# Transmission Planning Criteria – Basis and Assumptions

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# 1. Introduction

This document presents the reliability standards, criteria, and assumptions to be used as the basis for planning the Alberta Transmission System. The criteria, standards and assumptions identified in this document supersede those previously established.

# 2. Transmission Reliability Standards and Criteria[1]

The AESO applies the following Alberta Reliability Standards to ensure that the transmission system is planned to meet applicable performance requirements under a defined set of system conditions and contingencies. A brief description of each of these standards is given below:

1. **TPL-001-AB-0: System Performance Under Normal Conditions**

   Category A represents a normal system condition with all elements in service (N-0). All equipment must be within its applicable rating, voltages must be within their applicable ratings and the system must be stable with no cascading outages. Under Category A, electric supply to load cannot be interrupted and generating units cannot be removed from service.

2. **TPL-002-AB1-0: System Performance Following Loss of a Single BES Element**

   Category B events result in the loss of any single element (N-1) under specified fault conditions with normal clearing. The specified elements are a generating unit, a transmission circuit, a transformer or a single pole of a direct current transmission line. The acceptable impact on the system is the same as Category A with the exception that radial customers or some local network customers, including loads or generating units, are allowed to be disconnected from the system if they are connected through the faulted element. The loss of opportunity load or opportunity interchanges is allowed. No cascading can occur.

3. **TPL-003-AB-0: System Performance Following Loss of Two or More BES Elements**

   Category C events result in the loss of two or more bulk electric system elements (sequential, N-1-1 or concurrent, N-2) under specified fault conditions and include both normal and delayed fault clearing. All of the system limits for Category A and B events apply with the exception that planned and controlled loss of firm load, firm transfers and/or generation is acceptable provided there is no cascading.

4. **TPL-004-AB-0: System Performance Following Extreme BES Events**

   Category D represents a wide variety of extreme, rare and unpredictable events, which may result in the loss of load and generation in widespread areas. The system may not be able to reach a new stable steady state, which means a blackout is a possible outcome. The AESO needs to evaluate these events, at its discretion, for risks and consequences prior to creating mitigation plans.

5. **FAC-014-AB1-2: Establishing and Communicating System Operating Limits**

   The AESO is required to establish system operating limits where a contingency is not mitigated through construction of transmission facilities

[1] A complete description of the *Alberta Reliability Standards* can be found on the AESO's website: https://www.aeso.ca/rules-standards-and-tariff/alberta-reliability-standards/

## 2.1 Thermal Loading Criteria

The AESO Thermal Loading Criteria require that the continuous thermal rating of any transmission element is not exceeded under normal and post-contingency operating conditions. Thermal limits are assumed to be 100% of the respective normal summer and winter ratings. Emergency limits are not considered in the planning evaluations.

## 2.2 Voltage Range and Voltage Stability Criteria

The normal minimum and maximum voltage limits as specified in the following table are used to identify Category A system voltage violations, while the extreme minimum and maximum limits are used to identify Category B and C system violations. Table 2-1 presents the acceptable steady state and contingency state voltage ranges for the AIES. Table 2-2 provides voltage stability criteria used to test the system performance.

**Table 2-1: Acceptable Range of Steady State Voltage (kV)**

| Nominal Voltage | Extreme Minimum | Normal Minimum | Normal Maximum | Extreme Maximum |
|---|---|---|---|---|
| 500 | 475 | 500 | 525 | 550 |
| 240 | 216 | 234 | 252 | 264 |
| 260 (Northeast & Northwest)* | 234 | 247 | 266 | 275 |
| 144 | 130 | 137 | 151 | 155 |
| 138 | 124 | 135 | 145 | 150 |
| 72 | 65 | 68.5 | 75.5 | 79 |
| 69 | 62 | 65.5 | 72.5 | 76 |

**Table 2-2: Voltage Stability Criteria**

| Performance Level | Disturbance (1)(2)(3)(4) Initiated by: Fault of No Fault DC Disturbance | MW Margin (P-V method) (5)(6)(7) | MVAr Margin (V-Q method) (6)(7) |
|---|---|---|---|
| A | Any element such as:<br>One Generator<br>One Circuit<br>One Transformer<br>One Reactive Power Source<br>One DC Monopole | ≥5% | Worst Case Scenario(8) |
| B | Bus Section | ≥5% | 50% of Margin Requirement in Level A |
| C | Any combination of two elements such as:<br>A Line and a Generator<br>A Line and a Reactive Power Source<br>Two Generators<br>Two Circuits<br>Two Transformers<br>Two Reactive Power Sources<br>DC Bipole | ≥2.5% | 50% of Margin Requirement in Level A |
| D | Any combination of three or more elements such as:<br>Three or More Circuits on ROW<br>Entire Substation<br>Entire Plant Including Switchyard | > 0 | > 0 |

## 2.3 Transient Stability Analysis Assumptions

Standard fault clearing times as shown in Table 2-3 are used for the new facilities or when the actual clearing times are not available for the existing facilities. Double line-to-ground faults are applied for the Category C5 events with normal clearing times. Single line-to-ground faults are applied for Category C6 to C9 events with delayed clearing times as depicted in Table 2-4 and Table 2-5.

**Table 2-3: Fault Clearing Times**

| Nominal (kV) | Near End (Cycles) | Far End (Cycles) |
|---|---|---|
| 500 | 4 | 5 |
| 240 | 5 | 6 |
| 144/138 with telecommunications | 6 | 8 |
| 144/138 without telecommunications | 6 | 30 |

**Table 2-4: Stuck Breaker Clearing Times for Lines**

| Voltage (kV) | Fault Clearing Times (Cycles) | | |
|---|---|---|---|
| | Near End | Far End | 2nd Ckt (C5 and C7 only) |
| 138/144 | 15 | 24 | 24 |
| 240 | 12 | 6 | 14 |
| 500 | 9 | 5 | 11 |

**Table 2-5: Stuck Breaker Clearing Times for Transformers**

| Voltage (kV) | Fault Location | Fault Clearing Times (Cycles) | | |
|---|---|---|---|---|
| | | High Side | Low Side | 2nd Ckt (breaker fail) |
| 240/138 | 240 kV side | 12 | 6 | 14 |
| | 138 kV side | 5 | 15 | 24 |
| 500/240 | 500 kV side | 9 | 5 | 11 |
| | 240 kV side | 4 | 12 | 14 |