

**APPENDIX B**  
**NERC PLANNING STANDARDS**

## Compliance Templates

### NERC Planning Standards

I.A.M1

**Brief Description** System performance under normal (no contingency) conditions.

**Category** Assessments

**Section** I. System Adequacy and Security  
A. Transmission Systems

#### Standard

S1. The interconnected transmission systems shall be planned, designed, and constructed such that with all transmission facilities in service and with normal (pre-contingency) operating procedures in effect, the network can deliver generator unit output to meet projected customer demands and projected firm (non-recallable reserved) transmission services, at all demand levels over the range of forecast system demands, under the conditions defined in Category A of Table I (attached).

Transmission system capability and configuration, reactive power resources, protection systems, and control devices shall be adequate to ensure the system performance prescribed in Table I.

#### Measure

M1. Entities responsible for the reliability of the interconnected transmission systems shall ensure that the system responses for Standard S1 are as defined in Category A (no contingencies) of Table I (attached).

#### Assessment Requirements

Entities Responsible for the Reliability of Interconnected transmission Systems (ERRIS), as determined by the Region, for example:

1. Transmission owners,
2. Independent system operators (ISOs),
3. Regional transmission organizations (RTOs),

Or other groups responsible for planning the bulk electric system shall assess the performance of their systems in meeting Standard S1.

To be valid *and compliant*, assessments shall:

1. Be made annually,
2. Be conducted for near-term (years one through five) and longer-term (years six through ten) planning horizons,
3. Be supported by a current or past study and/or system simulation testing as accepted by the Region showing system performance following Category A of Table 1 (no contingencies) that addresses the plan year being assessed,
4. Address any planned upgrades needed to meet the performance requirements of Category A.

#### System Simulation Study/Testing Methods

System simulation studies/testing shall (as agreed to by the Region):

1. Cover critical system conditions and study years as deemed appropriate by the responsible entity.

2. Be conducted annually unless changes to system conditions do not warrant such analyses.
3. Be conducted beyond the five-year horizon only as needed to address identified marginal conditions that may have longer lead-time solutions.
4. Have established normal (pre-contingency) operating procedures in place.
5. Have all projected firm transfers modeled.
6. Be performed for selected demand levels over the range of forecast system demands.
7. Demonstrate that system performance meets Table 1 for Category A (no contingencies).
8. Include existing and planned facilities.
9. Include reactive power resources to ensure that adequate reactive resources are available to meet system performance.

### **Corrective Plan Requirements**

When system simulations indicate an inability of the systems to respond as prescribed in this Measurement (M1), responsible entities shall:

1. Provide a written summary of their plans to achieve the required system performance as described above throughout the planning horizon:
  - a. Including a schedule for implementation,
  - b. Including a discussion of expected required in-service dates of facilities,
  - c. Consider lead times necessary to implement plans.
2. For identified system facilities for which sufficient lead times exist, review in subsequent annual assessments for continuing need — detailed implementation plans are not needed.

### **Reporting Requirements**

The documentation of results of these reliability assessments and corrective plans shall annually be provided to the entities' respective NERC Region(s), as required by the Region. Each Region, in turn, shall annually provide a report of its reliability assessments and corrective actions to NERC.

### **Applicable to**

Entities responsible for reliability of interconnected transmission systems.

### **Items to be Measured**

System performance under normal (no contingency) conditions.

### **Timeframe**

Annually

### **Levels of Non-Compliance** (If non-compliant at more than one Level, the highest Level applies.)

Level 1 — N/A

Level 2 — A valid assessment and corrective plan for the longer-term planning horizon is not available.

Level 3 — N/A

## **Compliance Templates**

### **NERC Planning Standards**

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Level 4 — A valid assessment and corrective plan for the near-term planning horizon is not available.

#### **Compliance Monitoring Responsibility**

Regional Reliability Council. Each Region shall report compliance and violations to NERC via the NERC Compliance Reporting Process.

## NERC Planning Standards

Table I. Transmission Systems Standards — Normal and Contingency Conditions\*

| Category                                                               | Contingencies                                                                                                                                                                                                                                                                           |                      | Elements Out of Service              | System Limits or Impacts             |               |                                                                    |                                |  |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|--------------------------------------|--------------------------------------|---------------|--------------------------------------------------------------------|--------------------------------|--|
|                                                                        | Initiating Event(s) and Contingency Element(s)                                                                                                                                                                                                                                          | Thermal Limits       |                                      | Voltage Limits                       | System Stable | Loss of Demand or Curtailed Firm Transfers                         | Cascading Outages <sup>c</sup> |  |
| A - No Contingencies                                                   | All Facilities in Service                                                                                                                                                                                                                                                               | None                 | Applicable Rating <sup>a</sup> (A/R) | Applicable Rating <sup>a</sup> (A/R) | Yes           | No                                                                 | No                             |  |
| B - Event resulting in the loss of a single element.                   | Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing:<br>1. Generator<br>2. Transmission Circuit<br>3. Transformer<br>Loss of an Element without a Fault.                                                                                                               | Single               | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                                                    | No                             |  |
|                                                                        |                                                                                                                                                                                                                                                                                         | Single               | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                                                    | No                             |  |
|                                                                        |                                                                                                                                                                                                                                                                                         | Single               | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                                                    | No                             |  |
|                                                                        |                                                                                                                                                                                                                                                                                         | Single               | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                                                    | No                             |  |
| C - Event(s) resulting in the loss of two or more (multiple) elements. | Single Pole Block, Normal Clearing :<br>4. Single Pole (dc) Line                                                                                                                                                                                                                        | Single               | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                                                    | No                             |  |
|                                                                        | SLG Fault, with Normal Clearing :<br>1. Bus Section<br>2. Breaker (failure or internal fault)                                                                                                                                                                                           | Multiple<br>Multiple | A/R<br>A/R                           | A/R<br>A/R                           | Yes<br>Yes    | Planned/Controlled <sup>d</sup><br>Planned/Controlled <sup>d</sup> | No<br>No                       |  |
|                                                                        | SLG or 3Ø Fault, with Normal Clearing <sup>f</sup> , Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing :<br>3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency | Multiple             | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>                                    | No                             |  |
|                                                                        | Bipolar Block, with Normal Clearing :<br>4. Bipolar (dc) Line                                                                                                                                                                                                                           | Multiple             | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>                                    | No                             |  |
|                                                                        | Fault (non 3Ø), with Normal Clearing :<br>5. Any two circuits of a multiple circuit towerline <sup>f</sup>                                                                                                                                                                              | Multiple             | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>                                    | No                             |  |
|                                                                        | SLG Fault, with Delayed Clearing <sup>f</sup> (stuck breaker or protection system failure):<br>6. Generator<br>7. Transmission Circuit<br>8. Transformer<br>9. Bus Section                                                                                                              | Multiple<br>Multiple | A/R<br>A/R                           | A/R<br>A/R                           | Yes<br>Yes    | Planned/Controlled <sup>d</sup><br>Planned/Controlled <sup>d</sup> | No<br>No                       |  |

