Rochelle Municipal Utilities
TRANSMISSION PLANNING CRITERIA

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Contents

1 Background

This document provides the local planning criteria which will determine the reinforcements and enhancements to the RMU transmission system.

This RMU Transmission Planning Criteria ensure compliance with the transmission planning standards of the North American Electric Reliability Corporation (NERC) and those of Reliability*First* (RF), one of the eight Regional Entities (REs) of NERC. The RMU Planning Criteria also coordinates with the *ComEd Transmission Planning Criteria* as RMU is located within the ComEd transmission system.

In this document, "Transmission system" refers to the networked facilities operated at a voltage level of 138 kV. Facilities operated at 100 kV and above are considered part of the Bulk Electric System (BES), except as modified by the "Inclusions" and "Exclusions" listed in the NERC BES definition. All of RMU's transmission facilities are BES facilities.

2 National and Regional Criteria and Guides

2.1 NERC Transmission Planning Standards

The NERC was established to promote the reliability of the BES of North America and coordinates reliability standards for the power systems of the United States, the bordering provinces of Canada, and a portion of Mexico. NERC consists of eight Regional Entities; RMU is a member of the Reliability*First* RE. NERC has developed planning standards to ensure the reliable operation of the interconnected BES. These standards can be found on the NERC website.

The RMU Transmission Planning Criteria describes how RMU performs analyses to determine the ability of the interconnected transmission system to withstand probable and extreme contingencies. The analyses are performed by simulated testing of the transmission system as prescribed by NERC.

2.2 RFC Regional Reliability Planning Standards

As a member of Reliability*First*, RMU builds its BES facilities to meet the requirements of NERC and RFC.

2.3 PJM Planning Standards

RMU is a member of the PJM Interconnection, LLC (PJM) Regional Transmission Organization (RTO). 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 is set forth in PJM Manual 14B.

3 RMU Transmission Planning Adequacy Criteria

3.1 Planning Principles and Standards/Adequacy

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 assure 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 more probable 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 RMU 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 RMU transmission system meets the applicable reliability requirements of NERC, RFC and PJM.

System readjustment is allowed when attempting to reduce line loadings or improve a voltage profile. System readjustments considered in planning analysis include:

- Behind the Meter Generation
- Load tap changer adjustment
- Circuit breaker switching

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 are developed. A valid mitigation plan will bring the system into compliance through the most judicious use of a variety of feasible options. These include the development of an operator action plan in conjunction with the use of short-term emergency ratings, behind the meter generation dispatch, or the installation of a physical reinforcement.

In addition to those events and circumstances included in Table 1, more severe but less probable scenarios should also be considered for analysis to evaluate 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
RMU Adequacy Criteria

Outage Event	Thermal 50/50 Load Forecast	Thermal 90/10 Load Forecast	Voltage (pu) 138 kV
None (P0)	All Facilities Within Normal Ratings	All Facilities Within Long-Term Emergency Ratings (4)	0.95 min 1.03 max
1 Line (P1)	All Facilities Within Short-Term Emergency Ratings (1)	All Facilities Within Short-Term Emergency Ratings (2)	0.92 min 1.05 max
1 Open Circuit Breaker	All Facilities Within Short-Term Emergency Ratings (2)	All Facilities Within Short-Term Emergency Ratings (2)	0.92 min 1.05 max
One Line, followed by another Line	1st Contingency: All Facilities Within Short-Term Emergency Ratings (1) 2nd Contingency: All Facilities Within Short-Term Emergency Ratings (2)	Not required	0.92 min 1.05 max
2 Lines on a Common Tower (6) (simultaneous, all voltages) or 1 Faulted non-Bus Tie Circuit Breaker (7) (138 kV) or 1 Faulted Bus Tie Circuit Breaker (7) (all voltages) or 1 Faulted Bus Section (138 kV)	All Facilities Within Cascading Levels (3) (5)	Not required	0.92 min 1.05 max

(1) Must return to normal ratings post contingency, load shed not allowed
(2) Must return to long-term emergency ratings post contingency, load shed not allowed
(3) Must return to long-term emergency ratings post contingency, planned/controlled load shed allowed
(4) The 90/10 load forecast is higher than the expected 50/50 load forecast, thus equipment loading up to emergency ratings is acceptable for normal conditions
(5) As a proxy for cascading, RMU uses the lower of the relay loadability rating or 115% of the load dump rating
(6) Excludes lines that share a common structure for 1 mile or less.
(7) For Planning Criteria purposes a "bus tie circuit breaker" connects two individual substation bus configurations, such as two straight busses or two rings. Breakers within a ring, breaker-and-a-half, or double bus double breaker configuration are not considered bus ties when applying the Planning Criteria

Note: For contingency analysis, a synchronous condenser is treated the same as a line.
Note: Wind Turbines are to meet the same voltage requirements as Transmission Substations.

3.2 Detailed Adequacy Criteria

3.2.1 System Load Level

3.2.1.1 Peak Period Studies

The peak load period must be 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 total corporate system load projection provided by the PJM Load Analysis Subcommittee and the substation load forecasts provided by the Capacity Planning Group. 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 should also be conducted for the purpose of determining risks and consequences at 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 shall 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 RAS to operate when required
- Mis-operation of a 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 RMU 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.

RMU is part of a larger regional power system that must be capable of withstanding certain levels of power transfers between or through sub areas of the region. PJM conducts load and generator deliverability tests for specific sub areas as part of the RTEP process to determine whether the system can accommodate these transfers. The RMU 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. Reliability*First* also performs transfer limit testing to trend 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. RMU 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 RMU's transmission system. For transmission facilities serving load in the RMU Area a two-hour duration should be used. The two- hour duration provides Transmission Operations sufficient time to perform the required post-contingency operating steps that normally involve the adjustment of one or more phase angle regulating transformers. For all other transmission facilities serving load outside of the Chicago Metro Area a 30-minute duration should be used as Transmission Operations can normally perform the required post-contingency operating steps such as opening or closing a circuit breaker within this time frame.

The specific methodologies used for determining equipment ratings are outlined in the RMU 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.

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 RMU 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.

4 References

NERC TPL Standard – latest revision available on the NERC website:

- Standard TPL-001-4 – Transmission System Planning Performance Requirements

Load and Generator Deliverability Procedures – latest revision available on the PJM website:

- Manual 14B: PJM Regional Planning Process – Attachment C: PJM Deliverability Testing Method