

ISO New England Operating Procedure No. 17

Load Power Factor and System Assessment

(Via the Measurement of Reactive Power Interchange with Transmission System)

Effective Date: October 15, 2025

Review By Date: October 15, 2027

References:

ISO New England Operating Procedure No. 5 - Resource Maintenance and Outage Scheduling (OP-5)

ISO New England Operating Procedure No. 12 - Voltage and Reactive Control (OP-12)

ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Response Resources, Asset Related Demands and Alternative Technology Regulation Resources Appendix B – Resource Reactive Capability Data Explanation of Terms and Instructions for Data Preparation for ISO Form NX-12D (OP-14B)

ISO New England Operating Procedure No. 19 - Transmission Operations (OP-19)

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I. INTRODUCTION

This Operating Procedure (OP) establishes the ranges of acceptable load power factor (LPF) for various areas within the New England Control Area, and the responsibilities of the ISO, Transmission Owners (TOs), and Transmission Customers in New England with respect to LPFs. The procedure further defines the reactive power demands of TOs and Transmission Customers and allowable levels of interchange of reactive power to and from the transmission system. This OP also describes the analysis that ISO undertakes to monitor, assess, and report on LPF compliance, as well as the actions required by TOs and Transmission Customers where non-compliance occurs.

This OP is intended to complement other ISO New England Operating Procedures and ensure reliable operation of the transmission system. This OP directly supports the goals of ISO New England Operating Procedure No.19 - Transmission Operation (OP-19), which prescribes criteria for the reliable operation of the transmission system, including voltage and reactive limitations and contingencies, as well as the planning process described in ISO's Planning Procedures and the Tariff.

A. Overview

ISO is responsible for operating all transmission facilities rated 115 kV and above. Local Control Centers (LCCs) are responsible for operating all transmission facilities rated 69 kV and below. To maintain a reliable system, ISO and the LCCs manage the pre-contingent voltage profile of the New England Transmission System¹ and the system's reactive power resources to meet reactive power demands. Managing the reactive power output of energy Resources as well any dynamic and shunt reactive power devices connected to the transmission system helps supply the system's reactive losses and the reactive demand of load served by the system.

One key contributing factor to system voltage is the reactive demand of system load. The reactive demand component of load is often described in terms of LPF. The LPF is, in simple terms, the ratio of real power demand (MW) to apparent power (MVA). LPF, and by association reactive power exchange, is a key study assumption used in long range planning of the transmission system, and it is a key factor in its operation. With the changing power supply mix in New England, there is a need to measure the reactive power exchange, or MVAR interchange, between the transmission and distribution systems on an area by area basis of each TO/Transmission Customer within an area. This approach is helpful due to the tendency of the LPF measurement to become extremely sensitive to small changes in reactive power exchange as the real power demand of a TO/Transmission Customer approaches zero. Significant changes in the MVAR exchange between system load and the transmission system from that assumed in planning studies can lead to out-of-merit Resource commitments to prevent unacceptable high or low system voltages, and potential reliability concerns, when operating the system.

¹ The New England Transmission System is defined in the ISO New England Inc. Transmission, Markets, and Services Tariff (ISO Tariff) and includes the Reliability Coordinator Area/Balancing Authority Area (RCA/BAA), Bulk Electric System (BES) and NPCC bulk power system (BPS) elements found within New England on the transmission network.

B. Responsibilities

ISO monitors MVAR exchange throughout the New England Transmission System by surveying portions of the system defined as LPF Areas in Appendix A – Area Definitions.

Each TO and Transmission Customer shall meet the LPF standards as represented by allowed reactive power exchange by each load serving by area, and by extension MVAR exchange limits (minimum and maximum) specified in the ISO-NE Transmission Planning Technical Guide. The values specified in the ISO-NE Transmission Planning Technical Guide establishes for each TO and Transmission Customer within each LPF Area, its minimum and maximum allowable reactive power interchange with the transmission system. The reactive demand of each TO/Transmission Customer system within an LPF Area will be determined by ISO Planning based on the data provided by the TOs and Transmission Customers, and ISO Operations will monitor all hours for each TO/Transmission Customer within each LPF Area against these reactive power interchange limits.

