Southern New England Transmission Reliability Report 1 Needs Analysis

Redacted Public Version

January 2008

Southern New England Regional Working Group

ISO New England

National Grid

Northeast Utilities

The results of this study were first presented to ISO New England stakeholders in July 2006, with a draft report posted on the ISO's Web site the following month. Since then, the report has been modified to reflect clarifying comments that have been received. The working group has not intended to change any of the original results, assumptions, or conclusions.

Executive Summary

National Grid, Northeast Utilities, and ISO New England (ISO) formed a working group to conduct the studies necessary to develop a 10-year plan for transmission system improvements for the southern New England (SNE) region. The 10-year plan specifically addresses western and central Massachusetts (particularly the Springfield area), Rhode Island, and eastern and central Connecticut.

The objective of this plan is to ensure that the SNE region, as described in Section 1, complies with criteria and reliability standards established by the North American Electric Reliability Corporation (NERC), the Northeast Power Coordinating Council (NPCC), and the ISO.[1] These criteria and standards (summarized in Section 2) define regional transmission requirements and transmission-transfer capabilities with respect to stability, steady state, and fault-current simulations. They are in place to ensure, for the long term, that the regional transmission system serving New England is robust and flexible, reliably delivers power to customers under a wide range of projected future system conditions, and accounts for uncertainties and unforeseen events.

The first working group task was to assess the ability of the New England transmission system to satisfy these national and regional reliability standards, assuming an "as is" electric transmission system under future conditions. It also identified potential reliability violations (statements of need) for the southern New England transmission system and any likelihood of portions of this region not meeting the criteria and standards by 2009.[2] Section 3 presents the results of the coordinated needs-related studies.

The working group then developed solution options (groups of system upgrades) to address the deficiencies (needs) identified in this report and improve the transmission system in conjunction with the ISO's 10-year regional system planning process. A separate report, *New England East–West Solutions, Report 2—Options Analysis*, reviews the results of the working group's analysis of the solution options. It also explains how the solutions were developed to meet the identified needs, describes the main features of the solutions, and compares the solutions in terms of system performance characteristics.

The studies conducted were part of one of the most geographically comprehensive planning efforts to date in New England, addressing five interrelated problems in three states and multiple service territories. When the identified weaknesses in southern New England are improved, the regional

[1]The ISO system must comply with NERC and NPCC criteria and standards and ISO planning and operating procedures. As certified by the Federal Energy Regulatory Commission in 2006, NERC is the "electric reliability organization" (ERO) whose mission is to improve the reliability and security of the bulk power system in North America. Information on NERC requirements is available online at http://www.nerc.com (Princeton, NJ: NERC, 2007). NPCC is the cross-border regional entity and criteria services corporation for northeastern North America. NPCC's mission is to promote and enhance the reliable and efficient operation of the international, interconnected bulk power system in the geographic area that includes New York State, the six New England states, and the Ontario, Québec, and the Maritime provinces. Additional information on NPCC is available online http://www.npcc-cbre.org/default.aspx (New York: NPCC Inc., 2007). Information about ISO New England Planning Procedure No. 3 (PP 3), *Reliability Standards for the New England Area Bulk Power Supply System*, is available online at http://www.iso-ne.com/rules_proceds/isone_plan/PP3_R3.doc (Holyoke, MA: ISO New England, 2006).

[2] Summaries of the ISO's projections for the southern New England transmission system have appeared in the *2005*, *2006*, and *2007 Regional System Plans* (RSPs) as well as previous years' Regional Transmission Expansion Plans. These reports are available online at http://www.iso-ne.com/trans/rsp/index.html.

transmission system will be more reliable and generation will be less constrained, which should benefit all the New England states.

Method and Criteria

Following the Northeast Blackout of 1965, what is now known as NERC was formed to prevent future occurrences by establishing broad-based standards. NPCC, of which ISO New England (representing the New England Power Pool [NEPOOL]) is a member, was subsequently formed to develop regionally specific criteria based on NERC standards. ISO power system planning procedures are designed to meet these reliability standards, per ISO Planning Procedure No. 3 (PP 3), *Reliability Standards for the New England Bulk Power Supply System*, the specific standards that provide consistent system planning criteria throughout New England.

PP 3 defines the standards used to plan the interconnected generators and transmission circuits that comprise the region's electrical network. A number of "tests" must be "passed" before a system can be determined to meet these standards. These tests take into account historical data and system occurrences and examine the following:

- **Area Transmission Requirements:** Is the area transmission system capable of delivering the necessary generation to the system load under anticipated facility outage events? (PP 3, Section 3)
- **Transmission Transfer Capability:** Is the interconnected transmission system designed with adequate capability to transfer power within the ISO New England Control Area and between ISO New England and neighboring control areas? (PP 3, Section 4)

Similar standards exist throughout North America.

When analyzing future system reliability needs, planners must consider possible system configurations (load and generation scenarios) and possible system contingencies (e.g., the sudden and unplanned outage of a generating unit or a transmission line). Given the geographic scope of the SNE region, a tremendous number of variables and interrelationships are involved in studying the possible system configurations and contingencies. Moreover, individual solutions in one area must be evaluated to ensure that they do not produce unintended consequences in another area. Specifically, the potential effects that system conditions in one area have on another part of the system must be understood. For instance, as illustrated in Figure 1, an outage on a 345 kV line supplying the Manchester area in north-central Connecticut could overload facilities in the western Massachusetts–Springfield area and the northeastern Connecticut–Rhode Island area when redistributing the power flow in trying to reach the load.

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Figure 1: Illustration of interrelationships in the southern New England region.

Statements of Need

Analyses performed for the 10-year period (from 2007 to 2016) showed that on the basis of ISO planning procedures, the SNE transmission system over the 10-year study period has five major reliability concerns and a number of system deficiencies in transmission security, specifically area transmission requirements and transfer capabilities. These deficiencies form the justification for the needed transmission system improvements.

Reliability Concerns

The reliability concerns are as follows and are depicted in Figure 2.

- **East–West New England Constraints:** Regional east–west power flows could be limited during summer peak periods across the SNE region as a result of thermal and voltage violations on area transmission facilities under contingency conditions.
- **Springfield Reliability:** The Springfield, Massachusetts, area could be exposed to significant thermal overloads and voltage problems under numerous contingencies at or near summer peak-load periods. The severity of these problems would increase as the transmission system attempts to move power into Connecticut from the rest of New England.

- **Interstate Transfer Capacity:** Transmission transfer capability into Connecticut and into Rhode Island during summer peak periods could be inadequate under existing generator availabilities for criteria contingency conditions.
- **East–West Connecticut Constraints:** East-to-west power flows in Connecticut could stress the existing system under "line-out," or N-1-1, contingency conditions (i.e., conditions under which a transmission element is unavailable and a single power system element is lost) during system peaks.
- **Rhode Island Reliability**: The system depends heavily on limited transmission lines or autotransformers to serve its peak-load needs, which could result in thermal overloads and voltage problems during contingency conditions.

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Figure 2: Reliability concerns in the southern New England region.

Transmission Security Concerns

The analysis identified the following transmission security concerns related to meeting transfer capability and area transmission requirements:

Transfer Capability Concerns

- Power-transfer capabilities in the Connecticut area will not meet the area's import requirements as early as 2009. If improvements are not made by 2016, the import deficiency (outlined using a "load margin" approach in RSP06) for this area under conditions of generator unavailability and the loss of a single power system element (N-1 conditions) is expected to be greater than 1,500 MW assuming no new capacity is added.

