AESO FUNCTIONAL SPECIFICATION

Keephills Area
Transmission Re-Configuration
Functional Specification

APEGA
Permit-to-Practice P-8200

(Project Number 7065)

Issued to

AltaLink Management Ltd. (as the **legal owner** of a **transmission facility)**; and

EPCOR Distribution and Transmission Inc. (as the **legal owner** of a **transmission facility)**

February 14, 2018

Version V1

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Functional Specification Revision History

Revision	Description of Revision	By	Date
V1D1	• Initial Issue	Ed Mayer	2017-12-19
V1D2	• For internal review	Henry Ng	2018-01-15
V1D3	• Final draft for review	Henry Ng	2018-02-6
V1	• For Issuance	Henry Ng	2018-2-14

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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 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"). This Functional Specification is issued by the Alberta Electric System Operator (AESO) to:

(i) AltaLink Management Ltd., in its capacity as general partner of AltaLink, L.P., ("AltaLink"), as the **legal owner** of a **transmission facility** eligible under section 24 of the *Transmission Regulation* to apply for the construction or operation, or both, as the case may be, of **transmission facilities** described in the Functional Specification.

(ii) EPCOR Distribution and Transmission Inc., ("EDTI"), as the **legal owner** of a **transmission facility** eligible under section 24 of the *Transmission* Regulation to apply for the construction or operation, or both, as the case may be, of **transmission facilities** described in the Functional Specification.

(2) This Functional Specification is issued for the Purpose only, and the **legal owners** of the **transmission facilities** 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 Operating Policies & Procedures (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 facilities** is prohibited.

(2) The **legal owners** of the **transmission facilities** may make application, 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

On December 6, 2017, in accordance with the notification requirements outlined in section 306.7 of the **ISO rules**, *Mothball Outage Reporting*, TransAlta submitted a **mothball outage** notification to the AESO. TransAlta Corporation (TransAlta) has stated that on April 1, 2018 it plans to temporarily mothball two Sundance generating units, Sundance Unit 3 for a period of two years and Sundance Unit 5 for a period of one year. In addition, TransAlta has stated that on April 1, 2019 it plans to temporarily mothball Sundance 4, for a period of two years. The AESO has determined that during these **mothball outages** there will be transmission system reliability issues in the AESO's Northwest Planning region and west of the City of Edmonton.

The AESO has determined that these reliability issues can be addressed through the following proposed transmission development:

- Remove the jumpers that currently connecting the two circuits that comprise 1043L between Keephills 320P Substation and structure 1043L13.
- Continue to use one of the circuits created above as part of 1043L.
- Add a short 240 kV transmission line to connect the other circuit created above with 1045L, creating a three- terminal line terminating at the Keephills 320P, Sundance 310P and Jasper substations.
- Add or modify associated equipment as required for the above transmission developments.

The scheduled in-service date for the project is April 1, 2018.

4 FORECAST OF FUTURE DEVELOPMENT IN THE PROJECT AREA

Proposed long term developments in the Wabamun (Area 40) is described in the AESO 2017 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(s).

5 SCOPE OF WORK

5.1 General

(1) The **legal owners** of the **transmission facilities** 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 facilities** 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 facilities** 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 facilities** 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 facilities** 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 facilities** 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 facilities** 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, 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 facilities** must comply with the Authoritative Documents provisions which are applicable to the Project and which must be satisfied and 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 502.2, *Bulk Transmission Line Technical Requirements* (effective January 1, 2012);
    - Section 502.3, *Interconnected Electric System Protection Requirements* (effective September 1, 2018)[2];
    - 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 September 1, 2018)[2];
- AESO Generation and Load Interconnection Standard (dated September 19, 2006)[3].

5.3 Modelling Data Requirements

All modelling data shall be provided as per the Information Document ID# 2010-001R Facility Modelling Data (issued March 23, 2017).

5.4 Substation Equipment Specifications

All new substation equipment[4] must meet the following minimum specifications:

- Temperature rating of -50°C 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.