\* Any Region may implement standards that are more stringent, but not inconsistent with NERC's industry-wide standards.

# Compliance Templates

## NERC Planning Standards

I.A.M1

|                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
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| <p><sup>e</sup> D - Extreme event resulting in two or more (multiple) elements removed or cascading out of service</p> | <p>3Ø Fault, with Delayed Clearing (stuck breaker or protection system failure):</p> <ol style="list-style-type: none"> <li>1. Generator</li> <li>2. Transmission Circuit</li> <li>3. Transformer</li> <li>4. Bus Section</li> </ol> <p>3Ø Fault, with Normal Clearing :</p> <ol style="list-style-type: none"> <li>5. Breaker (failure or internal fault)</li> </ol> <p>Other:</p> <ol style="list-style-type: none"> <li>6. Loss of towerline with three or more circuits</li> <li>7. All transmission lines on a common right-of way</li> <li>8. Loss of a substation (one voltage level plus transformers)</li> <li>9. Loss of a switching station (one voltage level plus transformers)</li> <li>10. Loss of all generating units at a station</li> <li>11. Loss of a large load or major load center</li> <li>12. Failure of a fully redundant special protection system (or remedial action scheme) to operate when required</li> <li>13. Operation, partial operation, or misoperation of a fully redundant special protection system (or remedial action scheme) in response to an event or abnormal system condition for which it was not intended to operate</li> <li>14. Impact of severe power swings or oscillations from disturbances in another Regional Council.</li> </ol> |
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Evaluate for risks and consequences.

- May involve substantial loss of customer demand and generation in a widespread area or areas.
- Portions or all of the interconnected systems may or may not achieve a new, stable operating point.
- Evaluation of these events may require joint studies with neighboring systems.

- Applicable rating (A/R) refers to the applicable normal and emergency facility thermal rating or system voltage limit as determined and consistently applied by the system or facility owner. Applicable ratings may include emergency ratings applicable for short durations as required to permit operating steps necessary to maintain system control. All ratings must be established consistent with applicable NERC Planning Standards addressing facility ratings.
- Planned or controlled interruption of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall security of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted firm (non-recallable reserved) electric power transfers.
- Cascading is the uncontrolled successive loss of system elements triggered by an incident at any location. Cascading results in widespread service interruption which cannot be restrained from sequentially spreading beyond an area predetermined by appropriate studies.
- Depending on system design and expected system impacts, the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted firm (non-recallable reserved) electric power transfers may be necessary to maintain the overall security of the interconnected transmission systems.
- A number of extreme contingencies that are listed under Category D and judged to be critical by the transmission planning entity(ies) will be selected for evaluation. It is not expected that all possible facility outages under each listed contingency of Category D will be evaluated.
- Normal clearing is when the protection system operates as designed and the fault is cleared in the time normally expected with proper functioning of the installed protection systems. Delayed clearing of a fault is due to failure of any protection system component such as a relay, circuit breaker, or current transformer (CT), and not because of an intentional design delay.
- System assessments may exclude these events where multiple circuit towers are used over short distances (e.g., station entrance, river crossings) in accordance with Regional exemption criteria.

## Compliance Templates

### NERC Planning Standards

I.A.M2

**Brief Description** System performance following loss of a single bulk system element.

**Category** Assessments

**Section** I. System Adequacy and Security  
A. Transmission Systems

#### Standard

S2. The interconnected transmission systems shall be planned, designed, and constructed such that the network can be operated to supply projected customer demands and projected firm (non-recallable reserved) transmission services, at all demand levels over the range of forecast system demands, under the contingency conditions as defined in Category B of Table I (attached).

Transmission system capability and configuration, reactive power resources, protection systems, and control devices shall be adequate to ensure the system performance prescribed in Table I.

The transmission systems also shall be capable of accommodating planned bulk electric equipment outages and continuing to operate within thermal, voltage, and stability limits under the contingency conditions as defined in Category B of Table I (attached).

#### Measure

M2. Entities responsible for the reliability of the interconnected transmission systems shall ensure that the system responses for Standard S2 contingencies are as defined in Category B (event resulting in the loss of a single element) of Table I (attached).

#### Assessment Requirements

Entities Responsible for the Reliability of Interconnected transmission Systems (ERRIS), for example:

1. Transmission owners,
2. Independent system operators (ISOs),
3. Regional transmission organizations (RTOs).

Or other groups responsible for planning the bulk electric system shall assess the performance of their systems in meeting Standard S2.

