AMP
TRANSMISSION

FERC FORM 715
ANNUAL TRANSMISSION PLANNING AND EVALUATION REPORT
Part 4: Transmission Planning Reliability Criteria
April 1, 2019

Transmitting Utility Name AMP Transmission, LLC

AMP Transmission, LLC

TRANSMISSION PLANNING CRITERIA

April 01, 2019

AMP TRANSMISSION

Contents

1.0 Background

This document provides the local planning criteria which will determine the reinforcements and enhancements to the AMP Transmission, LLC (AMPT) transmission system.

These AMPT Transmission Planning Criteria ensure compliance with the transmission planning standards of the North American Electric Reliability Corporation (NERC), Reliability First, and PJM. AMPT is a Transmission Owning (TO) member of the PJM Interconnection Regional Transmission Organization. AMPT subscribes to and designs its bulk electric system (BES) and all non-BES PJM monitored facilities to comply with the reliability principles and responsibilities set forth in PJM's business practice manuals.

The Federal Energy Regulatory Commission (FERC) requires all transmission providers that own, operate, or control facilities used for transmitting electric energy in interstate commerce to have on file open access non-discriminatory transmission tariffs. PJM has these tariffs on file on behalf of its transmission-owning members to provide firm and non-firm point-to-point transmission service to other entities, as well as firm network service.

The NERC, ReliabilityFirst, and PJM standards and requirements previously referred to above are discussed in Section 2. The AMPT Planning Criteria are presented in Section 3.

2.0 National and Regional Criteria and Guides

2.1 NERC Transmission Planning Standards

NERC was established to oversee reliability of the North American BES. NERC develops and ensures compliance with reliability standards for BES facilities in the United States, the bordering provinces of Canada, and a portion of Mexico. NERC consists of eight Regional Entities. AMPT's transmission facilities are located in the ReliabilityFirst region. FERC approved reliability standards can be found on the NERC website at:
https://www.nerc.com/pa/Stand/Pages/AllReliabilityStandards.aspx?jurisdiction=United%20States.

2.2 ReliabilityFirst Regional Reliability Planning Standards

AMPT plans and builds its BES facilities to meet the FERC approved transmission planning requirements of NERC and ReliabilityFirst.

2.3 PJM Planning Standards

AMPT is a member of PJM. PJM manages a regional planning process for generation and transmission expansion to ensure the continued reliability of the electric system. PJM annually develops a Regional Transmission Expansion Plan (RTEP) to meet system enhancement requirements for firm transmission service, load growth, interconnection requests and other system enhancement drivers. The criteria PJM uses in developing the RTEP are set forth in PJM Manual 14 series, available at:
https://www.pjm.com/library/manuals.aspx

3.0 AMPT Transmission Planning Adequacy Criteria

3.1 Planning Principles and Standards/Adequacy

AMPT's planning criteria may impose more stringent standards than PJM, NERC, or RF. These standards often arise to address specific system conditions.

In general, AMPT's transmission system is planned to withstand forced outages of generators and transmission facilities, individually and combined. Table 1 describes the contingencies and measurements AMPT utilizes in testing and assessing the performance of its transmission system.

For all testing conditions, stability of the network should be maintained, and cascading outages should not occur. Specific modeling considerations are adhered to as part of the testing conditions, outlined in the PJM Manual 14 series.

The transmission system must perform reliably for a wide range of conditions. Because system operators can exercise only limited direct control, it is essential that studies be performed in advance to identify the facilities necessary to ensure a reliable transmission system in future years.

The voltages and equipment loadings on the transmission system should be within acceptable limits, both during normal operation and for an appropriate range of potential system faults and equipment outages. The contingency conditions should not result in voltages or equipment loadings beyond emergency limits. The emergency limits can vary based on equipment type and allowable time period.

Table 1 specifies the conditions analyzed by AMPT for the purpose of identifying any thermal or voltage violations. The 50/50 and 90/10 load forecasts are defined in section 3.2.1.1. Thermal capability is given with equipment ratings in Amps or MVA. Voltage limits are in reference to the nominal design voltage and shown in per unit (pu). Adherence to the criteria given in this table ensures that the AMPT transmission system meets the applicable reliability requirements of NERC, RF and PJM.

System readjustment is allowed when attempting to reduce line loadings or improve a voltage profile. System readjustments considered in a planning analysis include but are not limited to:

- Load tap changer adjustment;
- Circuit breaker switching;
- Modification of Generator voltage schedules;
- Load transfers schemes; and,
- Generation redispatches.

Loadings on facilities over their applicable ratings but below short-term emergency ratings, following a contingency, must be adjusted back down to the normal or long-term emergency rating, as indicated in Table 1, within the time frame of the short-term emergency ratings using the system readjustments listed above.

If the criteria described in this document cannot be met, mitigation plans and/or operating procedures will be developed. A valid mitigation plan will bring the system into compliance through a variety of feasible options.