II. LPF REQUIREMENT

The range of acceptable LPFs within the New England Control Area (described in Appendix A – Area Definitions) are expressed in terms of allowable MVAR interchange to and from the transmission system by each TO and Transmission Customer within an LPF Area. For a specific system load level (see Figure 2), the bandwidth between a pair of limiting curves represents the range of acceptable interchange of MVARs with the transmission system. The maximum and minimum MVAR exchange limits that are used to derive these values are defined in ISONE's Transmission Planning Technical Guide.

- The ISO shall determine these ranges by using the supplied MW and MVAR demands at minimum and maximum loads via planning model submissions and using the MVAR demands to determine the appropriate LPF at intermediate load levels for maximum and minimum load power factor. For example, if a peak system MVAR demand of 50 MVAR is applicable to a TO, that 50 MVAR is used to determine the acceptable LPF for peak and intermediate load levels for the minimum acceptable LPF. At the intermediate load level, with fewer MW of demand, the acceptable MVAR interchange limit will not change..
- The ISO Planning derived MVAR interchange ranges shall have a margin added to each for determination of acceptable performance.
 - For each LPF Area, the margin shall be 20 MVAR.
 - As long as an LPF Area remains at or below its allowable reactive power interchange plus 20 MVARs for all hours, one or more TOs and Transmission Customers may use portions of the margin.
 - Once the use of margin within an LPF Area for any given hour exceeds 20 MVARs total, no TO or Transmission Customer may use the margin in that LPF area and any TO or Transmission Customer using the margin shall be considered non-compliant.
 - For all LPF Areas, the maximum margin shall be 50 MVARs for any hour.

- As long as the sum total of all margin used within a load level (minimum, peak or other) for a given hour remains at or below 50 MVARs, one or more TOs and Transmission Customers may use portions of the margin to achieve compliance.
- Once the sum total of margin used within a load level condition for a given hour exceeds 50 MVARs, no TO or Transmission Customer may use the margin and any TO or Transmission Customer using the margin shall be considered non-compliant.
- The MVAR values measured for calculating the MVAR exchange and the margins used for each LPF area and the overall MVAR exchange for all of the LPF area is absolute instantaneous value at the top of the hour, measured at the low side of transmission distribution transformers OR low side of modeled transformers in the EMS. (It is **NOT** an average value over the period of an hour.)

The use of a MVAR margin to the acceptable reactive power interchange recognizes the difficulty in maintaining reactive power within the defined boundary for every hour of the year. However, because non-compliance by multiple TOs/Transmission Customers has a cumulative impact that can adversely impact reliability, this procedure limits the use of margin on a per LPF Area and total system basis.