- Based on planning assumptions concerning future generation additions and retirements within the Connecticut area, an import level of 3,600 MW for N-1 conditions and 2,400 MW for N-1-1 conditions will be needed by 2016.
- Connecticut currently has internal elements that can limit transfers from neighboring New England states under certain system conditions. These constraints limit the Connecticut east–west power transfers across the central part of Connecticut. The movement of power from east to west in conjunction with higher import levels to serve Connecticut overloads transmission facilities located within Connecticut that eventually tie into the new Middletown–Norwalk facilities.
- Under line-out (N-1-1) conditions and certain dispatch scenarios, the 345 kV transmission system in the southeastern Massachusetts and Rhode Island areas currently cannot support the requirements of southeast Massachusetts–Rhode Island, New England east–west, and the Connecticut power transfers following a contingency. These interfaces all have simultaneous and interrelated power-transfer limits.
- Rhode Island and Springfield have insufficient import capability to meet their load margins through 2016.
- The flow of power through the Springfield 115 kV system into Connecticut increases when the major 345 kV tie line between western Massachusetts and Connecticut (the Ludlow–Manchester–North Bloomfield 345 kV line) is open because of either an unplanned or a planned outage. As a result, numerous overloads occur in the 2009 simulations. These overloads are exacerbated when Connecticut transfers increase.

Concerns about Area Transmission Requirements

- In the Springfield area, local double-circuit tower (DCT) outages, stuck-breaker outages, and single-element outages currently can result in severe thermal overloads and low-voltage conditions.
- The severity, number, and location of the Springfield overloads and low-voltage conditions highly depend on the area's generation dispatch. Additional load growth and unit outages in the Springfield area would significantly aggravate these problems. As a result, network constraints in the Springfield area limit the system's present ability to serve local load under contingency conditions.
- Thermal and voltage violations can occur on the existing Rhode Island transmission system, dependent on unit availability and transmission outages (planned or unplanned). Relatively high load growth in the southwestern area and the coastal communities in recent years has increased the possible occurrence of criteria violations.
- The capabilities of the underlying Rhode Island 115 kV system currently are insufficient to handle the power requirements within the state following the loss of 345 kV transmission facilities, both lines and autotransformers, under certain system conditions. For line-out conditions, the next critical contingency involving the loss of a 345/115 kV autotransformer or a second 345 kV line would result in numerous thermal and voltage violations.

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Section 1
Introduction and Background Information

The analysis presented in this report is the culmination of several joint studies by ISO New England (ISO) transmission owners (TOs). The New England transmission system serving the southern New England (SNE) area was studied to evaluate projected future load and generation requirements to assess the performance of the transmission system and its ability to meet existing reliability standards. This report identifies the likely deficiencies in the performance of the electric transmission system in the future.

1.1 Southern New England

The map shown in Figure 1-1 depicts the load density for the geographic area of southern New England, namely Massachusetts, Rhode Island, and Connecticut. As shown in this figure, a substantial number of significant load pockets exist—Boston and its suburbs, central Massachusetts, Springfield, Rhode Island, Hartford/central Connecticut, and Southwest Connecticut. The load pockets of Springfield, Rhode Island, Hartford/central Connecticut, and Connecticut as a whole are primary areas of concern in this study with respect to the ability of the existing transmission and generation systems to reliably serve projected load requirements in these areas.

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Figure 1-1: Southern New England load concentrations.

Southern New England accounts for approximately 80% of the New England load. The 345 kV bulk transmission network is the key infrastructure that integrates the region's supply resources with load centers. The major southern New England generation resources, as well as the supply provided via ties from northern New England, Hydro-Québec, and New York, primarily rely on the 345 kV transmission system for delivery of power to the area's load centers. This network provides significant bulk power supply to Massachusetts, Rhode Island, and Connecticut and is integral to the supply of the Vermont load in northwestern New England. The SNE area has experienced significant load growth, numerous resource changes, and changes in inter-area transfers.

The east–west transmission interface facilities divide New England roughly in half. Vermont, southwestern New Hampshire, western Massachusetts, and Connecticut are located to the west of this interface; while Maine, eastern New Hampshire, eastern Massachusetts, and Rhode Island are to the east. The primary east–west transmission links are three 345 kV and two 230 kV transmission lines. A few underlying 115 kV facilities are also part of the interface; however, most run long distances, have relatively low thermal capacity, and do not add significantly to the transfer capability. In the early 1990s, this interface was important to monitor in day-to-day operations because of constraints in moving power from the significant generation in the west to Boston and its suburbs in the east. Following the influx of new generation in the east in the late 1990s, this interface now becomes constrained in the opposite direction, from east to west.

Supplying southern New England with electricity involves a number of complex and interrelated performance concerns. Connecticut's potential supply deficiencies, the addition of the Stoughton 345 kV station to serve the Boston area, and the demands of Rhode Island and western New England combine to significantly strain the existing 345 kV network. These challenges are compounded further by transmission constraints in the Springfield and Rhode Island areas under contingency conditions. The following transmission transfer capabilities are all interrelated:

- Southeastern Massachusetts (SEMA) export
- Greater Rhode Island export (mostly generation located in Massachusetts bordering on Rhode Island)
- Boston import
- Rhode Island import
- New England East–West interface
- Connecticut import
- Connecticut East–West interface
- Southwest Connecticut (SWCT) import

Transfers through these paths can contribute to heavy loadings on the same key transmission facilities.

These relationships exist for both thermal and stability limits. Studies have identified the relationship of stability limits among SEMA interface transfers, SEMA/RI exports, New England East–West transfers, New York–New England transfers, and the status of certain generators. Unacceptable torsional impacts on generators as a result of line reclosing also have become an issue in the SNE area. These behaviors illustrate the interdependent nature of the SNE 345 kV network. Recent analyses have quantified an additional interdependence between the ability to import power into Connecticut and the ability to supply load in the Springfield area. Springfield's reliability issues must be studied within the context of the overall southern New England analysis to not limit the benefits that improvements bring to the area and the ability to better integrate the supplies to the various load pockets in the region.

The existing transmission system does not allow for delivering surplus capacity to all load centers in southern New England. Regional east-west transfer limits and Connecticut power-transfer limitations do not allow this surplus capacity to be delivered to the load centers within Connecticut. The Springfield and Rhode Island areas have additional transmission reliability concerns, both thermal limitations and voltage violations, which lead to a set of interrelated concerns with respect to the reliability of transmission service across southern New England (see Figure 1-2).

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Figure 1-2: Southern New England subareas and constraints.

1.2 Connecticut

Approximately 70% of the Connecticut load is concentrated in the western part of the state, and 30% of the Connecticut load is located in the eastern part of the state. Approximately 6,779 MW of internal generation supplies Connecticut. Fifty-five percent of this internal generation is located in the eastern part of the state. Connecticut has two of the larger generators in New England, Millstone Point 2 and Millstone Point 3, which combine for approximately 2,000 MW. Around 55% (3,800 MW) of the internal generation is over 30 years old, 30% (2,100 MW) is over 40 years old, and 81 MW is over 60 years old.

Connecticut is integrated into the regional network primarily through three 345 kV lines, one 138 kV phase-angle regulator-controlled line, four 115 kV lines and one 69 kV line. Connecticut is tied to Massachusetts through the Manchester–North Bloomfield–Ludlow (395) 345 kV tie and three 115 kV ties (Southwick–North Bloomfield–1768, South Agawam–North Bloomfield–1821, and South Agawam–North Bloomfield–1836). Connecticut is tied to Rhode Island through a 345 kV line between Lake Road and Sherman (347) and a 115 kV line between Mystic and Wood River (1870). Connecticut is tied to the neighboring New York area through the Long Mountain–Pleasant Valley (398) 345 kV tie and through the Norwalk–Northport (1385) 138 kV tie. A high-voltage direct-current (HVDC) interconnection with Long Island Power Authority in New York is rated at 330 MW.