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

[2] The AESO has published these new or amended **ISO rules** on AESO's website. Future facilities that are not yet operational will be required to comply with the **ISO rules** as of the effective date.

[3] The AESO considers this standard to remain in effect, as it pertains to load, notwithstanding the statement in clause 1.5 in the standard. Efforts to revise the standard are currently underway.

[4] 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.

- Equipment maximum fault duty: 31.5 kA for 138/144 kV and 40 kA for 240 kV and 500 kV.

Table 1. 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 facilities**.

5.6 Specific Scope of Work for 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.
- Complete insulation coordination studies to establish appropriate insulation levels.
- 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 shall not have any terminal equipment that causes a derate of the minimum line capacity specified by the AESO.

(2) 240 kV Transmission Line 1045L/1045AL – See Appendix 7.2

- Remove the jumpers that are currently connecting the two circuits of the double circuit transmission line structures between Keephills 320P Substation and the 240 kV transmission line structure 1043L13.
- Establish a three-terminal line configuration among Keephills 320P, Sundance 310P and Jasper substations by adding new 240kV jumpers from structure 1043L13 to structure 1045L32A to connect one circuit of the 240 kV transmission lines 1043L to 1045L.
- The 240 kV transmission line segment between Keephills 320P and the 1045L tap will be designated as 1045AL.
- The new jumpers shall have a minimum capacity of 603 MVA (Summer) and 745 MVA (Winter).
- Connect 1045AL to the spare 240 kV circuit breaker (CB 1352) at Keephills 320P.

(4) Sundance 310P Substation

Protection and Control

- Complete system protection coordination studies and coordinate with the **legal owners** of the adjacent **transmission facilities** as required to establish settings appropriate for the facility additions and Alberta Interconnected Electric System (AIES) operations.
- Install a three-terminal line protection scheme on 1045L/1045AL. Maximum total fault clearance time shall not be more than 5 cycles.

Telecommunication

- Install new or modify/upgrade the existing communication system as necessary to meet the project requirements for operation, control, protection and SCADA.

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).
- All new Remote Terminal Units (RTU) shall have Global Positioning System (GPS) signaling for time synchronization.
- 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,** *SCADA Technical and Operating Requirements*. A complete listing of energy data requirements can be found in Appendix 7.4 of this document.

(5) Keephills 320P Substation – See Appendix 7.3

- Carry out the required work on the 240 kV circuit breaker (CB 1352) to connect the 240 kV line split at the double-circuit 240 kV transmission line 1043L terminal structure outside Keephills 320P substation.

Protection and Control

- Complete system protection coordination studies and coordinate with the **legal owner** of the adjacent **transmission facility** as required to establish settings appropriate for the facility additions and Alberta Interconnected Electric System (AIES) operations.
- Install a three-terminal line protection scheme on 1045L/1045AL, coordinate with EDTI on line protection requirements at Jasper 805S substation as required. Maximum total fault clearance time shall not be more than 5 cycles.

Telecommunication

- Install new or modify/upgrade the existing communication system as necessary to meet the project requirements for operation, control, protection and SCADA.

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).
- All new RTU shall have GPS signaling for time synchronization.

- 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,** *SCADA Technical and Operating Requirements*. A complete listing of energy data requirements can be found in Appendix 7.4 of this document.

5.7 Specific Scope of Work for EDTI

5.7.1 General Requirements

- Ensure project safety is appropriately managed from design through construction.

5.7.2 Jasper 805S Substation

Telecommunication

- Appropriate upgrade to the existing communication system and appropriate communication interface to EDTI's telecommunication system that teleprotection, SCADA, operational voice (OPX), operational Data, and mobile radio service requirements are met.

Protection and Control

- Coordinate with AltaLink to install a three-terminal line protection scheme on 1045L/1045AL. Maximum total fault clearance time shall not be more than 5 cycles.
- Complete system protection coordination studies and coordinate with AltaLink as required to establish settings appropriate for the facility additions and AIES operations.

SCADA

- 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. A complete listing of energy data requirements can be found in Appendix 7.4 of this document.

