

POTOMAC ELECTRIC POWER COMPANY

FERC Form 715 (Part 4) - Transmission Planning Study Guidelines

Transmission Reliability Guidelines

1. General Overview

The reliability guidelines used to plan the transmission system of Potomac Electric Power Company (Pepco) are the criteria by which the ability of the transmission system to serve the future load is determined. In addition to load growth, any significant changes to the generation capacity on Pepco's system or neighboring utility systems must also be included in any evaluation.

Pepco's bulk transmission system shall be planned and constructed in such a manner that it can be operated so that the more probable contingencies can be sustained with no loss of load. Less-probable contingencies will be examined to determine their effect on system performance.

These standards apply to bulk power transmission facilities including the facilities which have the primary function of giving Pepco a point of interconnection to generation and to the PJM and neighboring transmission systems. These Criteria do not apply to facilities affecting the reliability that only supply local loads. Exceptions are the 138kV/Bells Mill Road/Buzzard Point Network System and the 115kV/Benning Network System. These two systems are networked, with supply entering from either end of the tied system. Each of these two systems supply in excess of 1000 MVA of summer peak load, much of which is downtown area network government and large commercial load. The significant amount of load at risk and the type of load at risk necessitate more conservative planning criteria beyond that which is applied to the rest of the internal transmission and subtransmission systems. The recent retirement of Benning and Buzzard generation furthers the need for heightened transmission planning criteria within this part of the system.

2. Transmission Criteria

The Pepco service territory is governed by the reliability standards established by the North American Electric Reliability Corporation (NERC), Reliability *First* (RF), and PJM Interconnections, LLC (PJM). The exact planning requirements of these regulated institutions can be found on their websites and external publications. Pepco will adhere to any requirements directed by these agencies in order to meet their established reliability planning criteria.

In addition to these external organizations, Pepco also has its own internal planning criteria which will meet or exceed the strict standards above. The following criteria will be used for all transmission facilities within the Pepco zone:

The bulk transmission system shall be developed so that it can be operated at all load levels to meet the following unscheduled contingencies without instability, cascading, or interruption of load. Normally, maintenance is expected to be scheduled so that these criteria are not violated.

Thermal Requirements

- The loss of any single generating unit, transmission line, transformer, circuit breaker or bus, in addition to normal scheduled outages including maintenance outages, without exceeding the applicable Emergency Rating of any facility or the applicable voltage criteria. After the outage, the system must be capable of readjustment so that all equipment will be loaded within Normal Ratings.

After occurrence of the outage and the readjustment of the system specified above, the subsequent outage of any remaining generator, line, or transformer without exceeding the applicable Short Time Emergency Rating of any facility. After this outage, the system must be capable of readjustment so that all remaining equipment will be loaded within the applicable Emergency Rating and the voltage criteria will be met for the probable duration of the outage.

- The loss of any double-circuit line or the combination of facilities resulting from a line fault and a stuck breaker, in addition to normal scheduled outages including maintenance outages, without exceeding the applicable Short Time Emergency Rating of any facility. After the outage, the system must be capable of readjustment so that all remaining equipment will be loaded within the applicable Emergency Rating and the voltage criteria will be met for the probable duration of the outage.
- Perform a Generation Deliverability test that includes the following: (1) For normal system conditions with no line, transformer, or generation unit out of service all transmission facilities should not exceed their normal (continuous) rating; (2) For a contingency loss of any one facility (line, transformer, or generator), the system should not exceed its emergency (4 hour) rating; (3) For a contingency loss of any one facility (line, transformer, or generator) and the discrete outage of one generator, the system should not exceed its emergency (4 hour) rating; and (5) For generating stations where new generation is being added, all generation at the plant will be modeled at full output.

Voltage and Reactive Requirements

The Transmission System shall have controls capable of maintaining the voltages at levels which will not exceed the limits of the connected equipment and will allow for meeting the voltage limits specified below.

PEPCO Zone Base Line Voltage Limits				
Limit	500 kV	230 kV	138 kV	115 kV
High	550 1.10	242 1.05	145 1.05	121 1.05
Normal Low	500 1.00	219 0.95	131 0.95	109 0.95
Emergency Low	485 0.97	212 0.92	130 0.92	108 0.92
Load Dump	475 0.95	207 0.90	124 0.90	103.5 0.90

Note

These values may be different than the PJM base line voltage limits listed in Section 3, Exhibit 3 of the PJM Transmission Operations Manual MO3. These differences are recognized by PJM and provide more conservative operational limits for the PEPCO transmission zone.

Sufficient reactive compensation with adequate controls will be planned to allow supply of the reactive load and losses requirement in order to maintain acceptable voltage profiles, generally within $\pm 5\%$ of nominal voltage, on the Pepco Transmission System at all load levels during normal conditions and any of the contingencies described in {II} above.