Transmission import capability into Connecticut is influenced by several simultaneous transfers. Conditions that can affect the ability to import power into Connecticut include New York–New England imports and exports, New England east–west transfers, SEMA/RI exports, east–west transfers within Connecticut, and Springfield/western Massachusetts generation dispatches.

1.3 Greater Rhode Island

The Greater Rhode Island (GRI) area includes the transmission system in the state of Rhode Island and surrounding 345 kV transmission in Massachusetts and Connecticut. The Rhode Island transmission system consists of two 345 kV connections to Massachusetts, one 345 kV connection to Connecticut, and an underlying 115 kV network. The two Rhode Island–Massachusetts 345 kV connections are (1) line 315 from Brayton Point in Somerset, Massachusetts, to West Farnum in North Smithfield, Rhode Island, and (2) line 3361 from ANP–Blackstone in Massachusetts to Sherman Road in Rhode Island. Line 347 is the 345 kV connection that runs from Sherman Road to Lake Road, Connecticut. The Ocean State Power Plant is connected to Sherman Road via a 345 kV radial line (line 333).

Three 345/115 kV substations supply the underlying 115 kV system in Rhode Island—Brayton Point, West Farnum, and Kent County. The system is tied to the southeastern Connecticut system by a 115 kV interconnection from Kent County to Mystic. It is tied to Massachusetts via two 115 kV lines to Millbury substation and several 115 kV lines that ultimately terminate at Brayton Point and Somerset substations.

1.4 Western Massachusetts/Springfield

Western Massachusetts encompasses the four western counties of Massachusetts. Western Massachusetts Electric Company (WMECO)'s existing transmission circuits in Massachusetts consist of 104.5 circuit miles of 345 kV, 346.0 circuit miles of 115 kV (which includes 9.4 miles of underground cables and an abundance of double-circuit towers), and 5.5 circuit miles of 69 kV lines. The WMECO transmission system is interconnected to other electric utilities, including Connecticut Light and Power Company (CL&P), National Grid, Holyoke Gas and Electric, Holyoke Water Power Company (HWP), Public Service of New Hampshire (PSNH), and the Massachusetts Municipal Wholesale Electric Company (MMWEC).

The WMECO service territory is divided into two areas, Pittsfield/Greenfield and Springfield. The Springfield area is of concern for this analysis. The Springfield area includes the City of Springfield and extends west to Blandford, south to the Connecticut border, north to Amherst, and east to Ludlow. WMECO is the primary service provider for this area. Other providers that serve load in this area are Holyoke Gas and Electric, Holyoke Water Power Company, Chicopee Electric Light, Westfield Gas and Electric, South Hadley, and National Grid.

1.5 New England Regional Load Forecast Projections

The ISO develops a forecast of the regional peak load for New England on an annual basis. The New England regional forecast is derived by modeling load for each of the New England states on the basis of NEPOOL load data from various New England subareas. The results for each state are combined to produce the New England regional forecast. The analysis conducted to develop a New England forecast was based on the ISO’s April 2005 published peak-load forecast. The most recent updated version of the ISO’s peak-load forecast, published in March 2007, indicates that New England is expected to experience a slighter higher peak load than the April 2005 forecast used in the analysis in this report. This change is relatively small and would not change the results of the analysis performed for any of the areas studied. Consequently, the need and timing for system upgrades would not be affected as a result of the slight change in system load forecast. While forecasts and load levels vary from year to year, they tend to be insignificant when studying a relatively large area for a number of years into the future.

Table 1-1 summarizes the ISO’s *2005 Regional System Plan* (RSP05) subarea peak and energy forecast.

Table 1-1
Energy and Peak-Load Forecast Summary for the ISO New England Control Area and States

Area	Net Energy for Load (GWh)			Summer Peak Loads (MW)					Winter Peak Loads (MW)				
				50/50		90/10		CAGR (a)	50/50		90/10		CAGR (a)
	2005	2014	CAGR\ (a)	2005	2014	2005	2014		2005/06	2014/15	2005/06	2014/15	
NE Control Area	**134,085**	**152,505**	**1.4**	**26,355**	**30,180**	**27,985**	**32,050**	**1.5**	**22,830**	**26,005**	**23,740**	**27,030**	**1.5**
BHE	2,135	2,215	0.4	360	380	380	400	0.6	355	370	365	380	0.5
ME	6,500	7,520	1.6	1,045	1,225	1,090	1,280	1.8	1,065	1,235	1,090	1,260	1.7
SME	3,630	4,135	1.5	595	685	620	715	1.6	575	655	590	670	1.5
NH	9,665	11,540	2.0	1,860	2,250	2,010	2,440	2.1	1,675	1,990	1,745	2,070	1.9
VT	7,190	7,940	1.1	1,220	1,360	1,295	1,440	1.2	1,175	1,315	1,210	1,350	1.3
BOSTON	26,770	29,720	1.2	5,360	5,940	5,685	6,295	1.1	4,515	5,070	4,700	5,275	1.3
CMA/NEMA	8,520	9,635	1.4	1,705	1,965	1,815	2,085	1.6	1,470	1,645	1,540	1,720	1.3
WMA	10,775	11,735	1.0	2,015	2,200	2,140	2,335	1.0	1,865	2,035	1,940	2,115	1.0
SEMA	13,420	15,405	1.5	2,750	3,210	2,915	3,405	1.7	2,270	2,585	2,370	2,695	1.5
RI	11,285	12,985	1.6	2,390	2,755	2,540	2,925	1.6	1,905	2,200	1,975	2,280	1.6
CT	17,065	19,980	1.8	3,515	4,165	3,740	4,430	1.9	2,990	3,490	3,120	3,645	1.7
SWCT	11,275	12,950	1.6	2,290	2,645	2,440	2,815	1.6	1,980	2,260	2,065	2,360	1.5
NOR	5,880	6,760	1.6	1,250	1,415	1,330	1,505	1.4	1,000	1,170	1,045	1,220	1.8

(a) CAGR refers to the compound annual growth rate.

Section 2
Methodology for Analyzing System Reliability

One of the main activities of the ISO's transmission planning process is to analyze system reliability according to a number of planning standards and criteria, as described in this section. The results of these analyses show potential criteria violations that form the basis of this Needs Analysis.

2.1 Transmission Planning Process

Transmission planning for the New England electric power system is a dynamic, ongoing activity that is summarized annually in a regional system plan (RSP). This systemwide summary is the result of numerous assessments that evaluate the capacity and reliability of the transmission facilities that make up the New England bulk power transmission system and identify system needs, which may be addressed by market responses, including both transmission and nontransmission alternatives. In addition, the reliability needs within geographic subareas of the system are investigated to ensure that the load requirement of each subarea is reliably served. Absent appropriate market solutions proposing either transmission or nontransmission alternatives, the ISO is authorized to engage in the development of transmission solutions.

The future performance of the system under projected operating conditions over a 10-year period is periodically reviewed. To perform these evaluations, analytical modeling software simulates the systemwide performance of the transmission system. These models are designed to simulate load-flow patterns and loading characteristics across the system.

