

**AMERICAN ELECTRIC POWER – 2021 FILING**

**FERC FORM 715 – ANNUAL TRANSMISSION PLANNING  
AND EVALUATION REPORT**

**PART 4 – TRANSMISSION PLANNING RELIABILITY CRITERIA**

Attached is a document entitled "The American Electric Power System Transmission Planning Criteria". This document provides the criteria to test and assess the strength of AEP's transmission system to meet its load serving responsibility and provides a description of transmission planning criteria for the AEP System.

## **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) ReliabilityFirst Corporation (RFC) Standards, 3) PJM Planning and Operating Manuals: Manual 14B, 4) SPP Criteria with Appendices Section 3, Regional Transmission Planning, and 5) ERCOT Planning Guide Section 4, Transmission Planning Criteria where applicable.

## **Nominal Voltage Levels**

Nominal 765 kV, 345 kV, 161 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 500 kV, 230 kV, or 115 kV to match neighboring utilities' voltage, and some 69 kV lines may be constructed in appropriate situations.

The AEP transmission facilities for the PJM and MISO regions are divided into the following three performance categories:

- **EHV Facilities:**  
Transmission lines rated 765 kV, 500 kV, and 345 kV, and transformers with secondary voltages at or above 345 kV, are considered Extra High Voltage (EHV) facilities, and are referred to as "EHV facilities" in this document. These facilities are part of the BES.
- **HV Facilities:**  
Transmission lines rated 230 kV, 161 kV, and 138 kV, and transformers with secondary voltages above 100 kV but below 345 kV, are considered High Voltage (HV) facilities, and are referred to as "HV facilities" in this document. These facilities are part of the BES.
- **Sub-T Facilities:**  
Transmission lines rated below 100 kV, and transformers with secondary voltages below 100 kV are considered sub-transmission (Sub-T) facilities, and are referred to as "Sub-T facilities" in this document. These facilities are not part of the BES.

## **Voltage Limits**

### **For the SPP and ERCOT Regions:**

Transmission level buses above 60 kV shall meet the following steady state voltage response and post-contingency voltage deviation criteria:

- 0.95 per unit to 1.05 per unit in the pre-contingency state following the occurrence of any operating condition in category P0 of the NERC Reliability Standard [TPL-001-4](#) addressing Transmission System Planning Performance Requirements. Facilities associated with series line compensating capacitors are permitted to operate above 1.05 per unit.
- 0.92 per unit to 1.05 per unit in the post-contingency state following the occurrence of any operating condition in categories P1 through P7 of the NERC Reliability Standard [TPL-](#)

[001-4](#) addressing Transmission System Planning Performance Requirements. Facilities associated with series line compensating capacitors are permitted to operate above 1.05 per unit.

- Following the occurrence of any operating condition in categories P1 through P7 of the NERC Reliability Standard [TPL-001-4](#), further analysis is required in the event of a post-contingency steady-state voltage deviation that exceeds 8% at any load-serving bus above 100 kV, exclusive of buses on a radial system that serve only Resource Entities and/or Load.

For the PJM and MISO Regions:

Transmission level buses shall meet the following steady state voltage response and post-contingency voltage deviation criteria:

- 0.95 per unit to 1.05 per unit in the pre-contingency state following the occurrence of any operating condition in category P0 of the NERC Reliability Standard [TPL-001-4](#) addressing Transmission System Planning Performance Requirements. Certain 500 kV facilities are permitted to operate above 1.05 per unit to match neighboring utilities operating criteria.
- 0.92 per unit to 1.05 per unit in the post-contingency state following the occurrence of any operating condition in categories P1 through P7 of the NERC Reliability Standard [TPL-001-4](#) addressing Transmission System Planning Performance Requirements. Certain 500 kV facilities are permitted to operate above 1.05 per unit to match neighboring utilities operating criteria.
- Following the occurrence of any operating condition in categories P1 through P7 of the NERC Reliability Standard [TPL-001-4](#), a voltage deviation from system normal of 8% or greater is not acceptable at any station.

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. Static and dynamic reactive devices and LTC auto-transformers are used in transmission substations to hold voltage levels within acceptable ranges during normal and emergency conditions. The voltage limits of these reactive devices can exceed prescribed limits if distribution regulating equipment maintains customer voltage within acceptable limits. 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.

