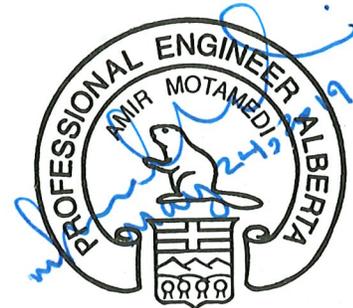


AESO System Operating Limits Methodology for the Planning Horizon (R1 FAC-010-AB-2.1)



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1 Purpose

This document sets out the System Operating Limits Methodology the Alberta Electric System Operator (“AESO”) uses for any studies conducted on the interconnected electric system in the planning horizon, including generation and load connection studies, for the purposes of R1 of Alberta Reliability Standard FAC-010-AB-2.1.

2 Glossary of Terms

For the purposes of this document:

- (a) Interconnection reliability operating limit T_v : This is the maximum time that an interconnection reliability operating limit can be violated before the risk to the interconnection or other reliability coordinator area(s) becomes greater than acceptable. Each interconnection reliability operating limit’s T_v is less than or equal to thirty (30) minutes.
- (b) Operating horizon: The operating horizon for study purposes is defined as any timeframe prior to the implementation of transmission system improvements intended to mitigate a Category A or B¹ contingency violation.
- (c) Planning horizon: The planning horizon for study purposes is defined as any timeframe subsequent to the implementation of transmission system improvements intended to mitigate a Category A or B contingency violation. This is typically defined as the 5 year and 10 year planning horizons.
- (d) Cascading: The uncontrolled successive loss of system elements triggered by an incident at any location, resulting in widespread electric services interruption that cannot be restrained from sequentially spreading beyond an area predetermined by studies.

3 System Performance Requirements

The contingencies that the AESO assesses in establishing the system operating limits over the planning horizon, along with the acceptable system performance, are as follows:

- (a) The system operating limits developed in the pre-contingency state and with all facilities in service provide for bulk electric system performance that:
 - (i) Demonstrates unconstrained flow of in-merit energy 100% of the time;
 - (ii) demonstrates transient, dynamic and voltage stability;
 - (iii) demonstrates all facilities operate within their facility ratings;
 - (iv) demonstrates system conditions are within thermal, voltage and stability limits; and
 - (v) reflects expected system conditions and changes to system topology for the time period being considered.

¹ As defined in Alberta Reliability Standards *TPL-001-AB-0 System Performance Under Normal Conditions* and *TPL-002-AB1-0 System Performance following Loss of a Single BES Element*, respectively.

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- (b) The system operating limits developed with all facilities in service and following any single contingency, including:
- (i) single line-to-ground fault or three-phase fault, whichever is most severe, with normal clearing, on any faulted generating unit, transmission line, transformer or shunt device;
 - (ii) loss of any generating unit, transmission line, transformer or shunt device without a fault; or
 - (iii) single pole block, with normal clearing, in a monopolar or bipolar high voltage direct current system;
- result in bulk electric system performance that:
- (iv) demonstrates transient, dynamic and voltage stability;
 - (v) has all facilities operating within their facility ratings;
 - (vi) is within voltage and stability limits; and
 - (vii) has no cascading or uncontrolled separation,
- with either or both of the following responses to the single contingency being acceptable:
- (viii) planned or controlled interruption of electric supply to radial customers or some local network customers connected to or supplied by the faulted facility or by the affected area; or
 - (ix) bulk electric system reconfiguration through manual or automatic control or protection actions.
- (c) When developing system operating limits, the AESO may make system adjustments including changes to generation, uses of the transmission system (e.g. Schedule curtailments), and the transmission system topology in preparation for the next contingency.
- (d) The system operating limits developed with all facilities in service and following any of the multiple contingencies identified in TPL-003-AB-0 provide for bulk electric system performance that:
- (i) demonstrates transient, dynamic and voltage stability;
 - (ii) has all facilities operating within their facility ratings;
 - (iii) is within voltage and stability limits; and
 - (iv) has no cascading or uncontrolled separation,
- with any of the following responses to such multiple contingencies being acceptable:
- (v) planned or controlled interruption of electric supply to radial customers or some local network customers connected to or supplied by the faulted facility or by the affected area;
 - (vi) bulk electric system reconfiguration through manual or automatic control or protection actions; or
 - (vii) planned or controlled interruption of demand to demand customers, the planned removal of a generating unit, or the curtailment of firm, non-recallable power transfers.