To be valid *and compliant*, assessments shall:

1. Be made annually,
2. Be conducted for near-term (years one through five) and longer-term (years six through ten) planning horizons,
3. Be supported by a current or past study and/or system simulation testing as accepted by the Region showing system performance following Category B contingencies that addresses the plan year being assessed,
4. Address any planned upgrades needed to meet the performance requirements of Category B,
5. Consider all contingencies applicable to Category B.

**System Simulation Study/Testing Methods**

System simulation studies/testing shall:

1. Be performed and evaluated only for those Category B contingencies that would produce the more severe system results or impacts:
  - a. The rationale for the contingencies selected for evaluation shall be available as supporting information,
  - b. An explanation of why the remaining simulations would produce less severe system results shall be available as supporting information.
2. Cover critical system conditions and study years as deemed appropriate by the responsible entity.
3. Be conducted annually unless changes to system conditions do not warrant such analyses.
4. Be conducted beyond the five-year horizon only as needed to address identified marginal conditions that may have longer lead-time solutions.
5. Have all projected firm transfers modeled.
6. Be performed and evaluated for selected demand levels over the range of forecast system demands.
7. Demonstrate that system performance meets Table 1 for Category B contingencies.
8. Include existing and planned facilities.
9. Include reactive power resources to ensure that adequate reactive resources are available to meet system performance.
10. Include the effects of existing and planned protection systems, including any backup or redundant systems.
11. Include the effects of existing and planned control devices.
12. Include the planned (including maintenance) outage of any bulk electric equipment (including protection systems or their components) at those demand levels for which planned (including maintenance) outages are performed.

**Corrective Plan Requirements**

When system simulations indicate an inability of the systems to respond as prescribed in this Measure (M2), responsible entities shall:

1. Provide a written summary of their plans to achieve the required system performance as described above throughout the planning horizon,
  - a. Including a schedule for implementation,
  - b. Including a discussion of expected required in-service dates of facilities,
  - c. Consider lead times necessary to implement plans.
2. For identified system facilities for which sufficient lead times exist, review in subsequent annual assessments for continuing need — detailed implementation plans are not needed.

**Reporting Requirements**

The documentation of results of these reliability assessments and corrective plans shall annually be provided to the entities' respective NERC Region(s), as required by the Region. Each Region, in turn, shall annually provide a report of its reliability assessments and corrective actions to NERC.



## **Compliance Templates**

### **NERC Planning Standards**

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**I.A.M2**

#### **Applicable to**

Entities responsible for reliability of interconnected transmission systems.

#### **Items to be Measured**

Assessments supported by simulated system performance following loss of a single bulk system element.

#### **Timeframe**

Annually

#### **Levels of Non-Compliance** (If non-compliant at more than one Level, the highest Level applies.)

Level 1 — N/A

Level 2 — A valid assessment and corrective plan, as defined above, for the longer-term planning horizon is not available.

Level 3 — N/A

Level 4 — A valid assessment and corrective plan, as defined above, for the near-term planning horizon is not available.

#### **Compliance Monitoring Responsibility**

Regional Reliability Council. Each Region shall report compliance and violations to NERC via the NERC Compliance Reporting process.

## NERC Planning Standards

Table I. Transmission Systems Standards — Normal and Contingency Conditions \*

| Category                                                               | Contingencies                                                                                                                            |                         | System Limits or Impacts             |                                      |               |                                            |                                |
|------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------------|--------------------------------------|---------------|--------------------------------------------|--------------------------------|
|                                                                        | Initiating Event(s) and Contingency Element(s)                                                                                           | Elements Out of Service | Thermal Limits                       | Voltage Limits                       | System Stable | Loss of Demand or Curtailed Firm Transfers | Cascading Outages <sup>c</sup> |
| A - No Contingencies                                                   | All Facilities in Service                                                                                                                | None                    | Applicable Rating <sup>a</sup> (A/R) | Applicable Rating <sup>a</sup> (A/R) | Yes           | No                                         | No                             |
| B - Event resulting in the loss of a single element.                   | Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing:                                                                    | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | 1. Generator                                                                                                                             | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | 2. Transmission Circuit                                                                                                                  | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | 3. Transformer                                                                                                                           | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
| C - Event(s) resulting in the loss of two or more (multiple) elements. | Loss of an Element without a Fault.                                                                                                      |                         |                                      |                                      |               |                                            |                                |
|                                                                        | Single Pole Block, Normal Clearing:                                                                                                      | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | 4. Single Pole (de) Line                                                                                                                 |                         |                                      |                                      |               |                                            |                                |
|                                                                        | SLG Fault, with Normal Clearing:                                                                                                         | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 1. Bus Section                                                                                                                           | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 2. Breaker (failure or internal fault)                                                                                                   |                         |                                      |                                      |               |                                            |                                |
|                                                                        | SLG or 3Ø Fault, with Normal Clearing, Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing:             | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency |                         |                                      |                                      |               |                                            |                                |
|                                                                        | Bipolar Block, with Normal Clearing:                                                                                                     | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 4. Bipolar (de) Line                                                                                                                     | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | Fault (non 3Ø), with Normal Clearing:                                                                                                    |                         |                                      |                                      |               |                                            |                                |
|                                                                        | 5. Any two circuits of a multiple circuit towerline <sup>e</sup>                                                                         |                         |                                      |                                      |               |                                            |                                |
|                                                                        | SLG Fault, with Delayed Clearing (stuck breaker or protection system failure):                                                           | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 6. Generator                                                                                                                             | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 7. Transmission Circuit                                                                                                                  |                         |                                      |                                      |               |                                            |                                |
|                                                                        | 8. Transformer                                                                                                                           |                         |                                      |                                      |               |                                            |                                |
|                                                                        | 9. Bus Section                                                                                                                           |                         |                                      |                                      |               |                                            |                                |

\* Any Region may implement standards that are more stringent, but not inconsistent with NERC's industry-wide standards.