For the SPP and ERCOT Regions:

Transmission level buses above 60 kV shall meet the following performance criteria:

- No facility may exceed its normal rating in the pre-contingency state following the occurrence of any operating condition in category P0 of the NERC Reliability Standard [TPL-001-4](#) addressing Transmission System Planning Performance Requirements.
- No facility may exceed its emergency rating in the post-contingency state following the occurrence of any operating condition in categories P1 through P7 of the NERC Reliability Standard [TPL-001-4](#) addressing Transmission System Planning Performance Requirements.

For the PJM and MISO Regions:

Transmission level buses shall meet the following performance criteria:

- No facility may exceed its normal rating in the pre-contingency state following the occurrence of any operating condition in category P0 of the NERC Reliability Standard [TPL-001-4](#) addressing Transmission System Planning Performance Requirements.
- No facility may exceed its emergency rating in the post-contingency state following the occurrence of any operating condition in categories P1 through P7 of the NERC Reliability Standard [TPL-001-4](#) addressing Transmission System Planning Performance Requirements.

**Steady State Testing Criteria**

The AEP transmission system will be designed so that there are no thermal or voltage criteria violations for a maintenance outage followed by an unscheduled outage of any transmission element during off-peak load periods. Load shedding is not permitted to maintain facilities within thermal and voltage limits.

For the ERCOT Region:

Steady State testing of the AEP transmission system is in accordance with NERC Reliability Standard [TPL-001-4](#) and the ERCOT Planning Guide Section 4.

For the PJM, MISO and SPP Regions:

Steady State testing of the AEP transmission system is in accordance with NERC Reliability Standard [TPL-001-4](#).

**Short Circuit Testing Criteria**

For the SPP and ERCOT Regions:

AEP steady state planning criteria requires that no bus voltage on AEP system shall exceed 1.05 per unit under system normal or contingency conditions. This voltage limit takes into consideration the equipment capabilities on AEP system. Short circuit assessment is performed assuming 1.05

per unit voltage at all the AEP system buses.

For the PJM and MISO Regions:

AEP steady state planning criteria requires that no bus voltage on AEP system shall exceed 1.05 per unit under system normal or contingency conditions. This voltage limit takes into consideration the equipment capabilities on AEP system. Short circuit assessment is performed assuming 1.05 per unit voltage at all the AEP system buses. This is a conservative approach but accounts for a wide range of system conditions. Circuit breakers at or near a generator plant shall be analyzed differently based on the scheduled voltage at the generator bus. This exception only applies to generator plants already in operation with established scheduled voltages.

**Stability Testing and Generation Ride-Through Performance Criteria**

Stability testing of the AEP transmission system is in accordance with NERC TPL-001-4. In addition, testing of the AEP system in the ERCOT Region is in accordance with the ERCOT Planning Guide Section 4.

TPL-001-4 R4.1.3 acceptable damping and R5 transient voltage response criteria may be found in PJM Manual 14B Section G.2.2, ERCOT Planning Guide Sections 4.1.1.5 and 4.1.1.6, and the SPP Disturbance Performance Requirements document for the PJM, ERCOT, and SPP areas, respectively.

An exception to TPL-001-4 stability testing criteria is that P7 category Planning Events are simulated with three-phase faults instead of phase-to-ground faults because three-phase is more conservative for common tower structure outages.

All transmission and sub-transmission connected generation, including wind and solar projects, are required to maintain stability and continuity of real and reactive power delivery through all TPL-001-4 planning events. ERCOT generation is further required to abide by the low and high voltage ride-through requirements of Nodal Operating Guide Section 2.9.

Generation that becomes radial through a series capacitor bank or multiple series capacitor banks may be exposed to RMS voltages greater than NERC PRC-024 and RTO criteria for High-Voltage Ride-Through (HVRT) no-trip zone levels because of natural system resonance. If such a radial configuration can result from N-1 or N-2 transmission outages, the generation must remain connected and producing power for the duration of such configuration even if voltages exceed the HVRT no-trip zone boundaries. An HVRT ride-through waver will be granted only under the following conditions:

1. Any SSR or SSCI resulting from the radial configuration is effectively mitigated, and
2. The potential loss of generation does not exceed the largest single unit in the interconnection, and
3. N-3 or greater configuration is necessary for the generation to become radial to a series capacitor, and
4. Agreed to by the RTO