The simulation software makes it possible to run a series of "what if" scenarios to analyze the impact of a contingency event on the transmission system and to test various operational adjustments that could be implemented to address any inadequacies discovered as a result of the contingency analysis. These adjustments typically include system reconfigurations, phase-angle regulator adjustments, fast-response unit dispatch, and load transfers between substations or transmission circuits. If the model shows that the transmission system would experience violations even with those adjustments in place, a reliability issue must be addressed through a more significant effort (i.e., the addition or upgrade of transmission facilities). Models were developed to test various alternatives for mitigating the reliability concern.

Because a relatively long lead-time is involved in identifying, planning, and implementing transmission line additions and upgrades, the 10-year planning-process horizon is designed to provide sufficient time to identify and plan for needed large-scale system changes, additions, or upgrades. However, the 10-year horizon also involves a significant amount of uncertainty as to the impact of future events, load-growth trends, and local area load growth on the system.

2.2 Planning Standards and Criteria

The ISO is responsible for dispatching generation and conducting the day-to-day operation of the integrated transmission system. It operates the various transmission systems owned by electric utilities in New England as a single transmission system. The performance of the New England transmission system must adhere to reliability standards and criteria established by NERC, NPCC, and the ISO, which ensure the electric power systems serving New England are appropriately designed to provide an adequate and reliable electric power delivery system.

These standards are under the purview of NERC, which has national authority to ensure the reliability of transmission systems across the United States.[3] NERC oversees a number of regional councils, one of which is the NPCC. The NPCC covers New York, New England, and Canada. Under this framework, NERC has established a general set of rules and criteria applicable to all geographic areas. NPCC has established a set of rules and criteria particular to the Northeast, although they also encompass the more general NERC standards. In turn, ISO New England has developed standards and criteria specific to New England that coordinate with the NPCC rules. Similar standards exist throughout the nation and other portions of North America.

Whether developed by NERC, NPCC, or the ISO, the standards and criteria applicable to the New England transmission system are applied in a deterministic fashion to assess the ability for 115 kV and 345 kV transmission systems to perform under contingency situations. Specifically, these standards and criteria dictate a set of operating circumstances or contingencies under which the New England transmission system must perform without experiencing thermal overloads, voltages below limits, or loss of synchronism. For NPCC, these performance measurements are set forth in *Basic Criteria for the Design and Operation of Interconnected Power Systems* (revised May 2004) (NPCC standards). For the ISO, these measurements are set forth in PP 3, which are used to plan the interconnected electrical network (generators and transmission circuits).

Both NPCC and ISO standards establish that the electric transmission system must pass specific tests to comply with the established criteria. These tests take into account historical data and occurrences and include an examination of the following:

- **Area Transmission Requirements:** Is the area transmission system capable of delivering the necessary generation to the system load under anticipated facility outage events? (PP 3, Section 3)
- **Transmission Transfer Capability:** Is the interconnected transmission system designed with adequate capability to transfer power within the ISO New England Control Area and between ISO New England and neighboring control areas? (PP 3, Section 4)

ISO Planning Procedure 3 states that:

> "The bulk power system should be designed and operated to a level of reliability such that the loss of a major portion of the system, or unintentional separation of a major portion of the system, should not result from any reasonably foreseeable contingencies. . . . Analyses of simulations of these contingencies should include assessment of the potential for widespread cascading outages due to overloads, instability or voltage collapse."[4]

The standards specifically define "reasonably foreseeable contingencies" that must be tested and the conditions under which these contingencies must be evaluated.[5] These circumstances generally

[3] *The Energy Policy Act of 2005* authorized the creation of a self-regulatory electric reliability organization (ERO) that spans North America, with Federal Energy Regulatory Commission (FERC) oversight in the United States. On July 20, 2006, FERC issued an order certifying NERC as the ERO for the United States.

[4] ISO New England Planning Procedure No. 3, *Reliability Standards for the New England Area Bulk Power Supply System*, February 1, 2005, Pg. 2.

[5] Ibid., Pg. 4

consider the loss of transmission system elements and the availability (or unavailability) of generating resources.

The New England transmission system is operated with sufficient capacity to serve area loads under normal operating conditions, as well as facility outage conditions. These outages, referred to as “contingencies,” are planned or unplanned events wherein a transmission element, substation transformer, or autotransformer is out of service. The reliability criteria specify that system voltages and transmission line and equipment loadings should be within applicable normal and emergency limits under a set of predefined conditions.[6]

To determine whether the system complies with the applicable criteria, analytical models are built to represent the existing system configuration and capabilities. These models then undergo contingency testing (i.e., the loss of one or more elements). Specifically, the criteria require a simulation of system performance in the event of an N-1 (single) contingency, which is the base system minus one element. For example, an N-1 contingency would occur when a transmission line is forced out of service because of a lightning strike or a fallen tree, for example. To perform this analysis, an exhaustive list of the transmission elements on the system is compiled. The elements include transmission lines, transformers, and breakers. A series of simulations are run to test the system with each of these individual elements taken out of service (contingencies). The simulations are used to monitor the power flows on all other elements in the event of each contingency and to technically evaluate the system’s capacity to meet normal and emergency operating requirements.

Events that include the outage of two transmission elements (N-1-1 contingency analyses) also are performed to evaluate the transmission system capabilities in each area. These analyses assess the performance of the system assuming the base-case condition minus two major resources, such as a loss of one transmission system element followed by the loss of a second transmission system element (assuming available resources are adjusted between outages). To the extent that the analysis determines an area’s resources to be inadequate under contingency conditions, it also identifies the increase in transmission capacity or level of area resources needed in these conditions to avoid being short of supply. Area resources can be added either by adding new supply-side resources or new transmission capacity. The addition of transmission capacity improvements to address the traditional reliability concerns associated with N-1 contingencies also may provide added capacity in support of N-1-1 area supply issues.

[6] Ibid.

Section 3
Assessment of Projected Southern New England System Performance

The study included the entire State of Connecticut and the State of Rhode Island as well as the Springfield area system. Previous analysis revealed the interrelationships that exist between these areas. For example, the power-transfer capability for the State of Connecticut is directly affected by the requirements and constraints of the Rhode Island and Springfield area supply systems. As indicated in Section 3.1 and Section 3.2, each area has its own set of resource requirements and transfer limits, and as shown in the results section (Section 3.3), their own set of reliability concerns. The analyses discussed in this section are based on tests of the projected system performance for the three study areas assuming the system would have no major transmission system upgrades beyond those currently planned (see list below) or extensive generation additions beyond those already installed.

The load levels tested include the 2009 and the 2016 peak-load conditions for summer based on the ISO's most recently available system load forecast (90/10) at the time of the study. Planned transmission upgrades expected to occur prior to 2009 were included in the base case. (At the initiation of the study, all the southwest Connecticut system upgrades were scheduled to be in place before summer 2009.) Subsequent discussion details the load, generation, and transmission system transfer capabilities assessed for the base-case conditions.

Additionally, all the projects listed below were included in the base-case models used to assess system performance and were considered as being in service before the implementation of the upgrades proposed in this analysis.

- Southwest Connecticut Phase I and II Projects
- Boston 345 kV Transmission Reliability Project
- Northeast Reliability Interconnection Project
- Northwest Vermont Reliability Projects
- Central Massachusetts Reliability Projects
- Southwest Rhode Island Reliability Projects
- Barbour Hill Reliability Project
- Killingly Reliability Project

3.1 Area Transmission and Projected Transfer-Capability Requirements

Table 3-1 and Table 3-2 summarize the load, generation, resource assumptions, transfer requirements, and transfer capabilities for the study areas. The interfaces used for Rhode Island and Springfield were defined for the purpose of conducting the reliability assessments and are not interfaces used for operational purposes. Similarly, the loads defined for these areas were based on the loads encompassed by the study interfaces and do not necessarily match any currently defined subareas of the system.

