROM THE AESO

31. Facility Wind Limit Directive (MW)
32. Facility Wind Limit Reason (Analog)

Transmission Facilities
502.8 Appendix 4

DATA TO AESO

1. Status
2. MW/Mvar Analogs
3. Voltage Analog (kV)
4. Frequency (Hz)
5. LTC Tap Position (TAP)
6. LTC Auto/Manual Status (AVR)
8. Automatic Voltage Regulation Setpoint
9. Reactive Power Resource Control Device Status
12. Reactive Power of Reactive Power Resource
13. Reactive Power Resource AVR Status
14. Reactive Power Resource Voltage Setpoint
15. IED Ganged Failure Alarm
16. RTU Failure Alarm

*Items in Green are required *Only if applicable*

Remedial Action Scheme (RAS)
502.8 Appendix 1-4

DATA TO AESO

51. RAS Enabled/Disabled Status
52. RAS IED/RELAY Failed Status
53. RAS IED/RELAY Communication Status
54. RAS Operated Status
55. RAS Runback Status
56. RAS Special Scheme Status*

*Items in Green are required *Only if applicable*

7.7 Energy Data Requirements

Facility/ Location	Device	Element	Indication	Update Rate/ Mode	Notes
972S Tinchebray	240kV line 9L177	Real Power	MW	15s	Point description change
	240kV line 9L177	Reactive Power	MVAr	15s	Point description change
	240kV line 9L177	Line voltage	kV	15s	Point description change
	240kV line 9L16	Real Power	MW	15s	
	240kV line 9L16	Reactive Power	MVAr	15s	
	240kV line 9L16	Line voltage	kV	15s	
	240kV CB4	CB4 associated with 9L16 and 9L93	Status	On Event	
	240kV MOS1	MOS1 associated with 9L16 re-termination	Status	On Event	
	240kV MOS2	MOS2 associated with 9L177	Status	On Event	
	(15) Comm	Communications Failure	Alarm	On Event	
	(16) Comm	RTU Failure	Alarm	On Event	
620S Goldeye	240kV line 9L177	Real Power	MW	15s	
	240kV line 9L177	Reactive Power	MVAr	15s	
	240kV line 9L177	Line voltage	kV	15s	
	240kV CB1	CB1 associated with T1	Status	On Event	
	34.5kV CB2	CB2 associated with Feeder 1	Status	On Event	
	34.5kV CB3	CB3 associated with Feeder 2	Status	On Event	
	34.5kV CB4	CB4 associated with Feeder 3	Status	On Event	
	34.5kV CB5	CB5 associated with Feeder 4	Status	On Event	
	34.5kV CB6	CB6 Bus tie	Status	On Event	

	34.5kV CB7	CB7 associated with Feeder 5	Status	On Event	
	34.5kV CB8	CB8 associated with Feeder 6	Status	On Event	
	34.5kV CB9	CB9 associated with Feeder 7	Status	On Event	
	34.5kV CB10	CB10 associated with Feeder 8			
	240kV MOS1	MOS1 associated with 9L177	Status	On Event	
	240kV MOS2	MOS2 associated with T1	Status	On Event	
	34.5KV BUS1	34.5kV Bus voltage	kV	15s	
	34.5KV BUS1	34.5kV Bus frequency	Hz	15s	
	34.5KV BUS2	34.5kV Bus voltage	kV	15s	
	34.5KV BUS2	34.5kV Bus frequency	Hz	15s	
	240/34.5 Transformer T1	T1 Real power	MW	15s	
	240/34.5 Transformer T1	T1 Reactive Power	MVAr	15s	
	240/34.5 Transformer T1	T1 Tap position	TAP	15s	
	34.5KV Feeder1	Feeder1 Real power	MW	15s	
	34.5KV Feeder1	Feeder1 Reactive Power	MVAr	15s	
	34.5KV Feeder2	Feeder2 Real power	MW	15s	
	34.5KV Feeder2	Feeder2 Reactive Power	MVAr	15s	
	34.5KV Feeder3	Feeder3 Real power	MW	15s	
	34.5KV Feeder3	Feeder3 Reactive Power	MVAr	15s	
	34.5KV Feeder4	Feeder4 Real power	MW	15s	
	34.5KV Feeder4	Feeder4 Reactive Power	MVAr	15s	
	34.5KV Feeder5	Feeder5 Real power	MW	15s	
	34.5KV Feeder5	Feeder5 Reactive Power	MVAr	15s	
	34.5KV Feeder6	Feeder6 Real power	MW	15s	
	34.5KV Feeder6	Feeder6 Reactive Power	MVAr	15s	
	34.5KV Feeder7	Feeder7 Real power	MW	15s	
	34.5KV Feeder7	Feeder7 Reactive Power	MVAr	15s	

	34.5KV Feeder8	Feeder8 Real power	MW	15s	
	34.5KV Feeder8	Feeder8 Reactive Power	MVAr	15s	
	Meteorological Data	Wind Speed	km/h	15s	
	Meteorological Data	Wind Direction	degrees	15s	
	Wind Farm Facility	Potential Real Power	MW	15s	
	Wind Farm Facility	Real Power Curtailment Limit Status	Status	On Event	
	Wind Farm Facility	Real Power Limit	MW	15s	
	Wind Farm Facility	Automatic voltage regulation status	Status	On Event	one status point per regulator/controller
	Wind Farm Facility	Automatic voltage regulation setpoint	kV	15S	one status point per regulator/controller
	Comm	Communications Failure	Alarm	On Event	
	Comm	RTU Failure	Alarm	On Event	
	RAS	ARM Status	Status	On Event	Ras points required as applicable based on final design
	RAS	COMM Status	Status	On Event	Ras points required as applicable based on final design
	RAS	TRIP Status	Status	On Event	Ras points required as applicable based on final design
	RAS	RUNBACK Status	Status	On Event	Ras points required as applicable based on final design
	RAS	Special Scheme Status	Status	On Event	Ras points required as applicable based on final design
From AESO	Wind Power Ramp Management	Wind curtailment reason	Analog	On Event	

	Wind Power Ramp Management	Wind curtailment limit	MW	On Event	
Note	**1. MW and MVAr SCADA data shall be gathered independently of the revenue metering data**				
	2. This list was prepared using the best available information. Final SCADA point will be determined based on the applicable SCADA Standard (ISO rule 502.8)				