In addition to those events and circumstances included in Table 1, more severe but less probable scenarios will also be considered for analysis to evaluate the resulting consequences. As permitted in the NERC TPL Standard, judgment shall dictate whether and to what extent a mitigation plan would be appropriate. Such events are listed in the “Steady State & Stability Performance Extreme Events” section of Table 1 of TPL-001-4.

Table 1
AMPT Adequacy Criteria

Outage Event	Initial Condition	Event	Applicable Voltage Levels	Thermal 50/50 Load Forecast	Thermal 90/10 Load Forecast	Voltage (pu)
None	Normal System	None	All voltage	All Facilities Within Normal Ratings	All Facilities Within Long-Term Emergency	0.95 min 1.05 max
Single Contingency	Normal System	**Loss of one of the following:** 1. Generator 2. Transmission Circuit 3. Transformer 4. Shunt Device	All voltages	All Facilities Within Short-Term Emergency Ratings	All Facilities Within Long-Term Emergency Ratings	0.92 min 1.05 max
Single Contingency	Normal System	1. Opening of a line section w/o a fault 2. Opening of a switch w/o a fault 3. Bus Section Fault 4. Internal Breaker Fault 5. Opening of a Circuit Breaker	All voltages	All Facilities Within Short-Term Emergency Ratings	All Facilities Within Long-Term Emergency Ratings	0.92 min 1.05 max
Multiple Contingency	Loss of generator unit followed by system adjustments	**Loss or opening on of one of the following:** 1. Generator 2. Transmission Circuit 3. Transformers 4. Shunt device 5. Opening of a Circuit Breaker 6. Opening of a line section w/o a fault 7. Opening of a switch w/o a fault	All voltages for events #1-4 100kV and above for events #5-7	All Facilities Within Short-Term Emergency Ratings	All Facilities Within Long-Term Emergency Ratings	0.92 min 1.05 max
Multiple Contingency (Fault plus stuck breaker)	Normal System	**Loss of multiple elements caused by a stuck breaker attempting to clear a Fault on one of the following:** 1. Generator 2. Transmission Circuit 3. Transformer 4. Shunt Device 5. Bus section 6. Breaker	100kV and above	All Facilities Within Short-Term Emergency Ratings	All Facilities Within Long-Term Emergency Ratings	0.92 min 1.05 max
Multiple Contingency (Fault plus relay failure to operate)	Normal System	**Delayed Fault Clearing due to the failure of a non-redundant relay protecting the faulted elements to operate as designed for one of the following:** 1. Generator 2. Transmission Circuit 3. Transformer 4. Shunt Device 5. Bus Section 6. Breaker	100kV and above	All Facilities Within Short-Term Emergency Ratings	All Facilities Within Long-Term Emergency Ratings	0.92 min 1.05 max
Multiple Contingency (Two overlapping singles)	Loss or opening of one of the followed by system adjustments. 1. Transmission Circuit 2. Transformer 3. Shunt Device 4. Switch (failure & opening) 5. Opening of a Circuit Breaker 6. Opening of a line section w/o a fault	**Loss or opening of one of the following:** 1. Generator 2. Transmission Circuit 3. Transformer 4. Shunt Device 5. Switch (failure & opening) 6. Breaker opening 7. Opening of a line section w/o a fault	All voltages for combination of events #1-4 100kV and above for combination of events including #5-7	All Facilities Within Short-Term Emergency Ratings	All Facilities Within Long-Term Emergency Ratings	0.92 min 1.05 max
Multiple Contingency (Common Structure/Right-of-Way)	Normal System	**The loss of:** 1. Two adjacent circuits on common structures 2. Two or more adjacent circuits on parallel geographically adjacent rights-of-way	100kV and above	All Facilities Within Short-Term Emergency Ratings	All Facilities Within Long-Term Emergency Ratings	0.92 min 1.05 max

3.2 Detailed Adequacy Criteria

3.2.1 System Load Level

3.2.1.1 Peak Period Studies

The peak load period is studied to determine future requirements for the transmission system. The basic references for system peak load to be used in studies for future years are the totals provided by the PJM Load Analysis Subcommittee. The actual peak load in any given future year is likely to be higher or lower than the forecast value. A “50/50” load forecast provides a peak load projection that has an equal probability of being higher or lower than the peak load that actually occurs in that year. A “90/10” forecast provides a peak load projection with a 10% probability that the actual peak will be higher than the level forecasted in that year. A system planned using the 90/10 forecast provides additional security, as the load estimate is usually about 7% higher than the 50/50 forecast.

3.2.1.2 Off-Peak Period Studies

Studies will also be conducted for the purpose of determining risks and consequences during light load or shoulder peak conditions and for any other period for which system adequacy cannot be evaluated from peak period study results. For these off-peak periods, it is assumed that the number of hours of occurrence is substantially higher than the number of hours at or near peak load levels.