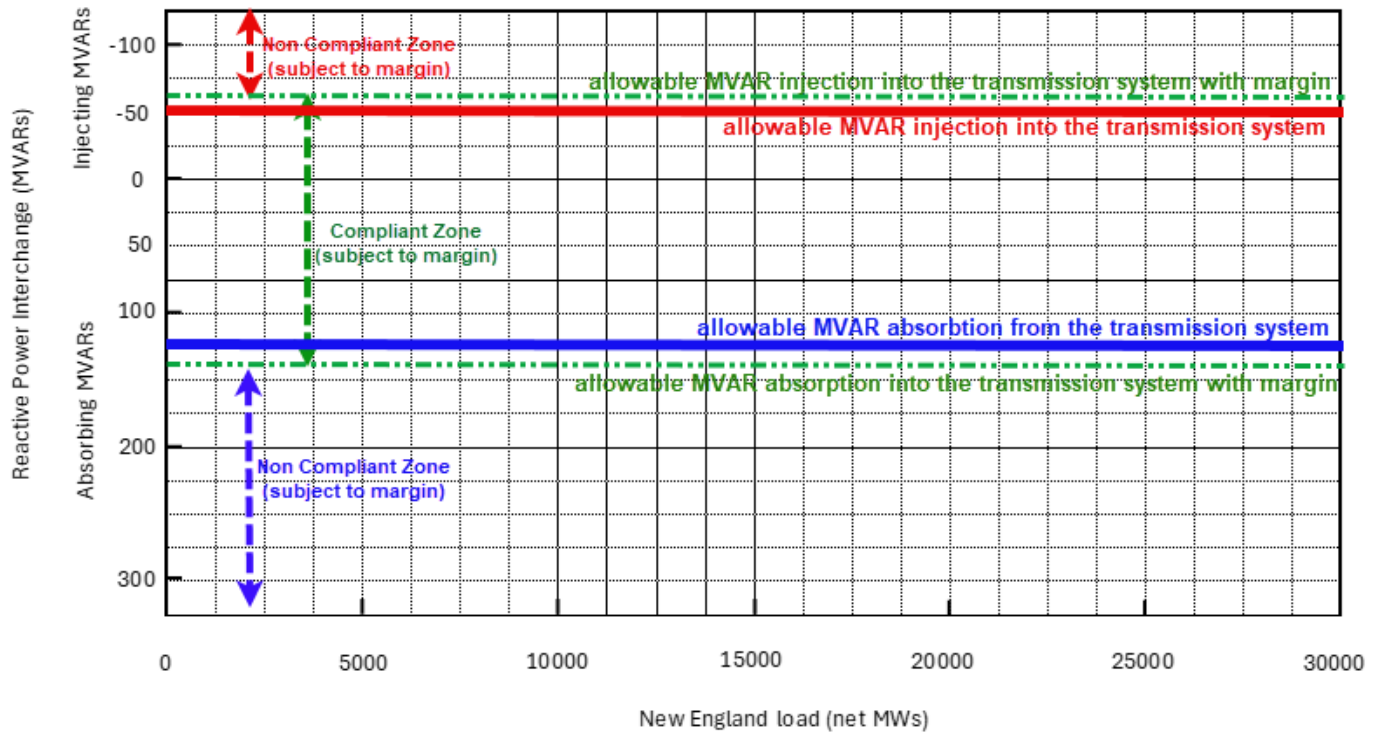
Figure 1, below, provides an example of allowed MVAR interchange to and from a TO/Transmission Customer within an LPF Area. The values shown in Figure 1 are then used to create Figure 2, which shows a graph of the allowable reactive power interchange through the appropriate load levels to achieve reliable system performance based on the Transmission Planning Technical Guide.

The graphs of allowable reactive power interchange are used to determine compliance versus non-compliance. Points that exist above the orange curve (maximum allowable MVAR injection into the transmission system) or below the blue curve (maximum allowable absorption of MVAR from the transmission system) constitute potential non-compliance, depending on magnitude and the ability to use margin.

Figure 1

maximum allowed MVAR injection to transmission system	50 MVAR
maximum allowed MVAR absorption from the system	125 MVAR

Figure 2



Consistent with the ISO Tariff, Transmission Customers have the responsibility to manage reactive demand of all connected distribution loads, and may do so by switching in-or-out-of-service, reactive resources or devices to meet the reactive power interchange requirements. Transmission Owners may, at the expense of the Transmission Customer, install transmission equipment to ensure the Transmission Customer meets reactive power interchange requirements. The ISO will monitor aggregate MVAR exchange for compliance using load at the low side of modeled transformers in the energy management system (EMS), normally as real time state estimated values.

III. LPF SURVEY AND ASSESSMENT PROCEDURE AND EVALUATION

A. LPF Survey

The ISO shall conduct a survey of all TO and Transmission Customer performance in the LPF Areas, annually or more frequently as circumstances may dictate. The survey will use load information in the energy management system to determine reactive power interchange performance compared to system planning established MVAR exchange limits for the TOs and Transmission Customers.

The ISO shall perform the LPF survey, calculate the reactive demands and reactive power interchange with the transmission system, evaluate the reactive power interchange compliance, review trends and share the results with the Voltage Task Force (VTF), M/LCC Heads and NEPOOL Reliability Committee. The ISO is responsible for collecting the data, sharing the data as needed and in accordance with the ISO New England Information Policy. The ISO may request additional data

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from TOs and/or Transmission Customers to complete this analysis. The TOs and Transmission Customers are required to provide the requested data to the ISO within the timeframes specified in Section IV.a of this procedure.