# Compliance Templates

## NERC Planning Standards

I.A.M2

|                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                        |
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| <p>D<sup>e</sup> - Extreme event resulting in two or more (multiple) elements removed or cascading out of service</p> | <p>3Ø Fault, with Delayed Clearing<sup>f</sup> (stuck breaker or protection system failure):</p> <ol style="list-style-type: none"> <li>1. Generator</li> <li>2. Transmission Circuit</li> <li>3. Transformer</li> <li>4. Bus Section</li> </ol> <p>-----</p> <p>3Ø Fault, with Normal Clearing<sup>f</sup>:</p> <ol style="list-style-type: none"> <li>5. Breaker (failure or internal fault)</li> </ol> <p>-----</p> <p>Other:</p> <ol style="list-style-type: none"> <li>6. Loss of towerline with three or more circuits</li> <li>7. All transmission lines on a common right-of way</li> <li>8. Loss of a substation (one voltage level plus transformers)</li> <li>9. Loss of a switching station (one voltage level plus transformers)</li> <li>10. Loss of all generating units at a station</li> <li>11. Loss of a large load or major load center</li> <li>12. Failure of a fully redundant special protection system (or remedial action scheme) to operate when required</li> <li>13. Operation, partial operation, or misoperation of a fully redundant special protection system (or remedial action scheme) in response to an event or abnormal system condition for which it was not intended to operate</li> <li>14. Impact of severe power swings or oscillations from disturbances in another Regional Council.</li> </ol> | <p>Evaluate for risks and consequences.</p> <ul style="list-style-type: none"> <li>▪ May involve substantial loss of customer demand and generation in a widespread area or areas.</li> <li>▪ Portions or all of the interconnected systems may or may not achieve a new, stable operating point.</li> <li>▪ Evaluation of these events may require joint studies with neighboring systems.</li> </ul> |
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- Applicable rating (A/R) refers to the applicable normal and emergency facility thermal rating or system voltage limit as determined and consistently applied by the system or facility owner. Applicable ratings may include emergency ratings applicable for short durations as required to permit operating steps necessary to maintain system control. All ratings must be established consistent with applicable NERC Planning Standards addressing facility ratings.
- Planned or controlled interruption of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall security of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted firm (non-recallable reserved) electric power transfers.
- Cascading is the uncontrolled successive loss of system elements triggered by an incident at any location. Cascading results in widespread service interruption which cannot be restrained from sequentially spreading beyond an area predetermined by appropriate studies.
- Depending on system design and expected system impacts, the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted firm (non-recallable reserved) electric power transfers may be necessary to maintain the overall security of the interconnected transmission systems.
- A number of extreme contingencies that are listed under Category D and judged to be critical by the transmission planning entity(ies) will be selected for evaluation. It is not expected that all possible facility outages under each listed contingency of Category D will be evaluated.
- Normal clearing is when the protection system operates as designed and the fault is cleared in the time normally expected with proper functioning of the installed protection systems. Delayed clearing of a fault is due to failure of any protection system component such as a relay, circuit breaker, or current transformer (CT), and not because of an intentional design delay.
- System assessments may exclude these events where multiple circuit towers are used over short distances (e.g., station entrance, river crossings) in accordance with Regional exemption criteria.

## Compliance Templates

### NERC Planning Standards

I.A.M3

**Brief Description** System performance following loss of two or more bulk system elements.

**Category** Assessments

**Section** I. System Adequacy and Security  
A. Transmission Systems

#### Standard

S3. The interconnected transmission systems shall be planned, designed, and constructed such that the network can be operated to supply projected customer demands and projected firm (non-recallable reserved) transmission services, at all demand levels over the range of forecast system demands, under the contingency conditions as defined in Category C of Table I (attached). The controlled interruption of customer demand, the planned removal of generators, or the curtailment of firm (non-recallable reserved) power transfers maybe necessary to meet this standard.

Transmission system capability and configuration, reactive power resources, protection systems, and control devices shall be adequate to ensure the system performance prescribed in Table I.

The transmission systems also shall be capable of accommodating planned bulk electric equipment outages and continuing to operate within thermal, voltage, and stability limits under the contingency conditions as defined in Category C of Table I (attached).

#### Measure

M3. Entities responsible for the reliability of the interconnected transmission systems shall ensure that the system responses for Standard S3 contingencies are as defined in Category C (event(s) resulting in the loss of two or more (multiple) elements element of Table I (attached).

#### Assessment Requirements

Entities Responsible for the Reliability of Interconnected transmission Systems (ERRIS), as determined by the Region, for example:

1. Transmission owners,
2. Independent system operators (ISOs),
3. Regional transmission organizations (RTOs).

Or other groups responsible for planning the bulk electric system shall assess the performance of their systems in meeting Standard S3.

