PNM Study Criteria and Guidelines

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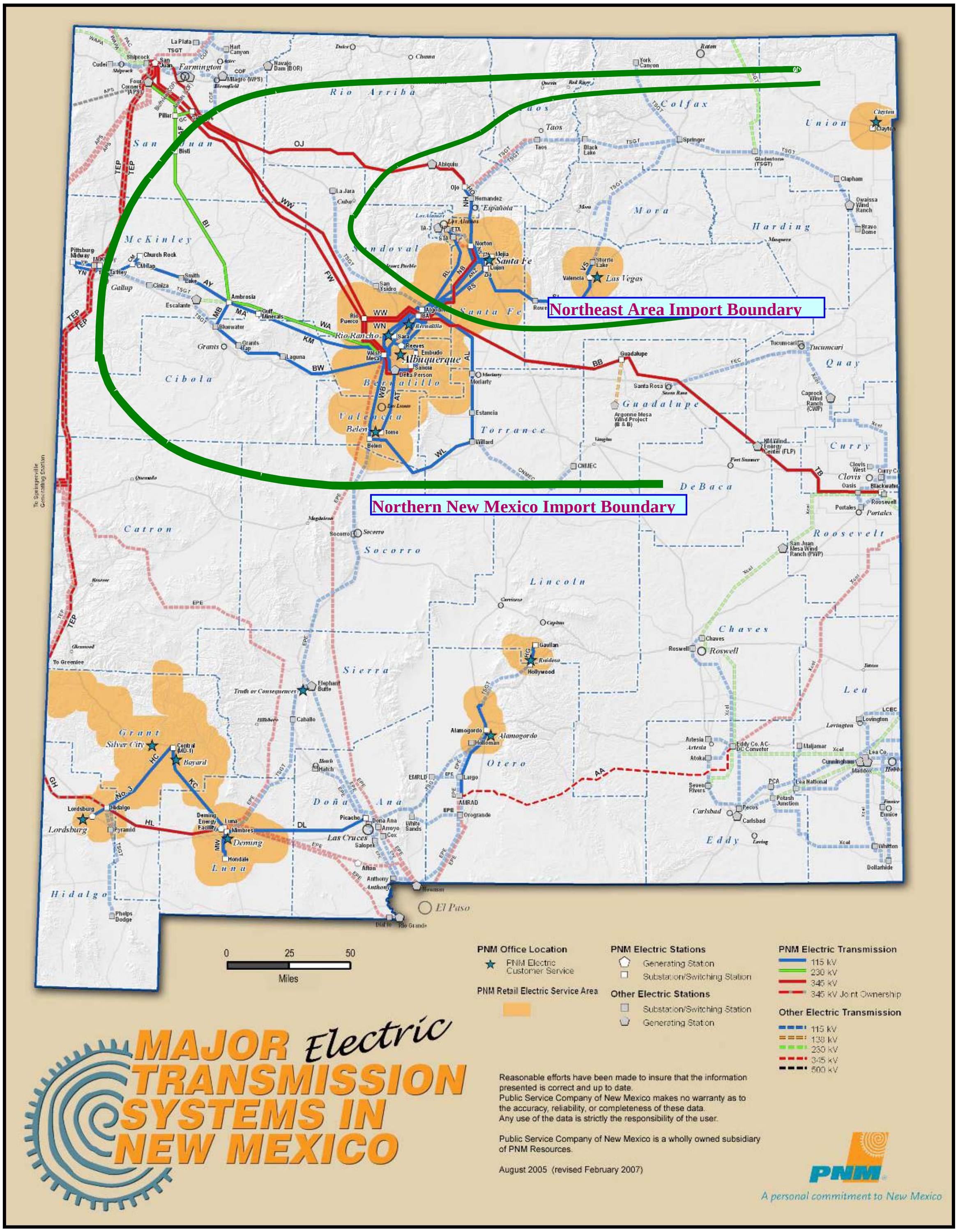
PNM use a deterministic approach for transmission system planning. Under this approach, system performance must meet specified criteria under normal conditions (all lines in service) and for various levels of system disturbances. In general, an adequately planned transmission system will:

- Provide an acceptable level of service to transmission customers, in a cost-effective manner, under normal and single contingency operating conditions.
- Not result in the loss of firm load for any single contingency outage. For more severe events, such as breaker failure or outage of two or more transmission elements, generation re-dispatch, generator tripping or controlled load dropping via remedial action scheme can be applied as an alternative to system reinforcements. These measures are often more cost-effective considering the low probability of the occurrence of these types of outages.
- Not result in cascading outages, overloaded equipment, or unacceptable voltage conditions for any credible contingency event.

The planning methodologies and criteria described below are used as the basis for the development of future transmission facilities and to maintain the reliability of the existing transmission system. Additionally, potential non-transmission alternatives (such as distributed generation or new technologies) are evaluated on a case-specific basis.