The TOs and Transmission Customers are responsible for reviewing the LPF survey results for their load and shall provide additional data if requested by the ISO, to determine the load entity or entities that were non-compliant. Transmission Customers are responsible for developing corrective actions when their load within an area is determined to be non-compliant.

The LPF Areas will continue to exist to specify where one or more TOs/Transmission Customers are not providing acceptable LPF performance.

The information gained from performing the reactive power interchange assessment, if appropriate, may then be used by the ISO to create and update system models for conducting system studies and creating new operating voltage guides, as appropriate.

B. LPF Assessment or Reliability Review

The ISO and LCC's VTF members (as needed) shall review performance and other information when assessing if a change in LPF Area definition is warranted. Any resulting change in the LPF Areas will then be used for any succeeding LPF assessments to determine which TOs/Transmission Customers within each area are compliant and which are not.

The allowable reactive power interchange standard is defined as a boundary that will be defined as two horizontal lines representing maximum and minimum MVAR exchange limits that will apply for the entire range of system net load level combinations. The area on one side of the curve denotes unacceptable performance while the other side yields acceptable performance. Allowable reactive power interchange curves shall be established using the real and reactive power demands via the LPF limits contained in the Transmission Planning Technical Guide.

Allowable reactive power interchange assessments determine the level of shunt compensation required to return the area in question to compliance. The assessment determines the change in shunt capacitance, or reactance, to return the area's reactive power interchange to within the defining curves for a low voltage, or high voltage, exceedance, respectively. These shunt compensation levels are reasonable estimates of the net relative change in area power factor that would need to occur to return the area to LPF compliance.

The ISO shall annually provide a report to the M/LCC Heads and NEPOOL Reliability Committee on LPF compliance by TO/Transmission Customer within each LPF Area and highlight future reactive targets. The report shall also include a summary of the LPF/reactive power interchange survey, assessment or reliability review and list the non-compliance notifications issued by the ISO.

For those TOs/Transmission Customers that exceed their allowable reactive power interchange limits, the following will occur:

- If TO/Transmission Customer reactive power exchange (after consideration of margin, if allowed) is outside of the reactive power exchange allowed by their MVAR exchange limits, the TO and Transmission Customer shall implement the actions listed in Section IV.b of this procedure.
- If an LPF Area exceeds the margin set for a single area or if the system as a whole exceeds the system margin limit, to achieve acceptable LPF performance, no TO/Transmission Customer within either the LPF Area or system as a whole can use margin for LPF compliance. Section II of this procedure provides additional detail on the allowable margin.

For compliance monitoring, the distribution stations will be aggregated by TO/Transmission Customer and LPF Area, and the sum of the MVAR exchanges at each distribution station will be used to calculate the aggregate MVAR exchange for each TO/Transmission Customer by LPF Area.

IV. DEMONSTRATION OF NON-COMPLIANCE AND COMPLIANCE ACTIONS

a. Non Compliance Letter

Where the LPF / reactive power interchange assessment finds that a TO or Transmission Customer in an LPF Area violates the MVAR exchange limits established in the Transmission Planning Technical Guide (after accounting for margin, if allowed), the ISO will issue a letter to the Transmission Customer Contacts (as recorded in Appendix C – Instructions for the ISO New England Load Power Factor Survey (OP-17C)) of the non-compliant TO or Transmission Customer within that LPF Area within 90 days of the completion of the assessment, which the ISO shall complete by the end of Q1 of each calendar year.

Prior to sending the letter, the ISO shall send a request to the LCC to confirm the TOs/Transmission Customer and Transmission Customer Contacts in a non-compliant area, within seven (7) Business Days. TO contacts are included within the Transmission Customer Contact list. The LCC shall confirm or correct the list of TOs and Transmission Customers and Transmission Customer Contacts in the non-compliant area within seven (7) Business Days of receipt of the list.

In the letter, the ISO shall identify specific hours of MVAR exchange exceedances to provide a potential starting or focus point for the TO's/Transmission Customers' investigation. The exceedance hours will represent up to 10 unique days of the highest MVAR surplus or deficiency. The hour of the highest MVAR surplus or deficiency of that day will also be identified. For example, if one day contains the three highest surplus hours for the year, only the highest surplus hour of that day will be listed in the letter.

