TCC, TNC and ETT are all members of the Electric Reliability Council of Texas (ERCOT), and as a condition of membership have agreed to conform to all approved and applicable ERCOT and North American Electric Reliability Corporation (NERC) Reliability Standards (NERC Standards) for the Bulk Electric Systems of North America. The ERCOT Transmission Planning Criteria is made available by ERCOT without conditions to FERC and the public for download from Internet Web Page: http://www.ercot.com/mktrules/guides/planning/current.

Regional organization name, mailing address, contact person and title, telephone and facsimile numbers:

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Austin, Texas 78744

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Vice President, General Counsel and Corporate Secretary
Phone: (512) 225-7076
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Common transmission reliability criteria for TCC, TNC and ETT have been developed and are included in this report. TCC, TNC and ETT comply with the ERCOT Reliability Criteria, the NERC Standards and the American Electric Power Transmission Reliability Criteria as the basis for the planning and design of the TCC, TNC and ETT transmission systems.
American Electric Power

Transmission Planning Reliability Criteria

**Purpose**

This report presents an overview of AEP’s transmission planning criteria.

The AEP criteria described herein supplements the: 1) North American Electric Reliability Corporation (NERC) Reliability Standards; 2) SPP Criteria with Appendices Section 3, Regional Transmission Planning, and 3) ERCOT Planning Guide Section 4, Transmission Planning Criteria.

**Nominal Voltage Levels**

Nominal 765 kV, 500 kV, 345 kV and 138 kV voltage levels will normally be used for most new power transmission lines and are considered Bulk Electric System (BES). Some interconnection lines may be at 115 kV, or 230 kV to match neighboring utilities’ voltage, and some 69 kV lines may be constructed in appropriate situations.

**Voltage Limits**

Transmission voltage should not exceed 105% nor fall below 92% of nominal voltage during emergencies (Table 1). Transmission voltages during emergencies should not result in customer voltages exceeding or falling below prescribed limits at distribution substations on the transmission system and voltages at generating stations below minimum acceptable levels established for each station must be avoided to prevent tripping of the generating units. Capacitor banks, reactors, and LTC auto-transformers are used in transmission substations to hold voltage levels within acceptable ranges during normal and emergency conditions. The low limit can be lower if voltage regulating equipment maintains voltage to the customers within prescribed limits at distribution substations involved without causing voltage problems at nearby loads. Voltage fluctuations (flicker) are addressed in the AEP Interconnection Guidelines.

**Thermal Limits**

Thermal ratings define transmission facility loading limits. Normal ratings are generally based upon no abnormal loss of facility life or equipment damage. Emergency ratings accept some loss of life or strength, over a defined time limit for operation at the rated loading level. The thermal rating for a transmission line is defined by the most limiting element, be it a conductor capability, sag clearance, or terminal equipment rating. Thermal limits establish the maximum amount of electrical current that a transmission circuit or electrical facility can conduct over a specified time period before it sustains permanent damage by overheating or before it violates public safety requirements.
Normal and emergency transmission equipment ratings are documented by AEP standards and guidelines.

**Contingency Criteria**

Single contingencies include the forced outage of generating units, transmission circuits, transformers, and/or other equipment. In general, a single contingency is defined as the outage of any one of these facilities. Due to the interconnected nature of power systems, testing includes outages of facilities in neighboring systems. A single facility is defined by the arrangement of automatic protective devices. Generally, double circuit tower outages, breaker failures, station outages, common right-of-way outages, and other common mode failures have substantially lower probabilities of occurrence than the outage of a single transmission facility and are, therefore, not considered single contingencies.

Less probable/extreme contingency testing shall investigate the following situations:

- Loss of any combination of related facilities, a critical transmission line when a 345 kV auto-transformer is out of service or a generating unit when another generating unit is out of service.
- Sudden outage of any multi-circuit transmission line at a time when any other single circuit is out of service.
- Sudden outage of any single or double-circuit transmission tower line at a time when two generating units are out of service, for maintenance or economics.
- Sudden outage of any generating unit at a time when any two other generating units are out of service for maintenance or economics.

For the occurrence of any of the above less probable/extreme contingencies, testing must conclude that neither uncontrolled islanding, nor uncontrolled loss of large amounts of load will result.

**Steady State Testing Criteria**

Table 1 documents the testing criteria for AEP transmission facilities under normal and contingency conditions.

**Short Circuit Testing Criteria**

Short circuit analysis is performed periodically to ensure the proper circuit interrupting capability during system fault conditions. Short circuit analysis is performed assuming 1.05 per unit voltage at all AEP system buses.

**Stability Testing Criteria**

The Appendix A stability disturbance testing criteria specify the disturbance events for which stable operation is required of all BES connected generation including renewable
generation. The stability testing criteria appropriate for sub-transmission connected
generation are determined on a case-by-case basis and may be less stringent as long as
instability may be shown not to adversely affect the BES. In cases where the BES is not
adversely affected and the speed of sub-transmission system fault clearing is inadequate
to prevent instability for normally cleared faults, out-of-step tripping would be required
to prevent adverse effects.