To be valid *and compliant*, assessments shall:

1. Be made annually,
2. Be conducted for near-term (years one through five) and longer-term (years six through ten) planning horizons,
3. Be supported by a current or past study and/or system simulation testing as accepted by the Region showing system performance following Category C contingencies that addresses the plan year being assessed,
4. Address any planned upgrades needed to meet the performance requirements of Category C,

5. Consider all contingencies applicable to Category C.

**System Simulation Study/Testing Methods**

System simulation studies/testing shall (as agreed to by the Region):

1. Be performed and evaluated only for those Category C contingencies that would produce the more severe system results or impacts.
  - a. The rationale for the contingencies selected for evaluation shall be available as supporting information,
  - b. An explanation of why the remaining simulations would produce less severe system results shall be available as supporting information.
2. Cover critical system conditions and study years as deemed appropriate by the responsible entity.
3. Be conducted annually unless changes to system conditions do not warrant such analyses.
4. Be conducted beyond the five-year horizon only as needed to address identified marginal conditions that may have longer lead-time solutions.
5. Have all projected firm transfers modeled.
6. Be performed and evaluated for selected demand levels over the range of forecast system demands.
7. Demonstrate that system performance meets Table 1 for Category C contingencies.
8. Include existing and planned facilities.
9. Include reactive power resources to ensure that adequate reactive resources are available to meet system performance.
10. Include the effects of existing and planned protection systems, including any backup or redundant systems.
11. Include the effects of existing and planned control devices.
12. Include the planned (including maintenance) outage of any bulk electric equipment (including protection systems or their components) at those demand levels for which planned (including maintenance) outages are performed.

**Corrective Plan Requirements**

When system simulations indicate an inability of the systems to respond as prescribed in this Measure (M3), responsible entities shall:

1. Provide a written summary of their plans to achieve the required system performance as described above throughout the planning horizon,
  - a. Including a schedule for implementation,
  - b. Including a discussion of expected required in-service dates of facilities,
  - c. Consider lead times necessary to implement plans.
2. For identified system facilities for which sufficient lead times exist, review in subsequent annual assessments for continuing need — detailed implementation plans are not needed.

## **Compliance Templates**

### **NERC Planning Standards**

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**I.A.M3**

#### **Reporting Requirements**

The documentation of results of these reliability assessments and corrective plans shall annually be provided to the entities' respective NERC Region(s), as required by the Region. Each Region, in turn, shall annually provide a report of its reliability assessments and corrective actions to NERC.

#### **Applicable to**

Entities responsible for reliability of interconnected transmission systems.

#### **Items to be Measured**

Assessments supported by simulated system performance following loss of two or more bulk system element.

#### **Timeframe**

Annually

#### **Levels of Non-Compliance** (If non-compliant at more than one Level, the highest Level applies.)

Level 1 — N/A

Level 2 — A valid assessment and corrective plan, as defined above, for the longer-term planning horizon is not available.

Level 3 — N/A

Level 4 — A valid assessment and corrective plan, as defined above, for the near-term planning horizon is not available.

#### **Compliance Monitoring Responsibility**

Regional Reliability Councils

Table I. Transmission Systems Standards — Normal and Contingency Conditions\*

| Category                                                               | Contingencies                                                                                                                                            |                         | System Limits or Impacts             |                                      |               |                                            |                                |
|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|--------------------------------------|--------------------------------------|---------------|--------------------------------------------|--------------------------------|
|                                                                        | Initiating Event(s) and Contingency Element(s)                                                                                                           | Elements Out of Service | Thermal Limits                       | Voltage Limits                       | System Stable | Loss of Demand or Curtailed Firm Transfers | Cascading Outages <sup>c</sup> |
| A - No Contingencies                                                   | All Facilities in Service                                                                                                                                | None                    | Applicable Rating <sup>a</sup> (A/R) | Applicable Rating <sup>a</sup> (A/R) | Yes           | No                                         | No                             |
| B - Event resulting in the loss of a single element.                   | Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing:                                                                                    | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | 1. Generator                                                                                                                                             | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | 2. Transmission Circuit                                                                                                                                  | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | 3. Transformer                                                                                                                                           | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | Loss of an Element without a Fault.                                                                                                                      |                         |                                      |                                      |               |                                            |                                |
| C - Event(s) resulting in the loss of two or more (multiple) elements. | Single Pole Block, Normal Clearing:                                                                                                                      | Single                  | A/R                                  | A/R                                  | Yes           | No <sup>b</sup>                            | No                             |
|                                                                        | 4. Single Pole (dc) Line                                                                                                                                 |                         |                                      |                                      |               |                                            |                                |
|                                                                        | SLG Fault, with Normal Clearing:                                                                                                                         | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 1. Bus Section                                                                                                                                           | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 2. Breaker (failure or internal fault)                                                                                                                   |                         |                                      |                                      |               |                                            |                                |
|                                                                        | SLG or 3Ø Fault, with Normal Clearing <sup>f</sup> , Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing <sup>f</sup> : | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency                 |                         |                                      |                                      |               |                                            |                                |
|                                                                        | Bipolar Block, with Normal Clearing:                                                                                                                     | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 4. Bipolar (dc) Line                                                                                                                                     | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | Fault (non 3Ø), with Normal Clearing:                                                                                                                    |                         |                                      |                                      |               |                                            |                                |
|                                                                        | 5. Any two circuits of a multiple circuit towerline <sup>e</sup>                                                                                         |                         |                                      |                                      |               |                                            |                                |
|                                                                        | SLG Fault, with Delayed Clearing <sup>f</sup> (stuck breaker or protection system failure):                                                              | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 6. Generator                                                                                                                                             | Multiple                | A/R                                  | A/R                                  | Yes           | Planned/Controlled <sup>d</sup>            | No                             |
|                                                                        | 7. Transmission Circuit                                                                                                                                  |                         |                                      |                                      |               |                                            |                                |
|                                                                        | 8. Transformer                                                                                                                                           |                         |                                      |                                      |               |                                            |                                |
|                                                                        | 9. Bus Section                                                                                                                                           |                         |                                      |                                      |               |                                            |                                |

\* Any Region may implement standards that are more stringent, but not inconsistent with NERC's industry-wide standards.