6 TRANSMISSION SYSTEM OPERATING CHARACTERISTICS

The **legal owners** of the **transmission facilities** 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 and 2b have been derived by the AESO based on information provided by the **legal owners** of the **transmission facilities,** 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 a **transmission facilities** 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 owners** of the **transmission facilities** 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 SP Pre-Project

Substation Name and Number	Base Voltage (kV)	Pre-Fault Voltage (p.u.)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (p.u.)	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (p.u.)
Keephills 320P	240	1.10	17.4	0.001821+j0.015088	15.5	0.000687+j0.011095
Keephills 320P	500	1.10	11.0	0.001230+j0.011481	11.2	0.001138+j0.009869
Sundance 310P	240	1.10	25.2	0.001827+j0.010359	25.7	0.000658+j0.049688
Harry Smith 367S	240	1.10	16.3	0.002953+j0.015949	9.5	0.014086+j0.049688
Sagitawah 77S	240	1.10	10.8	0.005591+j0.023966	7.2	0.012346+j0.059179
Wabamun 19S	240	1.10	13.9	0.003399+j0.018706	10.3	0.008393+j0.037997
Jasper 805S	240	1.10	18.8	0.003257+j0.013659	13.2	0.006394+j0.031300
Petrolia 816S	240	1.10	24.6	0.002558+j0.010438	18.9	0.004963+j0.020024

Note: 1.1 p.u. pre-fault bus voltage was used in calculating the short circuit currents to account for safety factor.

Table 2b: Maximum Short Circuit Current Levels – 2018 SP Post-Project

Substation Name and Number	Base Voltage (kV)	Pre-Fault Voltage (p.u.)	3-Φ Fault (kA)	Positive Sequence Thevenin Source Impedance (R1+jX1) (p.u.)	1-Φ Fault (kA)	Zero Sequence Thevenin Source Impedance (R0+jX0) (p.u.)
Keephills 320P	240	1.10	28.3	0.001484+j0.009229	20.1	0.0006987+j0.020867
Keephills 320P	500	1.10	11.3	0.001189+j0.011182	11.4	0.001165+j0.011273
Sundance 310P	240	1.10	31.2	0.001408+j0.008377	28.7	0.000523+j0.010749
Harry Smith 367S	240	1.10	17.3	0.002847+j0.015035	9.5	0.014323+j0.050693
Sagitawah 77S	240	1.10	11.2	0.005298+j0.023023	7.4	0.012334+j0.059219
Wabamun 19S	240	1.10	5.1	0.009932+j0.050593	3.5	0.026462+j0.117804
Jasper 805S	240	1.10	18.5	0.003426+j0.013907	12.5	0.006669+j0.034527
Petrolia 816S	240	1.10	24.5	0.002594+j0.010463	18.2	0.005192+j0.021473

Note: 1.1 p.u. pre-fault bus voltage was used in calculating the short circuit currents to account for safety factor.

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)
Sundance 310P	240	216	234	252	264
Keephills 320P	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

