MAINE POWER
RELIABILITY PROGRAM
A CENTRAL MAINE POWER COMPANY PROGRAM

Final Report

Maine Power Reliability Program

Needs Assessment of the Maine Transmission System

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Executive Summary

The Maine transmission system is both aging and nearing its technical and physical limits to meet the growing electrical demand needs for Maine customers and the reliability standards established by the North American Electric Reliability Corporation (NERC), the Northeast Power Coordinating Council (NPCC) and ISO New England (ISO-NE). The system is also nearing its limit to provide the transmission security expected from a reliable bulk power delivery system. In an effort to evaluate its reliability performance, a comprehensive ten year[1] forward looking transmission planning study has been completed on the Maine transmission system currently supporting the Bangor Hydro Electric (BHE) and Central Maine Power Company (CMP) service territories.

ISO-NE is the Regional Transmission Organization (RTO) for New England, and therefore the region's transmission planning authority. In that role, it conducts, coordinates and oversees the transmission needs for the region. For this study, CMP directly contracted with RLC to perform the needs analysis described in this report, which is based on steady-state thermal and voltage needs. ISO-NE chaired the study group and oversaw the work performed by RLC and CMP. Study Group participants included representatives from ISO-NE, CMP (and its consultants), BHE, Northeast Utilities (NU), Maine Public Service Company (MPS), and the Northern Maine Independent System Administrator (NMISA).

This study is the first phase, "Needs Assessment" of a much larger study associated with the Maine Power Reliability Program (MPRP). The principal objectives of the MPRP studies are to analyze the Maine bulk power transmission system and Pool Transmission Facilities (PTF) and to develop and evaluate alternative transmission solutions to maintain or improve current and future system reliability. This report details the study methodology, assumptions, and findings of the Needs Assessment segment of the regional system planning process. A separate study is underway to evaluate non-transmission alternatives to address the reliability needs identified in this study.

To evaluate the Maine bulk transmission system reliability and security performance, the study team scoped and performed a deterministic planning analysis for eighteen different operating scenarios, approximately 275 NERC Category B and C contingencies, and basic transmission reliability criteria for planning, designing, and operating the bulk power transmission system. The evaluation was conducted on stressed system conditions and assumptions for the year 2017 summer peak load level with no Maine generating station retirements assumed and while considering all currently proposed plan applications to upgrade the generation and transmission system in Maine and New England. In this reliability assessment, the Special Protection Systems (SPS) in Maine and New Brunswick were removed to better identify and understand the transmission system's weakness and the network consequences of the SPS failure to operate. Removing these SPSs from the Needs Assessment allows the study to reveal the underlying condition of the transmission system and thus permit a more detailed evaluation of solutions in the Alternatives Assessment, including SPSs, required to remedy identified deficiencies.

[1] This study analyzed planned transmission system conditions for the year 2017. Subsequent analysis to determine the specific year of need for any transmission solution will be conducted in a separate study that reviews alternatives to maintain acceptable reliability performance for Maine.

Summary of Key Findings

The Maine transmission system reliability evaluation identified several areas of weak performance and demonstrated the following transmission system needs.

1. Insufficient 345-kV Transmission – The 345 kV system is the backbone of the bulk power transmission system in Maine and throughout the New England system. Maine currently has redundant 345 kV transmission paths from Southern to Central Maine and is currently building a second path from Northern Maine to New Brunswick. Maine has a single 345 kV path in the central part of its system between Central and Northern Maine which becomes the critical weak link in the reliability performance of Maine's 345 kV bulk power transmission corridor. This weakness would be aggravated by a single 345 kV line outage or double circuit tower contingency on the 345 kV corridor which has the potential to cause a blackout for a significant portion of the state, and in a separation of both Maine and Canada from the rest of New England and the eastern interconnection.
2. Insufficient 345/115 kV Transformation Capacity – Currently, five major bulk power substations transform (convert) power from the 345 kV system down to the 115 kV transmission grid for wider distribution. The conversion from 345 kV to 115 kV is accomplished by a single autotransformer at four of the five locations. Orrington, which is connected to Bangor Hydro Electric's system, is equipped with two. The reliability of the 115 kV system is dependent on the capacity and availability of these autotransformers. Thermal overloads of the Maine 345 kV to 115 kV autotransformers with all lines-in-service illustrate insufficient transformation capacity. Autotransformer outage events may lead to voltage collapse. Large power transformers like the Maine 345 kV to 115 kV autotransformers have a significant lead time for replacement and limited transportability, which increases outage time to repair or replace from hours or days to months and possibly years.
3. Insufficient 345 kV Transmission Support for Portland and Southern Region – The South Gorham 345 kV Substation (S/S) is the single bulk power supply for the largest load pocket in Maine, which covers the Portland area all the way south to the New Hampshire border. Presently, South Gorham 345 kV S/S is served by a radial 345 kV transmission line that originates at Buxton Substation and terminates at the W.F. Wyman Station on Cousins Island in Yarmouth, Maine. Since it is radial and was originally established as a long generator lead for the 630 MW Wyman 4 unit, any outage of this line also removes the South Gorham 345 kV station and its supply to the Portland and Southern Regions from service. Under most scenarios, this South Gorham 345 kV S/S outage causes excessive thermal overloads on the remaining system and causes voltage collapse of this entire region.
4. Insufficient Transmission Infrastructure in Western, Central, and Southern Maine Regions – Each of these regions in Maine represents a major load pocket of residential, commercial, or industrial load with a dependence on local generation to meet reliability standards. Thermal overloads or voltage violations were exhibited for multiple occurrences in the multi-scenario and conditions analysis used in the Needs Assessment.
5. Insufficient Transmission Infrastructure in Mid-Coast and Downeast Maine Regions – These two regions are similar to the regions noted above but with one notable exception: there is no generation in these regions to depend on for reliability performance. Transmission outage events in these two regions result in violations of reliability criteria that stem from heavy load in relation to the transmission supply capability.

6. Insufficient Thermal Capacity Ratings of Transmission Lines – Nine transmission lines showed insufficient thermal capacity due to line ratings. Five 115 kV lines were overloaded in the base case and under post-contingency conditions. These overloads were unrelated to particular dispatch conditions. Four additional lines, one being 345 kV and the others 115 kV, were also determined to have insufficient capability. The line ratings evaluated in the study reflect the most recent changes in rating methodology for the entire Maine transmission system established by ISO-NE in Planning Procedure #7 – Procedures for Determining and Implementing Transmission Facility Ratings in New England.

There may be additional deficiencies or violations of reliability criteria that were not uncovered by the Needs Assessment due to inadequacies of Maine's bulk power transmission system. These inadequacies were masked by voltage collapse or failure to solve the powerflow simulation used to perform the reliability baseline evaluation on many critical contingencies. The above summary list of Key Findings should be considered as a starting point for evaluating required transmission or non-transmission solutions to address transmission system reliability needs in Maine.

The following report details the study assumptions, methodology, criteria, scenario definitions, and study results related to the Maine Power Reliability Program Needs Assessment.

Further required transmission planning analysis could result in significant additional transmission system upgrades. This analysis includes, but is not limited to, studies such as transient stability, Bulk Power System classification, and short circuit testing.