# Compliance Templates

## NERC Planning Standards

I.A.M3

|                                                                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                        |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>D<sup>e</sup> - Extreme event resulting in two or more (multiple) elements removed or cascading out of service</p> | <p>3Ø Fault, with Delayed Clearing<sup>f</sup> (stuck breaker or protection system failure):</p> <ol style="list-style-type: none"> <li>1. Generator</li> <li>2. Transmission Circuit</li> <li>3. Transformer</li> <li>4. Bus Section</li> </ol> <p>-----</p> <p>3Ø Fault, with Normal Clearing<sup>f</sup>:</p> <ol style="list-style-type: none"> <li>5. Breaker (failure or internal fault)</li> </ol> <p>-----</p> <p>Other:</p> <ol style="list-style-type: none"> <li>6. Loss of towerline with three or more circuits</li> <li>7. All transmission lines on a common right-of way</li> <li>8. Loss of a substation (one voltage level plus transformers)</li> <li>9. Loss of a switching station (one voltage level plus transformers)</li> <li>10. Loss of all generating units at a station</li> <li>11. Loss of a large load or major load center</li> <li>12. Failure of a fully redundant special protection system (or remedial action scheme) to operate when required</li> <li>13. Operation, partial operation, or misoperation of a fully redundant special protection system (or remedial action scheme) in response to an event or abnormal system condition for which it was not intended to operate</li> <li>14. Impact of severe power swings or oscillations from disturbances in another Regional Council.</li> </ol> | <p>Evaluate for risks and consequences.</p> <ul style="list-style-type: none"> <li>▪ May involve substantial loss of customer demand and generation in a widespread area or areas.</li> <li>▪ Portions or all of the interconnected systems may or may not achieve a new, stable operating point.</li> <li>▪ Evaluation of these events may require joint studies with neighboring systems.</li> </ul> |
|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

- Applicable rating (A/R) refers to the applicable normal and emergency facility thermal rating or system voltage limit as determined and consistently applied by the system or facility owner. Applicable ratings may include emergency ratings applicable for short durations as required to permit operating steps necessary to maintain system control. All ratings must be established consistent with applicable NERC Planning Standards addressing facility ratings.
- Planned or controlled interruption of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall security of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted firm (non-recallable reserved) electric power transfers.
- Cascading is the uncontrolled successive loss of system elements triggered by an incident at any location. Cascading results in widespread service interruption which cannot be restrained from sequentially spreading beyond an area predetermined by appropriate studies.
- Depending on system design and expected system impacts, the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted firm (non-recallable reserved) electric power transfers may be necessary to maintain the overall security of the interconnected transmission systems.
- A number of extreme contingencies that are listed under Category D and judged to be critical by the transmission planning entity(ies) will be selected for evaluation. It is not expected that all possible facility outages under each listed contingency of Category D will be evaluated.
- Normal clearing is when the protection system operates as designed and the fault is cleared in the time normally expected with proper functioning of the installed protection systems. Delayed clearing of a fault is due to failure of any protection system component such as a relay, circuit breaker, or current transformer (CT), and not because of an intentional design delay.
- System assessments may exclude these events where multiple circuit towers are used over short distances (e.g., station entrance, river crossings) in accordance with Regional exemption criteria.



**Brief Description** System performance following extreme events resulting in the loss of two or more bulk system elements.

**Category** Assessments

**Section** I. System Adequacy and Security  
A. Transmission Systems

**Standard**

S4. The interconnected transmission systems shall be evaluated for the risks and consequences of a number of each of the extreme contingencies that are listed under Category D of Table I (attached).

**Measure**

M4. Entities responsible for the reliability of the interconnected transmission systems shall assess the risks and system responses for Standard S4 as defined in Category D of Table I (attached).

**Assessment Requirements**

Entities Responsible for the Reliability of Interconnected transmission Systems (ERRIS), as determined by the Region, for example:

1. Transmission owners,
2. Independent system operators (ISOs),
3. Regional transmission organizations (RTOs),

Or other groups responsible for planning the bulk electric system shall assess the performance of their systems in meeting Standard S4.

To be valid *and compliant*, assessments shall:

1. Be made annually,
2. Be conducted for near-term (years one through five),
3. Be supported by a current or past study and/or system simulation testing as accepted by the Region showing system performance following Category D contingencies that addresses the plan year being assessed,
4. Consider all contingencies applicable to Category D.

**System Simulation Study/Testing Methods**

System simulation studies/testing shall (as agree to by the Region):

1. Be performed and evaluated only for those Category D contingencies that would produce the more severe system results or impacts:
  - a. The rationale for the contingencies selected for evaluation shall be available as supporting information,
  - b. An explanation of why the remaining simulations would produce less severe system results shall be available as supporting information.

2. Cover critical system conditions and study years as deemed appropriate by the responsible entity.
3. Be conducted annually unless changes to system conditions do not warrant such analyses.
4. Have all projected firm transfers modeled.
5. Include existing and planned facilities.
6. Include reactive power resources to ensure that adequate reactive resources are available to meet system performance.
7. Include the effects of existing and planned protection systems, including any backup or redundant systems.
8. Include the effects of existing and planned control devices.
9. Include the planned (including maintenance) outage of any bulk electric equipment (including protection systems or their components) at those demand levels for which planned (including maintenance) outages are performed.

**Corrective Plan Requirements**

None required.

**Reporting Requirements**

The documentation of results of these reliability assessments shall annually be provided to the entities' respective NERC Region(s), as required by the Region.

**Applicable to**

Entities responsible for reliability of interconnected transmission systems.

**Items to be Measured**

Assessments of system performance for extreme events (more severe than in I.A.M3) resulting in loss of two or more bulk system elements.