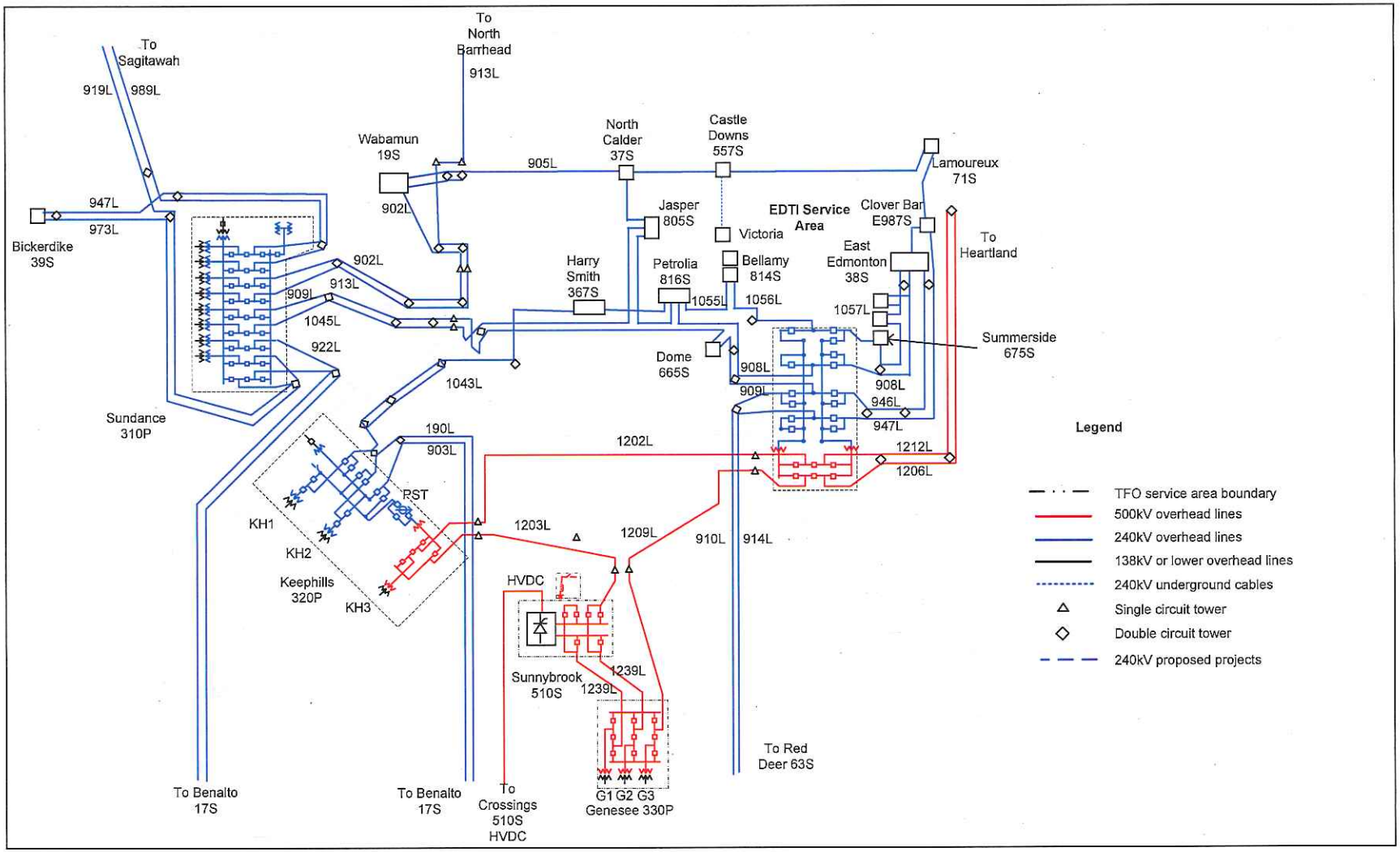
The Engineering Study Report (ESR) for this Project has indicated that no new or modification to existing / planned RAS(s) were identified for this Project, under Category B contingency conditions, based on assumptions used in the study. However, changes to the System Control Procedures (SCPs) are recommended to mitigate the thermal overload elements identified in the ESR.

Prior to the ISD of the Project, additional operations planning studies will be performed to determine and/or confirm the required mitigation measures, RAS(s), or procedures, by taking into account other connection and system projects, as appropriate. System conditions under additional contingency categories will also be assessed as part of operations planning studies. This will ensure that appropriate mitigation will be in place