In the letter, the ISO shall also direct the non-compliant TO/Transmission Customer to evaluate their individual LPF performance, and to propose mitigating actions to improve MVAR interchange performance.

b. Mitigation and Compliance Plan(s)

Within 90 Calendar Days following receipt of the letter, each TO/Transmission Customer that is found to be non-compliant shall submit to the ISO a mitigation plan to correct LPF non-compliance detailing the steps that the TO/Transmission customer will take to correct the issues. The mitigation plan shall include an expected date of a return-to-compliance based upon completion of the action plan. In the event that the TO/Transmission Customer is not able to respond within this time period, they may request a 30 Calendar Day extension, which the ISO may grant at the ISO's sole discretion.

Responsible TOs/Transmission Customers shall submit evidence of implementing the action plan to return-to-compliance to ISO commencing every six months after submitting the action plan and until the action plan is complete. The ISO will evaluate these plans and progress reports and consider the scope of effort needed to correct the LPF in a given area. LPF correction plans are expected to include factors such as budgeting, design, procurement, cost review, and

implementation/construction schedules. If the ISO does not expect the mitigation plan will result in LPF improvements, the ISO will work with the relevant TO/Transmission Customer to revise the mitigation plan.

The TO/TC shall comply with the requirements in this OP, including the provision and implementation of a mitigation plan.

c. Transitional Compliance State

Any TO/Transmission customer that does not meet the required MVAR interchange performance at the time of publishing of Rev.9 of OP 17 but submits and complies with its mitigation plan shall be considered compliant with the OP through January 1, 2031, unless the ISO determines that the mitigation plan is not being followed. After January 1, 2031 any TO/Transmission customer that does not meet the required MVAR interchange performance at the time of the publishing of Rev. 9 of OP 17 shall be deemed non-compliance with this OP.

OP-17 REVISION HISTORY

Document History (This Document History documents action taken on the equivalent NEPOOL Procedure prior to the RTO Operations Date as well revisions made to the ISO New England Procedure subsequent to the RTO Operations Date.)

Rev. No.	Date	Reason
Rev 1	03/07/03	
Rev 2	02/01/05	Updated to conform to RTO terminology
Rev 3	05/06/05	Update for initiation of VELCO Local Control Center
Rev 4	10/01/06	Updated for ASM Phase 2
Rev 5	12/8/06	Update for changes resulting from VTF meetings
Rev 6	12/17/14	Cover page under the "Local Control Center Instructions" section - Modified "REMVE II" to "REMVEC/NGRID" and added "NSTAR". Section II - Added a paragraph explaining how the VTF will address instances when projects assumed in-service in the forecasted LPF study are not placed in-service in the field as planned. Section III - modified Figure 1 to only plot 6 points. Removed the additional point.
Rev 6.1	07/06/16	Periodic review performed requiring no changes; Made administrative changes required to publish a Minor Revision;
Rev 6.2	06/14/18	Periodic review performed requiring no changes; Made the administrative changes (including globally updating OP-5 and OP-14 titles and replacing "REMVEC/NGRID" with "NGRID") required to publish a Minor Revision;
Rev 6.3	04/24/20	Periodic review performed requiring no changes; Made administrative changes required to publish a Minor Revision;
Rev 7	10/01/20	Targeted rewrite of document to describe changes in scope and process
Rev 8	09/08/22	Periodic review performed by procedure owner; Editorial edits to correct grammar and spelling; Swapped content of Section I.C.1 and Section I.C.2; Updated Section I.C.1 Non-compliance with LPF Standard; Updated Section I.C.2 Operating Issue.
Rev 8.1	06/05/24	Biennial review performed by procedure owner requiring no changes; Made administrative changes required to publish a Minor Revision.
Rev 9	10/15/25	Biennial review performed by procedure owner; Rewrite of document to update monitoring/compliance and link planning and operations in terms of reactive load management; Effort included reorganization of document, update of concepts and terms, and revision of OP-17 concept; Concept changes include use of MVAR interchange to determine compliance with LPF standards and revised compliance/mitigation processes.