3. Stability Requirements

Pepco's Transmission Planning team conducts stability studies to ensure the system can withstand NERC criteria disturbances and maintain stable operation throughout its territories. This analysis is to ensure nearby changes to the system configuration do not adversely impact the stability of the system.

Studied Contingencies

The stability of the system shall be maintained without loss of load during and after the following types of contingencies occurring at the most critical locations at all load levels:

- A three-phase fault with normal clearing time.
- A single-phase-to-ground fault with stuck breaker or other cause for delayed clearing.
- The loss of any single facility with no fault.

Generation Dispatch

As outlined in PJM Manual 14B, it is generally accepted that units operating at their highest possible power output and generating as little reactive power as necessary to maintain voltages are likely to be less stable. Under most circumstances, the units in the vicinity of a project under study will be turned to their maximum real power output with unity power factor at the high side of the GSU, or units' VAR output will be adjusted to hold scheduled voltages. Generators should be evaluated utilizing a 50/50 forecast under normal conditions or for single contingencies.

Studied Plant Selection

Pepco should evaluate system stability for areas where generators are connected to the BES system. Stability evaluation for generators not connected to a BES system should be determined on a case-by-case basis depending on impact and may be less stringent.

Monitoring Requirement

- Rotor angle, real power output, and terminal voltage are monitored.
- Bus voltage in the area of study is monitored.
- Following the disturbance, the voltages of the monitored buses maintain voltages within +/- 5% of the pre-contingency voltages.

Evaluation Frequency

Pepco shall conduct stability analysis every five years, or as needed when there have been significant changes to the transmission system and/or generation profile.

4. Tests by Simulation for the Ability of the Pepco System to Withstand Abnormal Disturbances

It is recognized that it is impossible to anticipate or test for all of the contingencies that can occur on the present or future Pepco system. The system, therefore, will be tested by simulation to determine the effect of various types of abnormal disturbances on system performance. These sensitivity tests serve primarily as a means to measure the ability of the system to withstand less probable contingencies, some of which may not be readily apparent. These tests are prescribed not on the basis of a high level of probability, but rather as a practical means to study the system for its ability to withstand disturbances beyond those which can reasonably be expected.

Recognition should be given to the occurrence of similar contingencies in neighboring systems and their effect on the Pepco system.

Examples of less probable contingencies to be studied are:

- A. The sudden loss of the entire generating capability of any station for any reason.
- B. The outage of the most critical transmission line on any one of the interconnected systems as the result of a three-phase fault immediately following (i.e., before adjustment) the tripping of another critical line on the same or an adjacent system.
- C. A single-phase-to-ground fault coupled with the malfunction of a protective device.
- D. The sudden loss of all lines of one voltage emanating from a substation.
- E. The sudden loss of all lines on a single right-of-way.
- F. The sudden dropping of a large load or a major load center.
- G. The occurrence of a multi-phase fault with delayed clearing.

5. Relaying and Protective Devices

Independent devices shall be installed to the extent necessary to provide backup for the primary protective devices and components so as to limit equipment damage, to limit the shock to the system and to speed restoration of service. The design of a particular line's relay protective schemes shall recognize the need for an appropriate balance between dependability (assurance that relays will operate when required) and security (protection against relay operation when not required). In cases where the requirements of Sections {II-A} and/or {IV} are not met, additional security against the over tripping of critical facilities may be considered. Relaying installed shall not restrict the normal or the necessary realizable network transfer capabilities of the system.

6. Ratings

Generally, ratings are defined as Normal, Emergency, or Short Time Emergency. All ratings are based on PJM rating methods and are provided by the responsible Engineering Department.

- A. Normal Operation -- All loads must be within the facility's normal rating.

B. Emergency Operation

1. The Emergency Rating referred to is a generic term for equipment emergency ratings of various durations depending on the type of equipment:

- Underground Pipe-Type cable = 300 hours
- All other underground cable = 36 hours
- All other equipment, generally = 24 hours

2. The Short Time Emergency Rating referred to is a generic term for equipment emergency ratings of various durations depending on the type of equipment:

- Overhead conductors = 10 hrs.
- Transformers = 4 hrs.
- Underground Pipe-Type cables for all 230kV & 115kV & for Feeder 13851 = 300 hrs.
- Underground Pipe-Type cables for all 138kV except Feeder 13851 = 4 hrs.

C. The capacities of existing circuits at 115kV up to 500kV have been determined, generally by using actual construction parameters.

D. In planning studies for adding new circuits, the thermal capacities to be used are to be based on the ratings and designed voltage-class of the cable or wire size to be installed, taking into account existing and proposed infrastructure installations along the route and the normal operating voltage.

7. Design Standards

Pepco applies specific design criteria to new and existing facilities, as applicable. Refer to the publically available documentation on PJM's website.

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