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- (e) For interconnections with other WECC jurisdictions as described in WECC path rating Catalogue², the system operation limits developed with all facilities in service and following any of the multiple contingencies identified in TPL-003-AB-0 or any of the following multiple contingencies:
- (i) simultaneous permanent phase-to-ground faults of each of two (2) adjacent transmission circuits on a multiple circuit tower with normal clearing. If multiple circuit towers are used only for station entrance and exit purposes, and if they do not exceed five (5) towers per double circuit at each station, this condition is an acceptable risk and therefore can be excluded;
 - (ii) a permanent phase-to-ground fault on any generating unit, transmission circuit, transformer, or bus section with delayed fault clearing except for bussectionalizing breakers or bus tie breakers;
 - (iii) simultaneous permanent loss of both poles of a high voltage direct current bipolar facility without an alternating current fault;
 - (iv) the failure of a circuit breaker associated with a remedial action scheme to operate when required following the loss of any element without a fault, or a permanent phase-to-ground fault, with normal clearing, on any transmission circuit, transformer or bus section; or
 - (v) a single-line-to-ground fault with normal clearing for a common mode contingency of two (2) adjacent circuits on separate towers,
- result in bulk electric system performance that:
- (vi) demonstrates transient, dynamic and voltage stability;
 - (vii) has all facilities operating within their facility ratings;
 - (viii) is within voltage and stability limits; and
 - (ix) has no cascading or uncontrolled separation,
- with any of the following responses to such multiple contingencies being acceptable:
- (x) planned or controlled interruption of electric supply to radial customers or some local network customers connected to or supplied by the faulted facility or by the affected area;
 - (xi) bulk electric system reconfiguration through manual or automatic control or protection actions; or
 - (xii) planned or controlled interruption of demand to demand customers, the planned removal of a generating unit, or the curtailment of firm, non-recallable power transfers.
- (f) For interconnections with other WECC jurisdictions, starting with all facilities in service and following either of these multiple contingencies:
- (i) a common mode outage of two (2) generating units connected to the same switchyard not otherwise addressed by reliability standard FAC-010-AB; or
 - (ii) the loss of multiple bus sections as a result of failure or delayed clearing of a bus tie or bus sectionalizing breaker to clear a permanent phase to ground fault,

²<https://www.wecc.org>

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the system operating limits result in bulk electric system performance such that cascading does not occur on other systems in other jurisdictions within the WECC.

- (g) Where the AESO makes changes to any contingencies and responses identified in subsections 3(e) and (f) of this document for specific facilities on interconnections to other systems within the WECC in accordance with the WECC performance category adjustment process based upon system performance and robust design, the system operating limits result in bulk electric system performance that satisfies the performance requirements in subsection 3(d) of this document.

4 Study Methodology

This section describes the methodology for determining system operating limits in the planning horizon.

The AESO normally conducts system operating limits studies at the same time as, and consistent with, any studies that it conducts for the purpose of ensuring compliance with the following Alberta Reliability Standards: *TPL-001-AB-0 System Performance Under Normal Conditions* (“TPL-001-AB-0”), *TPL-002-AB1-0 System Performance Following Loss of a Single BES Element* (“TPL-002-AB1-0”), *TPL-003-AB-0 System Performance Following Loss of Two or More BES Elements* (“TPL-003-AB-0”) and *TPL-004-AB-0 System Performance Following Extreme BES Events* (“TPL-004-AB-0”).

- (a) The AESO conducts studies which include:
 - (i) Power Flow Analysis: The AESO analyzes all facility loading and voltage violations under Category A and B contingencies.
 - (ii) Voltage Stability Analysis: The AESO conducts voltage stability analysis for peak load conditions under select Category B and Category C³ contingencies.
 - (iii) Transient Stability Analysis: The AESO conducts transient stability analysis for stressed system conditions under select Category B and Category C contingencies. The AESO applies faults to critical transmission lines identified in studies conducted under TPL-001-AB-0, TPL-002-AB1-0 and TPL-003-AB-0.
- (b) The study model is based on a base case developed by the AESO that is relevant for the study. The study model includes a full representation of the Alberta electric system, which may be modified by the study. The model includes:
 - (i) load representation relevant to the region of study, planning year and the period of the year (e.g. peak winter, summer or other) and the type of study (e.g. power flow, stability);
 - (ii) generation dispatch based on the AESO generation scenarios and the in-merit dispatch order;
 - (iii) critical system conditions as described in the assessments of the bulk electric system required under TPL-001-AB-0, TPL-002-AB1-0, TPL-003-AB-0 and TPL-004-AB-0;
 - (iv) transmission enhancement projects that are planned to be in-service in the planning horizon being studied; and
 - (v) representation of other planning authority areas provided in the approved base case, based on WECC base cases. When studying interconnections to other planning authority areas, the AESO reviews representation of the other planning authority area with the applicable planning authority.

³ As defined in ARS TPL-003-AB-0.

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- (c) The AESO considers all contingencies potentially impacting the system operating limits as identified through the studies conducted under TPL-001-AB-0, TPL-002-AB-0 and TPL-003-AB-0. The AESO may consider prior study results in order to determine the contingencies for which simulations are required. The contingencies used in these studies are a subset of the contingencies used in the studies conducted under TPL-001-AB-0, TPL-002-AB1-0 and TPL-003-AB-0.
- (d) The AESO models load characteristics suitable for the study type as close as practically possible. Dynamic models are used representing voltage and frequency characteristics of loads. Actual load models are used when available. Otherwise, accepted industry models are used.
- (e) The study models include existing and proposed remedial action schemes.
- (f) Where a range of load forecast and generation assumptions may impact system operating limits, sensitivity studies are conducted to assess the potential impact.
- (g) System operating limits on interconnections to adjacent jurisdictions and system operating limits impacting on these interconnections are also interconnection reliability operating limits. The AESO bases interconnection reliability operating limits T_v on WECC requirements, being twenty (20) minutes for stability and thirty (30) minutes for thermal.
- (h) A list of monitored elements is included in the study documentation.
- (i) The AESO does not generally apply reliability margins to the studies conducted under TPL-001-AB-0, TPL-002-AB1-0 and TPL-003-AB-0.

Revision History

Effective Date	Description
May 09, 2019	Section 3a Added unconstrained flow of in-merit energy Section 4f Removed transmission must run generation units
Sept 04, 2014	Initial release