LONG-RANGE TRANSMISSION PLAN ANALYSIS TOOLS AND METHODOLOGIES

1. Introduction

Con Edison's transmission system is assessed using a variety of system modeling and simulation tools to measure the transmission system's capabilities against design criteria. This is done for present and planned configurations at present and future load levels, respectively. Assessments are performed as needed in the following areas using standardized software packages to study the system's performance:

- Thermal;
- Voltage;
- Short Circuit;
- Stability;
- Transient Switching Surge and Lightning Withstand Capabilities; and
- Extreme Contingencies.

2. FERC Form 715

Load flow studies are conducted year-round by Transmission Planning for a wide variety of analyses, including planned expansions and real-time contingencies, overall system-wide assessments are required once a year to support the NYISO's requirement to file FERC Form 715, the Annual Transmission Planning and Evaluation Report. This is a comprehensive effort that includes updating the system model in terms of configuration and impedances, and adjusting the transmission system. A battery of load flow base cases are developed for the FERC Form 715 filing that include present summer and winter seasonal cases, as well as five and ten year look-ahead cases. The future cases incorporate all planned changes such as additions, expansions, and retirements according to the scheduled timelines for these changes.

The software used for these studies is provided by Power Technologies International, a division of Siemens AG, and is referred to as PSS/e, the acronym for Power System Simulator / Engineering. This is the leading software package for bulk transmission system load flow studies. The PSS/e application is the primary method

used by Transmission Planning to assess the performance of the transmission system under normal and contingency conditions.

2.1. Thermal

The load flow levels established by the studies are measured against the thermal ratings of transmission facilities. Con Edison's Central Engineering Department assigns facilities thermal ratings for normal, long-time emergency (LTE), and short-time emergency (STE) conditions.

Load flow studies are conducted to simulate normal operation under peak forecast loads, followed by various contingency conditions defined by NERC (North American Electric Reliability Corporation), the Northeast Power Coordinating Council (NPCC), the New York State Reliability Council (NYSRC), and Con Edison Transmission Planning Criteria. In order to comply with the more stringent Con Edison Transmission Planning Criteria, the transmission system must exhibit the capability to be returned to operation within normal thermal limits following the worst case contingencies.

3. Voltage

Voltages throughout the transmission system are checked using the same load flow studies that are used to make the thermal assessments described in the section above. The focus, however, shifts from the delivery of real power, measured in MW, to voltage support and control provided by reactive power, measured in Mvar[1].

4. Short Circuit

Short circuit studies are conducted using the ASPEN One-Liner program. These are done to assess the ability of the transmission system, specifically circuit breakers, to withstand and interrupt fault currents. The NYISO conducts semi-annual updates of its short circuit base case models. Significant data for these studies include system configuration, i.e., network topology, impedances of all connected equipment, and

[1] Voltages must remain within a prescribed range of 0.95 to 1.05 per unit throughout all contingencies.

circuit breaker interrupting ratings. All short circuit base cases use all available generation to ensure that the maximum possible current levels are simulated.

5. Stability

Stability studies are performed as needed, using the dynamic simulation capability of the PSS/E software. The studies encompass the full range of stability considerations on the power system, namely, steady-state stability, transient stability, and dynamic stability. These studies are very dependent on the detailed modeling of generator characteristics including excitation systems, control systems, inertia, and governor response.

Stability is assessed in accordance with NPCC Regional Reliability Reference Directory #1 “Design and Operation of the Bulk Power System”. Directory #1 specifies a variety of faults and other contingencies, including stuck breaker conditions, through which the power system must remain stable. Provision is included for automatic reclosing which can be very effective in maintaining system stability following transient faults such as those induced by lightning.

Within NPCC Directory #1, Appendix B – “Guidelines and Procedures for NPCC Area Transmission Reviews” states that stability assessment is to be part of the Comprehensive Review conducted once every five years in each of the NPCC Areas. The NYISO conducts the Comprehensive Review for the New York Control Area. Beyond this requirement, Con Edison undertakes stability studies when planned system changes have potential stability implications. In some cases, the studies are quite specific, targeted on a particular vicinity of the system. In other cases, the studies are broad in nature, encompassing a widespread territory. Transmission planners must use their experience and engineering judgment in determining the boundaries for such studies. Otherwise the studies become unwieldy and the results can be difficult to interpret.

6. Transient Switching Surge and Lightning Withstand Capabilities

The ability of the transmission system to withstand transient switching surges and surges due to lightning is assessed as needed using the Electromagnetic Transients

Program, known throughout the industry as EMTP. These types of studies, while not explicitly required by any of the various industry oversight entities, are conducted by electric utilities to ensure that planned expansions are designed in a manner that will not impose transient stresses beyond the capability of equipment on their system, either existing or new. Scenarios studied include energizing and de-energizing, fault clearing under normal and stuck breaker conditions, backfeed conditions, and potential resonance conditions. Occasionally, studies are conducted to address unusual or unexpected electrical phenomena observed on the transmission system in real time operation. From a technical perspective, these are very sophisticated studies that require detailed modeling of system parameters and even the specific electrical characteristics of equipment.

EMTP studies can identify a need for surge arrestors, and determine the required capability thereof. They can also identify a need for shunt reactors to mitigate transient overvoltages, even in cases where they would not be required for normal voltage control.

7. Extreme Contingencies

Extreme contingency scenarios that stress the transmission system beyond its design criteria are assessed in accordance with NPCC Directory #1, Appendix B – "Guidelines and Procedures for NPCC Area Transmission Reviews". Appendix B states that extreme contingency assessment, similar to stability assessment, is to be part of the Comprehensive Review conducted once every five years in each of the NPCC areas. The NYISO conducts the Comprehensive Review for the New York Control Area. Beyond this requirement, Con Edison also conducts extreme contingency assessments for its own transmission system. The intent is to gauge the extent of customer and overall system impact that could be incurred under selected worst case scenarios involving multiple contingencies, and to identify potential mitigating actions that could be taken to minimize the adverse impact.