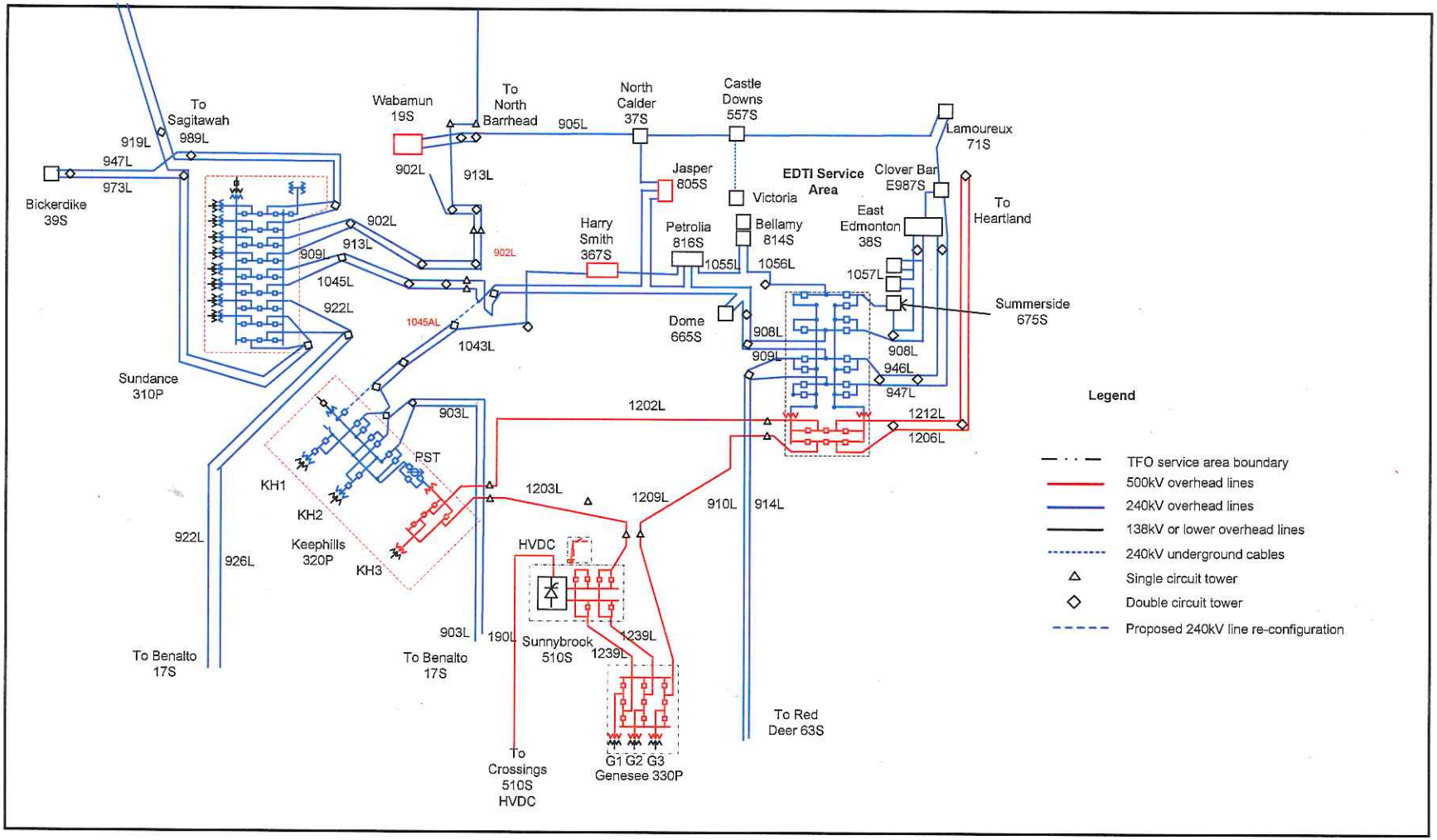
prior to the ISD of the Project. The AESO will consult with the **legal owners** of the **transmission facilities** before specifying revised and/or new mitigation measures.