The resource assumptions consider likely generation additions, generation retirements based on a 60-year age limit, and equivalent forced outage rates (EFOR) based on typical EFOR statistical performance for each of the areas of concern. The new generation additions for Connecticut were based on the assumption that 500 MW of additional generation is fully operational by 2016. The Connecticut power-transfer capabilities are based on an assumption that the Springfield transmission system constraints are not limiting as they apply to Connecticut import capabilities.

The data in Table 3-1 and Table 3-2 suggest that certain areas in the southern New England system are of concern at present and that all areas analyzed will experience substantial reliability concerns by 2016. Specifically, these tables assess the resource requirements and adequacy for each of the areas under study and include the following items:

- *Area loads*—The projected area peak loads are identified on the basis of the ISO's 2005 90/10 forecast. These forecast loads are the loads that are encompassed by the interfaces being studied and do not necessarily align with state or ISO zone boundaries.
- *Existing capacity*—The existing generation capacity values are based on the summer claimed capability values in the *2005 Capacity, Energy, Load and Transmission (CELT) report*.[7]
- *Retirements*—The retirement values were determined based on an assumption that generation units greater than 60 years old would no longer be available.
- *EFOR*—The EFOR values are based on calculated values for the equivalent forced outage rate for units in the specified areas.
- *Unavailable generation*—The unavailable generation values are derived from the values of the largest unit in the area. Under emergency import conditions, the largest unit is assumed to be available and import capability is based on loss of two transmission elements.
- *New generation*—As stated above, new generation for Connecticut was assumed to be 500 MW based on the likelihood that either one large unit, such as the Kleen Project, or a number of smaller ones would be in service by 2016.
- *Total resource*—Total resource values are based on the net sum of existing capacity plus new generation less retirements, EFOR, and unavailable generation.
- *Transfer required*—Comparing the total area resource value with projected peak loads provides the transfer levels that would be needed to serve area peak loads.
- *Existing transfer capability*—Existing transfer capabilities are based on today's values as derived through the studies.
- *Load margin/(deficiency)*—The load margin is the amount of additional load that can be supplied reliably. Conversely, the load deficiency is the amount of load that cannot be supplied reliably.

[7] *2005– 2014 Forecast of Capacity, Energy, Loads, and Transmission*. Available on line at http://www.iso-ne.com/trans/celt/report/2005/2005_celt_report.pdf (Holyoke, MA: ISO New England, April 2005).

Table 3-1
Summary of 2009 Area Requirements

	CT Normal	CT Emergency	RI Normal	RI Emergency	Springfld Normal	Springfld Emergency
2009 area load 90/10 [(a)]	8,065	8,065	1,883	1,883	1,015	1,015
Existing capacity	6,797	6,797	1,016	1016	874	874
Retirements >60 yrs old	-81	-81	0	0	-31	-31
EFOR	-501	-501	-23	-43	-60	-70
Unavailable generation	-1,200	0	-515	0	-231	0
New generation	0	0	0	0	0	0
Total resource	5,015	6,215	478	993	552	773
Transfer required	3,050	1,850	1,405	910	463	242
Existing transfer capability	2,500	1,220	1420	900	446[(b)]	326[(b)]
Load margin/(deficiency)	(550)	(630)	15	(10)	(17)	84

(a) This analysis is based on the ISO's April 2005 published peak-load forecast.

(b) The import values exclude constraints associated with 115 kV double-circuit tower contingencies that are not normally used in daily operation of the system. Thus, transfer capability into the Springfield load pocket would be greatly reduced if these design contingencies were included.

Table 3-2
Summary of 2016 Area Requirements

	CT Normal	CT Emergency	RI Normal	RI Emergency	Springfld Normal	Springfld Emergency
2016 area load 90/10 [(a)]	8,970	8,970	2,085	2,085	1,135	1,135
Existing capacity	6,797	6,797	1,016	1,016	874	874
Retirements >60 yrs old	-204	-204	0/0	0/0	-31	-31
EFOR	-501	-501	-30	-50	-60	-70
Unavailable generation	-1,200	0	-515	0	-231	0
New generation	500	500	0	0	0	0
Total resource	5,392	6,592	471	966	552	773
Transfer required	3,578	2,378	1,614	1,119	583	362
Existing transfer capability	2,500	1,220	1370	865	205[(b)]	274[(b)]
Load margin/(deficiency)	(1078)	(1158)	(244)	(254)	(378)	(88)

(a) This analysis is based on the ISO's April 2005 published peak-load forecast.

(b) The import values exclude constraints associated with 115 kV double-circuit tower contingencies that are not normally used in daily operation of the system. Thus, transfer capability into the Springfield load pocket would be greatly reduced if these design contingencies were included.

3.2 Interface Transfer Limits

The transmission system interfaces that define each of the study areas for this analysis are summarized below. The interfaces described may not be identical to interfaces that system operators currently use for the day-to-day management of system resources under varying system conditions. The Connecticut import interface is commonly used in daily system operations; however, the Rhode Island and Springfield interfaces were developed for this study and were based on the limiting transmission elements of their boundaries.

3.2.1 Connecticut Power-Transfer Limits

For these studies, the set of transmission system elements shown in Table 3-3 define the Connecticut import area.

Table 3-3
Connecticut Import Interface Definition

Line #	Transmission Element				% of Interface Flow
	From Bus Name	kV	To Bus Name	kV	
395	Ludlow	345	Meekville Junction	345	30.0
330	Lake Rd.	345	Card	345	29.08
	Killingly	345	Killingly	115	5.5
398	Pleasant Valley	345	CT/NY border	345	23.7
1870	Wood River	115	CT/RI border	115	4.1
1768	Southwick	115	North Bloomfield	115	2.4
1830	South Agawam	115	North Bloomfield	115	2.6
1821	South Agawam	115	North Bloomfield	115	2.6

The Connecticut import interface as defined in Table 3-3 is capable of reliably supporting import levels of 2,500 MW. As shown, the 395 and 330 lines carry approximately 60% of the Connecticut import flows under typical dispatch conditions. The projected Connecticut resource requirements indicate that the existing transmission infrastructure will not be sufficient to support future import requirements.

3.2.2 Rhode Island Power-Transfer Limits

For these studies, the set of transmission system elements shown in Table 3-4 define the Rhode Island import area.

Table 3-4
Rhode Island Import Interface Definition

Line #	From Bus	From kV	To Bus	To kV	Ckt ID	% of Interface Flow
175X	West Farnum	345	West Farnum	115	1	13.5
174X	West Farnum	345	West Farnum	115	2	19.5
3X	Kent County	345	Kent County	115	1	32.8
W4	Somerset	115	Swansea	115	1	4.4
T7	Somerset	115	Pawtucket	115	1	3.5
X3	Somerset	115	Phillipsdale	115	1	3.9
1870	CT/RI border	115	Wood River	115	1	-2.8[a]
Q143	Millbury	115	Whitins Pond	115	1	-3.2
R144	Millbury	115	Woonsocket	115	1	-6.1
E183	Brayton Point	115	Warren 83	115	1	13.3
F184	Brayton Point	115	Warren 84	115	1	21.0

(a) The negative numbers indicate that flows on these elements are generally in the export direction.

The import capability of these facilities is approximately 1,420 MW in 2009, which is reduced to 1,370 MW in 2016 as a result of load growth. About 65% of the flows into the area are delivered through three 345 kV to 115 kV autotransformers, and another 30 to 35% is delivered via the Brayton Point 115 kV station.