**Timeframe**

Annually

**Levels of Non-Compliance** (If non-compliant at more than one Level, the highest Level applies.)

Level 1 — A valid assessment, as defined above, for the near-term planning horizon is not available.

Level 2 — N/A

Level 3 — N/A

Level 4 — N/A

**Compliance Monitoring Responsibility**

Regional Reliability Councils. Each Region shall report compliance and violations to NERC via the NERC Compliance Reporting process.

## NERC Planning Standards

Table I. Transmission Systems Standards — Normal and Contingency Conditions\*

| Category                                                               | Contingencies                                                                                                                                                                                                                                                                           |                                      | System Limits or Impacts             |                                      |                          |                                                                          |                                |
|------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------|--------------------------------------------------------------------------|--------------------------------|
|                                                                        | Initiating Event(s) and Contingency Element(s)                                                                                                                                                                                                                                          | Elements Out of Service              | Thermal Limits                       | Voltage Limits                       | System Stable            | Loss of Demand or Curtailed Firm Transfers                               | Cascading Outages <sup>c</sup> |
| A - No Contingencies                                                   | All Facilities in Service                                                                                                                                                                                                                                                               | None                                 | Applicable Rating <sup>a</sup> (A/R) | Applicable Rating <sup>a</sup> (A/R) | Yes                      | No                                                                       | No                             |
| B - Event resulting in the loss of a single element.                   | Single Line Ground (SLG) or 3-Phase (3Ø) Fault, with Normal Clearing:<br>1. Generator<br>2. Transmission Circuit<br>3. Transformer<br>Loss of an Element without a Fault.                                                                                                               | Single<br>Single<br>Single<br>Single | A/R<br>A/R<br>A/R<br>A/R             | A/R<br>A/R<br>A/R<br>A/R             | Yes<br>Yes<br>Yes<br>Yes | No <sup>b</sup><br>No <sup>b</sup><br>No <sup>b</sup><br>No <sup>b</sup> | No<br>No<br>No<br>No           |
|                                                                        | Single Pole Block, Normal Clearing :<br>4. Single Pole (dc) Line                                                                                                                                                                                                                        | Single                               | A/R                                  | A/R                                  | Yes                      | No <sup>b</sup>                                                          | No                             |
| C - Event(s) resulting in the loss of two or more (multiple) elements. | SLG Fault, with Normal Clearing :<br>1. Bus Section<br>2. Breaker (failure or internal fault)                                                                                                                                                                                           | Multiple<br>Multiple                 | A/R<br>A/R                           | A/R<br>A/R                           | Yes<br>Yes               | Planned/Controlled <sup>d</sup><br>Planned/Controlled <sup>d</sup>       | No<br>No                       |
|                                                                        | SLG or 3Ø Fault, with Normal Clearing <sup>f</sup> , Manual System Adjustments, followed by another SLG or 3Ø Fault, with Normal Clearing :<br>3. Category B (B1, B2, B3, or B4) contingency, manual system adjustments, followed by another Category B (B1, B2, B3, or B4) contingency | Multiple                             | A/R                                  | A/R                                  | Yes                      | Planned/Controlled <sup>d</sup>                                          | No                             |
|                                                                        | Bipolar Block, with Normal Clearing :<br>4. Bipolar (dc) Line<br>Fault (non 3Ø), with Normal Clearing :<br>5. Any two circuits of a multiple circuit towerline <sup>g</sup>                                                                                                             | Multiple<br>Multiple                 | A/R<br>A/R                           | A/R<br>A/R                           | Yes<br>Yes               | Planned/Controlled <sup>d</sup><br>Planned/Controlled <sup>d</sup>       | No<br>No                       |
|                                                                        | SLG Fault, with Delayed Clearing <sup>f</sup> (stuck breaker or protection system failure):<br>6. Generator<br>7. Transmission Circuit<br>8. Transformer<br>9. Bus Section                                                                                                              | Multiple<br>Multiple                 | A/R<br>A/R                           | A/R<br>A/R                           | Yes<br>Yes               | Planned/Controlled <sup>d</sup><br>Planned/Controlled <sup>d</sup>       | No<br>No                       |

\* Any Region may implement standards that are more stringent, but not inconsistent with NERC's industry-wide standards.

# Compliance Templates

## NERC Planning Standards

I.A.M4

|                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><sup>e</sup> - Extreme event resulting in two or more (multiple) elements removed or cascading out of service</p> | <p>3Ø Fault, with Delayed Clearing (stuck breaker or protection system failure):</p> <ol style="list-style-type: none"> <li>1. Generator</li> <li>2. Transmission Circuit</li> <li>3. Transformer</li> <li>4. Bus Section</li> </ol> <p>-----</p> <p>3Ø Fault, with Normal Clearing:</p> <ol style="list-style-type: none"> <li>5. Breaker (failure or internal fault)</li> </ol> <p>-----</p> <p>Other:</p> <ol style="list-style-type: none"> <li>6. Loss of towerline with three or more circuits</li> <li>7. All transmission lines on a common right-of-way</li> <li>8. Loss of a substation (one voltage level plus transformers)</li> <li>9. Loss of a switching station (one voltage level plus transformers)</li> <li>10. Loss of all generating units at a station</li> <li>11. Loss of a large load or major load center</li> <li>12. Failure of a fully redundant special protection system (or remedial action scheme) to operate when required</li> <li>13. Operation, partial operation, or misoperation of a fully redundant special protection system (or remedial action scheme) in response to an event or abnormal system condition for which it was not intended to operate</li> <li>14. Impact of severe power swings or oscillations from disturbances in another Regional Council.</li> </ol> |
|                                                                                                                      | <p>Evaluate for risks and consequences.</p> <ul style="list-style-type: none"> <li>▪ May involve substantial loss of customer demand and generation in a widespread area or areas.</li> <li>▪ Portions or all of the interconnected systems may or may not achieve a new, stable operating point.</li> <li>▪ Evaluation of these events may require joint studies with neighboring systems.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