3.2.2 Multiple Contingencies/Common Mode Failures

Credible contingencies more severe than those included in Table 1 shall also be considered for analysis. The types of contingencies considered for this analysis are defined in the “Steady State & Stability Performance Extreme Events” section of Table 1 in TPL-001-4. The transmission system will be evaluated for the risks and consequences of a number of each of these extreme contingencies, as listed below:

- Loss of a tower line with three or more circuits
- Loss of all transmission lines on a common right-of-way
- Loss of a switching station or substation (one voltage level plus transformers)
- Loss of a generating station
- Loss of a major load center
- Failure of a Remedial Action Scheme RAS to operate when required
- Misoperation of a Remedial Action Scheme RAS
- Impact of severe power swings or oscillations from disturbances in another Regional Council
- Loss of the most critical transmission line followed by the loss of another critical transmission line in an adjacent system
- Single phase to ground fault with a failure of a protective device
- A multi-phase fault with delayed clearing.

3.2.3 Power Transfers

All studies should consider known firm power transfers affecting the AMPT transmission system. This includes known firm transmission service reservations, including those with rollover rights, as well as parallel path power transfers through the system that may impact system reliability.

AMPT is part of a larger regional power system that must be capable of withstanding certain levels of power transfers between or through subareas of the region. PJM conducts load and generator deliverability tests for specific subareas as part of the RTEP process to determine whether the system can accommodate these transfers. The AMPT transmission system must reliably accommodate these transfers per the PJM Load and Generator Deliverability Procedures. A description of the deliverability testing procedures can be found on the PJM web site. RF also performs transfer limit testing to test the strength of the transmission system. PJM's resource reliability criterion is a loss of load expectation (LOLE) of .04 day per year for each zone in PJM and 0.1 day per year for the entire PJM footprint.

3.2.4 Equipment Ratings

Allowable loading levels (ratings) for transmission facilities are available in an equipment ratings database and include ratings for normal and emergency conditions. AMPT has defined three types of emergency ratings based on time duration: long-term, short-term, and load-dump emergency ratings. The long-term emergency rating is defined as lasting the duration of the contingency, taking into account the daily load cycle for the transmission facility. The short-term emergency rating is defined as lasting either 30 minutes or two hours. The load-dump emergency rating is defined as lasting for 15 minutes. The following durations and assumptions will be used to establish short-term emergency ratings on AMPT's transmission system. For transmission facilities in the AMPT area a two-hour duration shall be used. The two-hour duration provides Transmission Operations sufficient time to perform the required post-contingency operating steps such as opening or closing a circuit breaker.

The specific methodologies used for determining equipment ratings are outlined in the AMPT Transmission Ratings Methodology technical reference document. These ratings are set to obtain a reasonable useful life (40 to 50 years) from the equipment throughout normal and emergency use. Equipment ratings are issued to all appropriate areas of the company and are used by both planning and operating personnel.

3.2.5 Circuit Breaker Interrupting Capability

Under normal conditions, the current through a circuit breaker shall not exceed the maximum normal ratings of that breaker. Further, a circuit breaker shall have sufficient capability to interrupt a close-in single-phase or three-phase to ground fault at a voltage of 1.05 PU.

3.2.6 Reactive Power Planning

The objective of system reactive power planning is to efficiently coordinate the reactive requirements of the transmission and distribution systems to satisfy voltage criteria. Meeting this objective ensures voltage stability, provides generator auxiliary power systems and the distribution system with adequate voltage, and minimizes transmission losses and reactive interchange. System reactive requirements can be supplied by generating units, transmission, sub-transmission, and distribution level static capacitors, synchronous condensers and by a variety of solid-state reactive compensation devices (SVCs, STATCOMS, etc.).

The AMPT transmission system is planned so that transmission voltages will be maintained within an acceptable range for normal and emergency conditions as described in Table 1. Low transmission voltage levels will lead to undesirable effects in both the transmission and distribution systems, such as higher losses, reduced insulation life, and reduced effectiveness of capacitors. These effects would also increase the difficulty in recovering from low transmission voltage level situations. The outage events analyzed to assess voltage adequacy are the same as those listed in Table 1.

3.2.7 Radial Load Criteria (MW-mile)

The objective of the Radial Load Criteria is to quantifiably determine the necessity to provide a second delivery feed to any load delivery point served by an AMPT-owned facility. To determine the necessity of providing a second feed to a load delivery point, AMPT utilizes a MW-mile threshold of >= 30 MW-miles. AMPT determines the MW-mile value for each load delivery point by multiplying the total peak MW of load value by the total distance of line exposure in miles. To mitigate a facility with >= 30 MW-miles of exposure a second source will be investigated to provide additional redundancy to the system serving the load.