3.2.3 Springfield Power-Transfer Limits

For these studies, the set of transmission system elements shown in Table 3-5 define the Springfield import area.

Table 3-5
Springfield Import Interface Definition

	Transmission Element				% of Interface Flow [a]
Line #	**From Bus**	**kV**	**To Bus**	**kV**	
1421	Pleasant	115	Blandford	115	5.1
1768	North Bloomfield	115	Southwick	115	5.7
1481	Ludlow	115	East Springfield	115	15.8
1552	Ludlow	115	Orchard	115	13.2
1845	Ludlow	115	Shawinigan	115	36.0
1515	Ludlow	115	Scitico	115	6.2
1821	North Bloomfield	115	South Agawam	115	9.0
1836	North Bloomfield	115	South Agawam	115	9.0

(a) The percent flow values vary as a function of Connecticut import levels.

The import capability of the Springfield facilities is approximately 450 MW in 2009 and, as a result of load growth, is reduced to 200 MW in 2016. About 65% of the flows into the area are delivered through three 115 kV lines emanating from the Ludlow substation.

3.3 Results of Transmission Reliability Analysis

This section describes the results of the 2009 analysis concerning the reliability performance of the transmission systems in Connecticut, Springfield, and Rhode Island. These results are based on assessments of the transmission system under projected load and generation conditions as established for these areas at the time of the study. *Not all of the reliability violations found are being included in the descriptions, tables, and diagrams that follow. Results noted in subsequent sections are obtained using only sample, representative system conditions. A wide variety of other probable system conditions also were analyzed, the results for which are not described herein.*

Also, “all-lines-in” refers to an N-1 (first-contingency) analysis, and “lines-out” refers to an N-1-1 (second-contingency) analysis. Both analyses are dictated by criteria.

3.3.1 Connecticut Power-Transfer Concerns

The 2009 resource requirements for the Connecticut area demonstrate the need for improvements to the area’s import capability, generating resources, or a combination of both. Some improvement in import capability can be obtained by mitigating the limitations associated with the Springfield area. However these improvements are still insufficient to meet the projected supply resource requirements for the 2009 Connecticut peak-load conditions. Limitations of the Connecticut import capabilities are a result of insufficient available 345 kV transmission capacity. This can be seen through simulation of 345 kV contingencies associated with the Connecticut interface. Loss of major 345 kV transmission lines on the interface results in overloads of the underlying 115 kV transmission. This problem is most prevalent in the Springfield area and, as shown in Table 3-6 and Table 3-7, a number of Springfield area 115 kV transmission facilities would overload from the loss of a major 345 kV line under the simulated import conditions.

Table 3-6
Connecticut Transmission Line Overloads, 2009 Peak Load, All-Lines-In (N-1)

Worst Scenario		Overloaded Elements						
Generator Out of Service	**Contingency**	**Line/ Auto**	**From Bus**	**From kV**	**To Bus**	**To kV**	**Rating**	**Max Loading (%) Over Rating**
Largest generator unavailable **Average EFOR** **One unit retired**	This data has been redacted and may be accessed by calling ISO New England Customer Service at (413) 540-4220.		ANP Blackstone	345	Sherman Road	345	1400	110.9
			Sherman Road	345	CT/RI	345	1618	109.6
			Carpenter Hill	345	Millbury	345	1405	102.2
			Ludlow	345	Barbour Hill autotrans.	345	1604	121.9
			Barbour Hill autotrans.	345	Meekville Junction	345	1604	103.1
			Bloomfield Junction	115	Northwest Hartford	115	228	114.7

Table 3-7
Connecticut Transmission Line Overloads, 2009 Peak Load, Line-Out (N-1-1)

Worst Scenario			Overloaded Element						
Generator Out of Service	**Line/Auto Out of Service**	**Contingency**	**Line/ Auto**	**From Bus**	**From kV**	**To Bus**	**To kV**	**Rating**	**Max Loading (%) Over Rating**
Average EFOR **One unit retired**	This data has been redacted and may be accessed by calling ISO New England Customer Service at (413) 540-4220.		Ludlow autotrans.	Ludlow	345	Ludlow	115	705	124.0
			371	Montville	345	Millstone	345	1793	112.7
			364	Montville	345	Haddam Neck	345	1912	114.7
			348	Millstone	345	Haddam autotrans.	345	1912	112.5
			353	Manchester	345	Portland Junction	345	1446	108.9
			1207	Manchester	115	East Hartford	115	382	101.1
			1777	North Bloomfield	115	Bloomfield	115	228	106.0
			1751	Bloomfield Junction	115	Northwest Hartford	115	228	131.0

Consequently, significant improvement in Connecticut's power-transfer capability is essential for maintaining an adequate and reliable level of supply resource for the Connecticut area beginning in 2009 and beyond. The risk of system disruptions increases as the in-service date for such improvements is postponed beyond 2009.

Table 3-6 shows that elements of the Connecticut area transmission system overload for the 2009 system at a power-transfer level of 3,050 MW, which is the transfer level required per Table 3-1 to ensure system security. Transmission line overloads specific to the Springfield area are not included in Tables 3-6 and 3-7 but are addressed in Section 3.3.3. The line overload summary tables in this section show only the most severe overload contingency conditions and do not list all of the outage conditions that may overload the element shown. In many cases, numerous outage events may overload the elements shown. Additionally, more significant N-1-1 overloads are not shown here because of the special protection system (SPS) that backs down the Millstone plant output for certain contingency conditions

Figure 3-1 and Figure 3-2 are one-line 345 kV diagrams that display these overloads.

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and may be accessed by calling
ISO New England Customer Service
at (413) 540-4220.

Figure 3-1: 2009 Connecticut transmission line overloads, N-1.

This graphic has been redacted
and may be accessed by calling
ISO New England Customer Service
at (413) 540-4220.

Figure 3-2: 2009 Connecticut transmission line overloads, N-1-1.

3.3.2 Rhode Island Area Transmission Reliability Concerns

Transmission system reliability and dependence on local generation are the major concerns for the Greater Rhode Island area. A number of steady-state thermal and voltage violations have been observed on the transmission facilities while analyzing the conditions for the 2009 system.

The reliability problems on the Rhode Island 115 kV system are caused by a number of contributing factors (both independently and in combination), including high load growth (especially in southwestern Rhode Island and the coastal communities), generation unit availability, and transmission outages (planned or unplanned). Additionally, the Rhode Island 115 kV system is constrained when one of the Greater Rhode Island 345 kV lines is out of service. The 345 kV transmission lines critical for serving load in the Rhode Island 115 kV system are as follows:

- Line 328 (Sherman Rd–West Farnum)
- Line 332 (West Farnum–Kent County)
- Line 315 (West Farnum–Brayton Point)
- Line 303 (ANP Bellingham–Brayton Point)

Outage of any of these transmission lines result in limits to power transfer into Rhode Island. For line-out conditions, the next critical contingency would involve a loss of a 345/115 kV autotransformer or the loss of a second 345 kV tie.

The contingency testing for transmission system outages for the Rhode Island system, as summarized in Table 3-8 and Table 3-9, were run for the 2009 system and represented the extreme summer forecast (90/10) peak-load levels. They were run with the Connecticut import operating at its required level (per Table 3-1), 3,050 MW (normal) and 1,850 MW (emergency), given projected load and generation conditions in Connecticut. For the N-1 analysis, the largest unit in the area was considered unavailable, as was the equivalent forced outage of other area generation. For the N-1-1 analysis, only the equivalent forced outage generation was considered unavailable. Table 3-8 and Table 3-9 show the most severe overload contingency conditions only and do not list all the outage conditions that may overload the element shown. In many cases, numerous outage events may overload the elements shown.