7 APPENDICES

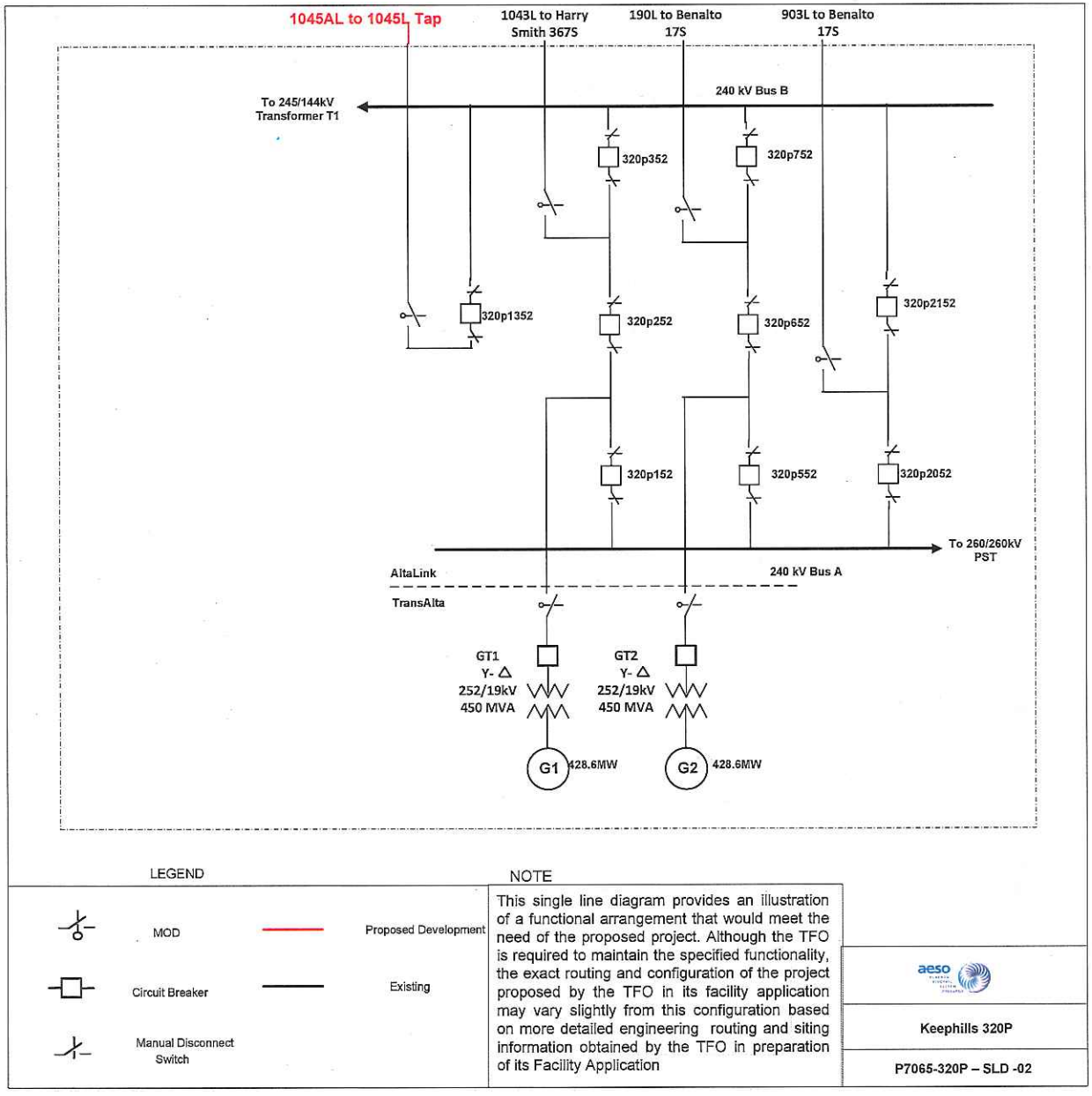
7.1 Area Transmission Map – Pre-Project



7.2 Area Transmission Map – Proposed Development

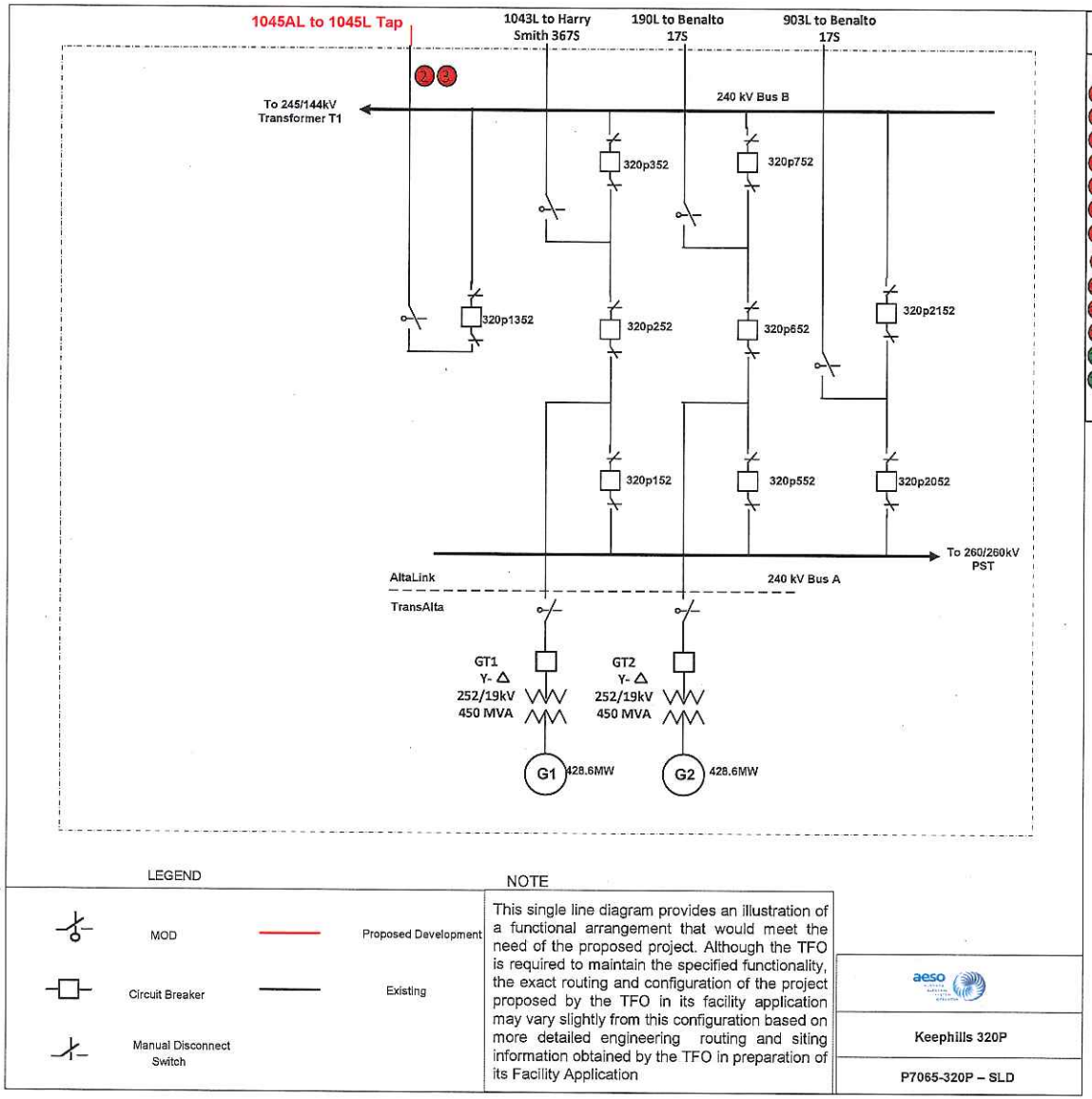


7.3 Keephills 320P Substation– Proposed Development



7.4 SCADA Requirements

7.4.1 SCADA Points Requirements – Keephills 320P Substation



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*

7.4.2 SCADA DATA REQUIREMENTS- KEEPHILLS 320P SUBSTATION

Facility/ Location	Device	Element	Indication	Max Latency	Notes
Keephills 320P	240 kV Line	1045AL Line Voltage	kV	15s	
	240 kV Line	1045AL Real Power	MW	15s	
	240 kV Line	1045AL Reactive Power	MVAr	15s	
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 (502.8)				