- Applicable rating (A/R) refers to the applicable normal and emergency facility thermal rating or system voltage limit as determined and consistently applied by the system or facility owner. Applicable ratings may include emergency ratings applicable for short durations as required to permit operating steps necessary to maintain system control. All ratings must be established consistent with applicable NERC Planning Standards addressing facility ratings.
- Planned or controlled interruption of electric supply to radial customers or some local network customers, connected to or supplied by the faulted element or by the affected area, may occur in certain areas without impacting the overall security of the interconnected transmission systems. To prepare for the next contingency, system adjustments are permitted, including curtailments of contracted firm (non-recallable reserved) electric power transfers.
- Cascading is the uncontrolled successive loss of system elements triggered by an incident at any location. Cascading results in widespread service interruption which cannot be restrained from sequentially spreading beyond an area predetermined by appropriate studies.
- Depending on system design and expected system impacts, the controlled interruption of electric supply to customers (load shedding), the planned removal from service of certain generators, and/or the curtailment of contracted firm (non-recallable reserved) electric power transfers may be necessary to maintain the overall security of the interconnected transmission systems.
- A number of extreme contingencies that are listed under Category D and judged to be critical by the transmission planning entity(ies) will be selected for evaluation. It is not expected that all possible facility outages under each listed contingency of Category D will be evaluated.
- Normal clearing is when the protection system operates as designed and the fault is cleared in the time normally expected with proper functioning of the installed protection systems. Delayed clearing of a fault is due to failure of any protection system component such as a relay, circuit breaker, or current transformer (CT), and not because of an intentional design delay.
- System assessments may exclude these events where multiple circuit towers are used over short distances (e.g., station entrance, river crossings) in accordance with Regional exemption criteria.

**APPENDIX C**  
**RESULTS SUMMARY**

| Scenario  | # Cat B<br>Contingencies | "Raw" Results | Caused by X<br>Contingencies | Significant<br>Results* | Caused by X   |                                       |         |             |
|-----------|--------------------------|---------------|------------------------------|-------------------------|---------------|---------------------------------------|---------|-------------|
|           |                          |               |                              |                         | Contingencies | Cascade Results                       |         |             |
|           |                          |               |                              |                         |               | >500 MW                               | No Load | Interrupted |
| Base Case | 769                      | 74            | 21                           | 50                      | 15            | Not run through Cascade Analysis Tool |         |             |
| Import    | 767                      | 60            | 34                           | 38                      | 17            | 0                                     | 0       | 0           |
| SN        | 767                      | 163           | 75                           | 93                      | 44            | 1                                     | 3       | 0           |
| NS        | 767                      | 448           | 105                          | 231                     | 63            | 2                                     | 3       | 0           |

| Scenario        | # Cat C<br>Contingencies | "Raw" Results | Caused by X<br>Contingencies | Significant<br>Results* | Caused by X   |         |         |             | Cascade Results |       | Roll Up |                   |
|-----------------|--------------------------|---------------|------------------------------|-------------------------|---------------|---------|---------|-------------|-----------------|-------|---------|-------------------|
|                 |                          |               |                              |                         | Contingencies | >500 MW | No Load | Interrupted | Total           | Total | Total   | Potential Cascade |
|                 |                          |               |                              |                         |               |         |         |             |                 |       |         |                   |
| Base Case       | 23,890                   | 3,611         | 1,635                        | 1,381                   | 674***        | 61      | 36      | 27          | 124             | 157   | 83      |                   |
| Bus Fault       | 380                      | 129           | 44                           | 112                     | 37            | 5       | 2       | 3           | 10              | NA    | NA      |                   |
| Breaker Failure | 43                       | 24            | 18                           | 19                      | 17            | 2       | 0       | 0           | 2               | NA    | NA      |                   |
| Import          | 23,533                   | 5,266         | 3,256                        | 1,891                   | 836***        | 84      | 62      | 12          | 158             | 179   | 90      |                   |
| SN              | 22,109                   | 15,299        | 7,234                        | 3,714                   | 1,979         | 76      | 174     | 76          | 326             | 178   | 65      |                   |
| NS              | 27,178                   | 25,024        | 9,824                        | 8,506                   | 3,154         | 160     | 241     | 50          | 451             | 228   | 113     |                   |

\*Significant Results were identified for subsequent analysis by the Cascade Analysis Tool. A contingency was deemed significant if it caused overloads >105% on any facility or voltages <0.90pu at any bus. Contingencies causing only voltage change violations (>0.1 pu) were not checked for further cascading potential.

\*\*We were able to find operating procedures to eliminate violations associated with all of the contingencies identified as having the potential to cascade using the 105% overload and 0.9 pu voltage criteria. \*\*\*these counts of significant contingencies for the base and import cases are 809 and 917, respectively if the contingencies causing only voltage change 'violations' are included. Since this criterion was not used to determine the list that would be run through the cascade tool, these contingencies have been removed from the 809 and 917 numbers.

| Scenario  | # Cat D<br>Contingencies | "Raw" Results | Caused by X<br>Contingencies | Significant<br>Results**** | Caused by X   |               |
|-----------|--------------------------|---------------|------------------------------|----------------------------|---------------|---------------|
|           |                          |               |                              |                            | Contingencies | Contingencies |
|           |                          |               |                              |                            |               |               |
| Base Case | 5,771                    | 4,048         | 636                          | 1,114                      | 188           |               |

\*\*\*\*This number and the 188 contingencies that caused these significant results include 7 contingencies that diverged.



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