Table 3-8
Rhode Island Line Overloads, 2009 Peak Load,
All-Lines-In (N-1), One Generator Out of Service

	Overloaded Elements						
Worst Contingency	**Line/Auto**	**From Bus**	**From KV**	**To Bus**	**To kV**	**Rating (MVA)**	**Loading (%)**
This data has been redacted and may be accessed by calling ISO New England Customer Service at (413) 540-4220.	Kent Co. 3 transformer	Kent Co.	345	Kent Co.	115	478	101.4
	E-105	Franklin Square	115	Hartford Ave.	115	240	145.7
	F-106	Franklin Square	115	Hartford Ave.	115	240	145.7
	T3	Somerset	115	Pawtucket	115	128	121.1
	G-185 N	Drumrock	115	Kent T1	115	286	116.3
	C-181 S	Brayton Point	115	Chartley Pond	115	268	115.2
	J-188	Drumrock	115	Kilvert T8	115	218	112.0
	Kent Co. 3 transformer	Kent Co.	345	Kent Co.	115	550	109.4
	E-183 E	Brayton Point	115	Warren 83	115	410	104.9
	I-187	Drumrock	115	Amtrak 187	115	218	102.0
	S-171 S	Johnston 171	115	Hartford Ave.	115	426	101.6

Table 3-9
Rhode Island Line Overloads, 2009 Peak Load,
Line-Out (N-1-1), No Generation Out of Service

		Overloaded Elements						
Line Out of Service	**Worst Contingency**	**Line/Auto**	**From Bus**	**From KV**	**To Bus**	**To kV**	**Rating (MVA)**	**Loading (%)**
This data has been redacted and may be accessed by calling ISO New England Customer Service at (413) 540-4220.		S-171 S	Rise 171	115	West Cranston 71	115	449	229.3
		T-172 S	West Cranston 72	115	Rise 172	115	449	227.6
		S-171 S	Drumrock	115	West Cranston 71	115	449	216.4
		T-172-S	Drumrock	115	West Cranston 72	115	449	214.7
		F-106	Franklin Square	115	Hartford Ave.	115	240	182.5
		E-105	Franklin Square	115	Hartford Ave.	115	240	178.4
		S-171 S	Johnston 171	115	Hartford Ave.	115	426	151.1
		G-185 N	Drumrock	115	Kent T1	115	286	146.7
		P-142 S	Wyman Gordan TP42	115	Millbury	115	141	133.8
		T-172 S	Johnston 172	115	Rise 172	115	449	126.0
		S-171 S	Johnston 171	115	Rise 171	115	449	125.6
		Rise Tap	Rise 171	115	Rise	115	550	124.4
		Rise Tap	Rise 172	115	Rise	115	550	124.2
		T7	Somerset	115	Pawtucket	115	128	121.1
		1870-S	Wood River	115	CT/RI 1870	115	218	114.6
		J-188	Drumrock	115	Kilvert T8	115	218	111.3
		D-182 S	Brayton Point	115	Mansfield 82	115	283	107.5
		Brayton Point 3B Transformer	Brayton Point	345	Brayton Point	115	361	106.1
		K-189	Drumrock	115	Kent T7	115	359	104.4
		Kent Co. 3 Transformer	Kent Co.	345	Kent Co.	115	550	103.1
		F-184	Brayton Point	115	Warren 84	115	370	100.9
		W4	Somerset	115	Swansea	115	165	100.9
		Brayton Point T3	Brayton Point	115	Brayton Point T3 MID	99	561	100.8
		I-187	Drumrock	115	Amtrak 187	115	218	100.5

Each of these criteria violations are made worse by the unavailability of local area generation and transmission outages (line-out conditions). Figure 3-3 to Figure 3-5 depict a sampling of the Rhode Island reliability violations.

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Figure 3-3: 2009 Rhode Island reliability problems, N-1 thermal overloads.

This graphic has been redacted
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Figure 3-4: 2009 Rhode Island low voltages for an area “design” contingency.

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and may be accessed by calling
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at (413) 540-4220.

Figure 3-5: 2009 Rhode Island reliability problems, N-1-1 thermal overloads.

3.3.3 Springfield Area Transmission Reliability Concerns

The Springfield area faces a number of reliability concerns. Many local single outages, double-circuit tower outages and stuck breaker outages result in severe line overloads and low voltages in the Springfield area.

Additionally, the Springfield 115 kV transmission system is one of the paths for transporting power into Connecticut. The flow of power through the Springfield 115 kV system increases when the major 345 kV tie line between western Massachusetts and Connecticut (the Ludlow–Manchester–North Bloomfield 345 kV line) is open as a result of a forced or planned outage. For all years simulated, this leads to the appearance of numerous overloads on the Springfield 115 kV system, and increased Connecticut imports aggravate the thermal loadings in Springfield.

Overall, the severity, number, and location of the Springfield overloads or low-voltage conditions highly depend on the area's generation dispatch. These dependencies are illustrated in Figure 3-6 through Figure 3-9. The number of violations in the tables below indicates the number of transmission circuits that overload. Each transmission circuit may overload for multiple contingencies.

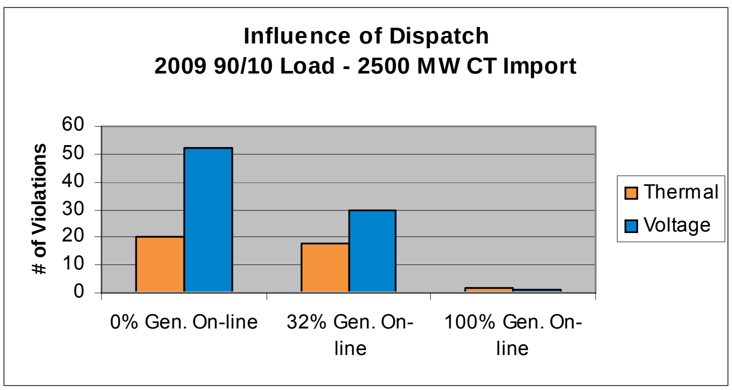

Figure 3-6: Influence of dispatch on Springfield violations—number of violations.

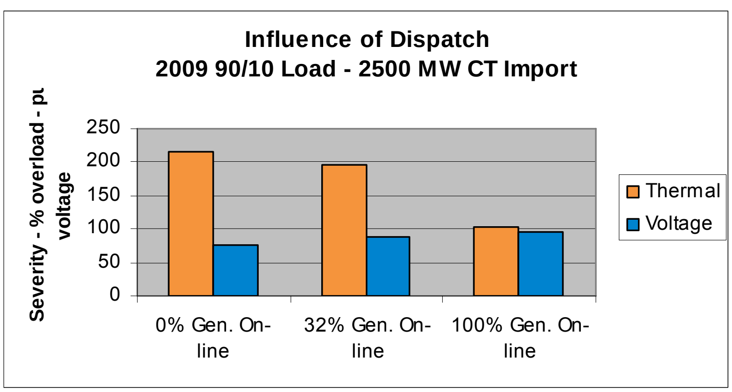

Figure 3-7: Influence of dispatch on Springfield violations—severity of violations.