Criteria A through E in Appendix A are applicable to planning and operational planning
studies. The A through E disturbance events correspond to the NERC Category B2, B3,
and C3 contingencies listed in NERC TPL Table 1, and also to NERC Category C7 and
C8 contingencies. F and G criteria may be applied in operational planning studies when a
long-term facility outage is anticipated. Testing with disturbance events other than those
specified in Appendix A may be performed in planning and operational planning studies
where applicable. Examples of such testing include common-failure mode disturbances
such as double circuit tower faults (NERC Category C5) or bus faults (NERC Category
C9) that result in the outage of multiple facilities at a location. On the AEP transmission
system, NERC Category C1, C2, and C9 contingencies are generally either of the same or
less severity than the A criterion (Appendix A) breaker failure events that result in
tripping the same facilities.
<table>
<thead>
<tr>
<th>NERC Contingency Category</th>
<th>Transmission Facilities</th>
</tr>
</thead>
</table>
| **A – System Normal**    | **Thermal:** No facility may exceed its normal rating.  
|                          | **Voltage:** All station voltages must stay between 1.05 per unit and 0.95 per unit. |
| **B1 – Single Generator** | **Thermal:** No facility may exceed its emergency rating.  
| **B2 – Single Line**     | **Voltage:** All station voltages must stay between 1.05 per unit and 0.92 per unit. |
| **B3 – Single Transformer** | **Thermal:** No facility may exceed its emergency rating.  
|                          | **Voltage:** All station voltages must stay between 1.05 per unit and 0.92 per unit. |
| **C1 – Bus**             | **Thermal:** No facility may exceed its emergency rating.  
| **C2 – Breaker Failure** | **Voltage:** All station voltages must stay between 1.05 per unit and 0.92 per unit. |
| **C5 – Double Circuit Tower** | **Thermal:** No facility may exceed its emergency rating.  
|                          | **Voltage:** All station voltages must stay between 1.05 per unit and 0.92 per unit. |
| **D6 – Loss of Tower Line with 3 or More Circuits** | **Note:** Performance is evaluated for risks and consequences. Issues identified may not be mitigated, but may be used to screen viable solutions to resolve violations from Category B and C contingencies. |
| **D7 – Loss of All Transmission Lines on Same Right of Way** |  
| **D8 – Loss of Substation** |  
| **D9 – Loss of Switching Station** |  
| **D10 – Loss of All Generating Units at a Station** |  

*Note:* Performance is evaluated for risks and consequences. Issues identified may not be mitigated, but may be used to screen viable solutions to resolve violations from Category B and C contingencies.
## AEP Stability Disturbance Testing Criteria

<table>
<thead>
<tr>
<th>Prefault Condition</th>
<th>765 KV Plants</th>
<th>345 KV Plants</th>
<th>138 KV Plants</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Transmission Facilities in Service</td>
<td>1A Permanent single line-to-ground (SLG) fault with 1φ breaker failure. Fault cleared by backup breakers.</td>
<td>2A Permanent SLG fault with 1φ breaker failure. Fault cleared by backup breakers.</td>
<td>3A Permanent SLG fault with 3φ breaker failure. Fault cleared by backup breakers.</td>
</tr>
<tr>
<td></td>
<td>1B Permanent SLG fault cleared by primary breakers. 3φ fault developed following HSR. Fault cleared by primary breakers.</td>
<td>2B Permanent 3φ fault with unsuccessful HSR, if applicable. Fault cleared by primary breakers.</td>
<td>3B Permanent 3φ fault with unsuccessful HSR, if applicable. Fault cleared by primary breakers.</td>
</tr>
<tr>
<td></td>
<td>1C 3φ line opening without fault.</td>
<td>2C 3φ line opening without fault.</td>
<td>3C 3φ line opening without fault.</td>
</tr>
<tr>
<td>One Transmission Facility Out of Service</td>
<td>1D Permanent SLG fault with unsuccessful HSR, if applicable. Fault cleared by primary breakers.</td>
<td>2D Permanent 3φ fault with unsuccessful HSR, if applicable. Fault cleared by primary breakers.</td>
<td>3D Permanent 3φ fault with unsuccessful HSR, if applicable. Fault cleared by primary breakers.</td>
</tr>
<tr>
<td></td>
<td>1E 3φ line opening without fault.</td>
<td>2E 3φ line opening without fault.</td>
<td>3E 3φ line opening without fault.</td>
</tr>
<tr>
<td>Two Transmission Facilities Out of Service</td>
<td>1F Temporary SLG fault with successful HSR, if applicable.</td>
<td>2F Temporary 3φ fault with successful HSR, if applicable.</td>
<td>3F Temporary 3φ fault with successful HSR, if applicable.</td>
</tr>
<tr>
<td></td>
<td>1G 3φ line opening without fault.</td>
<td>2G 3φ line opening without fault.</td>
<td>3G 3φ line opening without fault.</td>
</tr>
</tbody>
</table>