For transmission system study purposes, PNM divides its system into several logical cut-sets as shown in Figure 1. These cut-sets or subsystems allow for a tiered method of analysis ensuring each portion of the system is operated reliably. For each of these subsystems, an actual flow can be monitored and then compared to the system's limits for the 1) Northern New Mexico (NNM) Transmission System, 2) Northeastern Area (NEA) of New Mexico and 3) other subsystems within New Mexico. The NNM system refers generally to the transmission system between the Four Corners area and the central New Mexico load centers.

Figure 1 Defined Transmission Cut-Sets



All studies are performed in accordance with criteria stated below. These studies will, at a minimum, consist of the following analyses:

Powerflow Analysis

A powerflow analysis is conducted to assess the steady-state performance of the system under normal and contingency conditions, before operator action takes place. . The results predict powerflow magnitudes and voltage levels under the loss of any individual system element. The powerflow analysis enables the prediction of equipment overloads and the determination of excessive voltage drops, which may be encountered.

Short Circuit Analysis/Breaker Rating Analysis

A short circuit (*i.e.*, fault current) analysis is performed to determine the effect that the new generation or transmission will have on maximum system fault currents. The analysis evaluates the impact of system changes or additions on the fault capability (*i.e.*, interrupting capability or rating) of the existing equipment such as circuit breakers and switches and design requirements of new equipment.

Transient Stability Analysis

A transient stability analysis is performed to determine the transmission system's response to a sudden change in the state of the system due to system faults, switching operations and generator outages. Specifically, the analysis will evaluate the response of the transmission system and generators in the area affected by transmission system modifications as well as the response of new generators to system faults.

Methodology:

System performance is assessed with the power flow simulations using the methodologies listed below to reflect the system response to an outage.

- All manually operated voltage control and phase shifting devices will be fixed.
- All load-side SVC and generator resources are operated such that the pre-disturbance Mvar output is held at or close to zero unless higher ouput is needed to maintain reasonable base case voltages.
- All generators which control a high side remote bus will be set to control terminal voltage at the pre-disturbance voltage level, except for generators that have line drop compensation.

Criteria:

PNM adheres to approved National Electric Reliability Corporation (NERC) and WECC Planning Standards[1] with a few exceptions as noted below.

The criteria from applicable NERC/WECC standards are listed below:

- Changes in bus voltages from pre- to post-contingency must be less than 5% and 10% for single and double contingencies, respectively.

- All equipment loadings must be below their normal ratings under normal conditions.

- All line loadings must be below their emergency ratings for both single and credible double contingencies. All transformers and equipment with emergency rating should be below their emergency rating.

- Stability is divided into two categories, which include 1) transient or dynamic stability, and 2) steady-state voltage stability (P-V and Q-V Analysis). The operating criteria for each of the performance criteria are discussed below.

  - The transient stability criteria require that all machines remain in synchronism, all voltage swings should be damped, and voltage/frequency performance must meet the following performance criteria:
    - Following fault clearing for single contingencies, voltage on load buses may not dip more than 25% of the pre-fault voltage or dip more than 20% of the pre-fault voltage for more than 20 cycles.
    - For double contingencies (i.e., breaker failures), voltage on load buses may not dip more than 30% of the pre-fault voltage or dip more than 20% of the pre-fault voltage for more than 40 cycles.

  - Voltage stability criteria requires: "The most reactive deficient bus must have adequate reactive power margin for the worst single contingency to satisfy either of the following conditions for n-1 outages, whichever is worse: (i) a 5% increase beyond maximum forecasted loads or (ii) a 5% increase beyond maximum allowable interface flows. The worst single contingency is one that causes the largest decrease in the reactive power margin." For double contingencies (i.e., breaker failures) the reactive margin is reduced to 2.5%.

Listed below are PNM's additions and exceptions to the WECC reliability criteria.

[1] NERC/WECC Planning Standards, April 2003. This document is accessible through the Internet at *http://www.wecc.biz*.

- At buses with nominal voltage of 46 kV and 115 kV, the minimum and maximum allowed voltages are 0.925 p.u. and 1.05 p.u., respectively, for N-1 contingencies. At buses with nominal voltage of 230 kV and above, the minimum and maximum allowed voltages are 0.90 p.u. and 1.05 p.u., respectively, for N-1 contingencies. For N-2 and breaker failures the minimum voltage level is 0.90 p.u. and the maximum voltage level is 1.05. p.u for all nominal voltage levels.

- Exceptions to the above criteria apply for buses along the BA-Blackwater 345 kV line. At the Blackwater 345 kV bus, Tiaban Mesa 345 kV bus and Guadalupe 345 kV bus, the normal, N-1 and N-2 minimum allowed voltage is 0.95 p.u. At the Tiaban Mesa 345 kV bus and Guadalupe 345 kV bus, the normal, N-1 and N-2 maximum allowed voltage is 1.1 p.u.

- Voltage drop for N-1 contingencies at 46 kV and above buses must be no greater than 6% in Northern New Mexico and 7% in Southern New Mexico. PNM allows no greater than a 10% voltage drop at 46 kV and above for N-2 and breaker failures outages.

- The maximum transient swing voltage at the Tiaban Mesa 345 kV bus and Guadalupe 345 kV bus is 1.2 p.u..