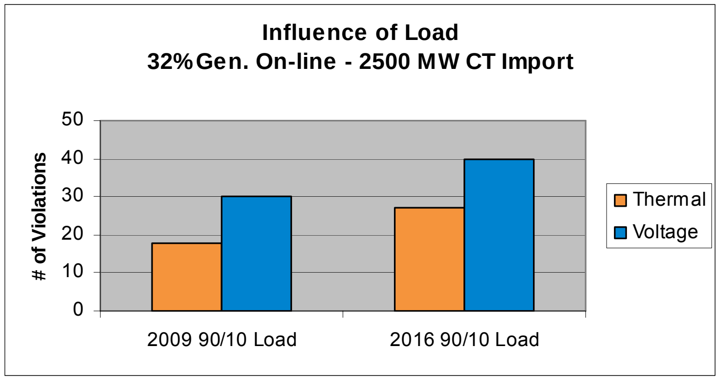

Figure 3-8: Influence of load on Springfield violations—number of violations.

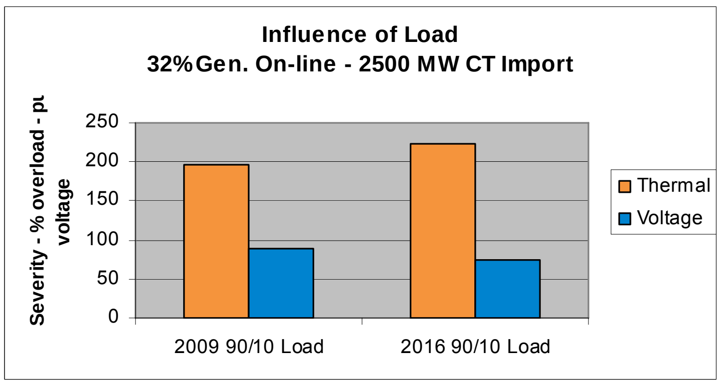

Figure 3-9: Influence of load on Springfield violations—severity of violations.

The above analysis indicates that network constraints in the Springfield area limit the ability to serve load under contingency conditions and also limit the Connecticut import capability through Springfield under certain area dispatch conditions.

The specific overload and voltage violation conditions are summarized in Table 3-10 through Table 3-12. The line overload summary tables in this section only show the most severe overload contingency conditions and do not list all of the outage conditions that may overload the element shown. In many cases, numerous outage events may overload the elements shown.

Table 3-10
Springfield Line Overloads, 2009 Peak Load, All-Lines-In (N-1)

Worst Scenario		Overload Elements						
Generator Out of Service	**Contingency**	**Line/Auto**	**From Bus**	**From kV**	**To Bus**	**To kV**	**Rating**	**Max Loading (%) Over Rating**
This data has been redacted and may be accessed by calling ISO New England Customer Service at (413) 540-4220.		1254	East Springfield Junction 1254	115	Chicopee	115	265	111.6
		1254	East Springfield Junction 1254	115	Freemont South	115	282	101.9
		1254	East Springfield Junction 1254	115	Shawinigan	115	382	152.3
		1512	Southwick	115	Granville Junction	115	191	101.8
		1768	Southwick	115	North Bloomfield	115	165	100.3
		1433	West Springfield	115	Breckwood	115	140	249.9
		1314	Agawam	115	Chicopee	115	228	105.7
		1322	Breckwood	115	East Springfield	115	141	295.3
		1481	East Springfield	115	Ludlow	115	289	117.4
		1552	Orchard	115	Ludlow	115	305	101.0
		1845	Ludlow	115	Shawinigan	115	311	107.7
		1723	Piper Rd.	115	East Springfield Junction 1723	115	164	113.3

Table 3-11
Springfield Voltage Violations, 2009 Peak Load, All-Lines-In (N-1)

Worst Scenario		Bus Terminals		
Generator Out of Service	**Contingency**	**Bus**	**Bus kV**	**Low Voltage (per unit)**
This data has been redacted and may be accessed by calling ISO New England Customer Service at (413) 540-4220.		Five Corners 13	115	0.8477
		Five Corners 34	115	0.8463
		Agawam	115	0.9215
		Amherst	115	0.8368
		Breckwood	115	0.9357
		Chicopee	115	0.9033
		Clinton	115	0.924
		Franconia	115	0.9214
		Freemont North	115	0.8485
		Freemont South	115	0.8514
		Gunn	115	0.8588
		Midway	115	0.8534
		Mt. Tom	115	0.8537
		Orchard	115	0.9488
		Piper Rd.	115	0.9131
		Pochassic	115	0.8859
		South Agawam	115	0.948
		South Agawam	115	0.948
		Scitico	115	0.8988
		Silver 81	115	0.9252
		Silver 82	115	0.9252
		South Agawam	115	0.9269
		Southampton	115	0.8666
		West Springfield	115	0.9245

Table 3-12
Springfield Line Overloads, 2009 Peak Load, Line-Out (N-1-1)

Worst Scenario			Overloaded Elements						
Generator Out of Service	Line/Auto Out of Service	Contingency	Line/ Auto	From Bus	From kV	To Bus	To kV	Rating	Max Loading (%) Over Rating
This data has been redacted and may be accessed by calling ISO New England Customer Service at (413) 540-4220.			1512	Blandford	115	Granville Junction	115	147	118.3
			1421	Blandford	115	Pleasant	115	167	112.7
			1322	Breckwood	115	East Springfield	115	141	252.3
			1481	East Springfield	115	Ludlow	115	289	131.6
			1426	East Springfield	115	Orchard	115	311	102.8
			1007	Elm	115	Agawam	115	239	100.9
			1254	East Springfield Junction 1254	115	Freemont South	115	282	108.8
			1254	East Springfield Junction 1254	115	Shawinigan	115	382	137.2
			1525	Holyoke	115	Frreemont South	115	192	107.9
			Auto 1X	Ludlow	345	Ludlow	115	705	110.4
			1552	Orchard	115	Ludlow	115	305	119.9
			1723	Piper Rd.	115	East Springfield Junction 1723	115	164	104.1
			1781	South Agawam	115	Silver 81	115	228	108.6
			1782	South Agawam	115	Silver 82	115	228	108.2
			1512	South wck	115	Granville Junction	115	191	138.0
			1412	West Springfield	115	Agawam	115	143	144.0
			1311	West Springfield	116	Agawam	116	143	144.0
			1433	West Springfield	115	Breckwood	115	140	210.4
			1371	Woodland	115	Pleasant	115	228	109.3

Figure 3-10 to Figure 3-12 of Springfield area transmission display the overloads and low voltages shown above.

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and may be accessed by calling
ISO New England Customer Service
at (413) 540-4220.

Figure 3-10: 2009 Springfield overloads, N-1.

This graphic has been redacted
and may be accessed by calling
ISO New England Customer Service
at (413) 540-4220.

Figure 3-11: 2009 Springfield N-1 low voltages for an area “design” contingency.

This graphic has been redacted
and may be accessed by calling
ISO New England Customer Service
at (413) 540-4220.

Figure 3-12: 2009 Springfield overloads, N-1-1.

3.4 Needs Analysis Conclusions

In summary, this analysis demonstrates that in 2009 area transmission capabilities will be inadequate to meet NERC, NPCC, and ISO New England reliability standards and criteria for the projected load and generation conditions in the Connecticut, Springfield, and Rhode Island areas. These problems, some of which may already exist, become increasingly more severe as peak load continues to grow. The problems enumerated in this report demonstrate a need to construct new transmission facilities to significantly improve the reliability of the transmission grid serving Connecticut, Rhode Island, and western Massachusetts. Given the lead times necessary for permitting and other preconstruction activities, as well as the time required for construction itself, these problems constitute needs that should be addressed now.