Appendix C - Explanation of Terms and Instructions for Data Preparation of NX-9C

ISO New England Transmission Equipment Rating, Characteristic, and Operational Data

Transformer - Phase Shifting

Effective Date: October 23, 2025

Review By Date: October 23, 2027

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I. EQUIPMENT REQUIREMENTS

Data for all phase shifting transformers designated as part of the Bulk Electric System[1] (BES) or connecting to the New England Transmission System[2] at a voltage of 69 kV or greater shall be provided by the Transmission Owners and Market Participants who own the equipment.[3]

A separate NX-9C form shall be provided for each transformer. ISO shall provide ISO Identification Numbers for all transformers. All data items shall be completed for each winding unless these instructions specifically indicate otherwise.

A copy of the manufacturer's nameplate, either by document (.pdf format) or digital photograph (.tif or .jpg formats), shall be included as a file attachment to the NX-9C form for new or replaced equipment and upon revision of existing NX-9C forms.

A copy of the manufacturer's test report document (in .pdf format) shall be included as a file attachment to the NX-9C form for new or replaced equipment and upon revision of existing NX-9C forms.

II. GENERAL DATA INSTRUCTIONS

The NX-9C form provides for entry of both ISO and MP/TO data. ISO fields cannot be modified by the MP or TO. The MP or TO is responsible for providing data for all non-ISO fields via the NX Application.

The circuit number shall initially be entered by the MP or TO for new equipment and thereafter maintained by ISO.

Select the terminals that reflect the connection points of the equipment. Terminals are created and maintained by ISO. The user should contact the ISO NX-9 Administrator (nx9admin@iso-ne.com) if terminal additions or changes are needed.

To remove equipment from service, select the Remove Equipment From Service checkbox. Equipment is removed from service either when the equipment is retiring from service or if new forms are being submitted as a replacement due to a change in configuration.

All voltage data item responses are to be in kV unless otherwise noted in these instructions.

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[1] Bulk Electric System (BES) is defined in the Glossary of Terms Used in NERC Reliability Standards.

[2] New England Transmission System is defined in the ISO Transmission, Markets, and Services Tariff, Section I.2.2.

[3] Generally, under Section I of Operating Procedure No. 16, data shall be provided by Transmission Owners (TOs) and Market Participants, *i.e.* Market Participants who own the equipment or Lead Market Participants for Generator Assets (collectively MPs).

To assist in completing the NX-9C form, sample manufacturer's nameplate data and a completed NX-9C form utilizing that data are attached (Example 1).

III. RATING DATA INSTRUCTIONS

Facility rating data shall be provided in MVA (rounded down to the nearest whole number) and determined in accordance with Planning Procedure 7, "Procedures for Determining and Implementing Transmission Facility Ratings in New England" (PP7). The definition of Thermal Ratings is described in PP7 Section 2.0 Collaborative Development of Rating Procedures. A facility rating shall equal the rating of the most limiting individual equipment, shall reflect relay loadability limits[4], and shall account for auxiliary support equipment such as wave traps and any other equipment that Good Utility Practice suggests is necessary. This requirement does not remove the TO's obligation to adhere to PRC-023-4, and it successor standards, nor does it suggest a TO be allowed to change a relay setting to create a more limiting thermal rating for a facility.

The NX-9C form provides for entry of both summer (April 1 through October 31) and winter (November 1 through March 31) thermal ratings as well as ratings for special conditions or configurations. The ambient temperature (reported in Fahrenheit) used to establish the normal ratings shall be entered for each rating set. If ratings for special conditions or configurations are added to the NX-9C form, comments that describe the associated circumstances for use of the special ratings are required. The MP or TO is also responsible for providing a statement as to the authority of the ISO and the Local Control Center (LCC) for use and distribution of these special ratings.

IV. CHARACTERISTIC AND OPERATIONAL DATA INSTRUCTIONS

Complete the following fields as instructed below:

Nameplate kV - Provide the phase shifting transformer voltage rating for all connections as listed on the nameplate document.

Impedance Data - Provide the positive sequence resistance (R) and reactance (X) associated with the nameplate kV, in percent on a 100 MVA base at the tap value with the minimum impedance multiplier (typically 1). Do not adjust values to nominal system voltage. Impedance on new or revised NX-9C forms shall be calculated and provided out to at least the 3rd decimal place.

Transformer Type - Indicate the type of the transformer based upon the descriptions below:

> Auto (AWR) - Transformer has controls that are capable of complete automatic operation. May be remotely controlled by an LCC System Operator[5] or a TO control room operator via SCADA.

[4] The term "relay loadability limits", as used in this Appendix, represents the minimum flow at which the relay acts.

[5] System Operator is defined in the Glossary of Terms Used in NERC Reliability Standards.

Non-Auto - Transformer does not have controls for complete automatic operation. May be remotely controlled by an LCC System Operator or a TO control room operator via SCADA.

Normal Operating Mode - Indicate the normal operating mode based upon the descriptions below. The normal operating mode selected should reflect the operational state that the transformer is expected to be in the majority of the time:

Auto - Transformer controls are set up for complete automatic operation. Tap changes typically occur without LCC System Operator or TO control room operator intervention.

Manual-Remote - Tap changes are typically made using the SCADA system and are remotely initiated by an LCC System Operator or a TO control room operator. Device controls are not normally operated in flow sensing mode.

Manual-Local - Switching of the device is performed locally at the substation.

Auto Mode Tap Switching Time Delay – For phase shifters with the Normal Operating Mode field set to Auto, indicate the tap switching time delay before tap changes initiate (in seconds).

Normal Tap Position Number - Heavy Load/Light Load - This is required for all phase shifters whose Normal Operating Mode field is set to Manual-Remote or Manual-Local.

For the purposes of this document, heavy load shall mean the summer months of June through August and light load shall mean the remaining calendar months of January through May and September through December.

For phase shifters whose Normal Operating Mode field is set to Manual-Remote, indicate the tap position number at which the transformer is normally operated for heavy load conditions and for light load conditions.

For phase shifters whose Normal Operating Mode field is set to Manual-Local, indicate the tap position number at which the transformer is normally operated for heavy load conditions and for light load conditions.

Step Size - Indicate the change in angle (degrees) per change in tap position.

Maximum Angle - Indicate the maximum angle (degrees). This should be the angle associated with the first (top) tap indicated in the tap multiplier table

Minimum Angle - Indicate the minimum angle (degrees). This should be the angle associated with the last (bottom) tap indicated in the tap multiplier table.

Advancing Tap Increases MW Flow From Terminal A to Terminal B - Select if an advance in tap setting results in increased flow from terminal A to terminal B.

Tap Multiplier Table

Tap Number - Indicate tap numbers of available taps. First tap number (tap number entered nearest to the top of the column) should correspond to the tap at which maximum angle is achieved.

Impedance Tap Correction Multiplier - Indicate the phase shifter tap impedance correction multiplier adjacent to the appropriate tap positions.

V. EXPLANATION OF DATA CHANGES

Any time an NX-9C form is modified or created, a brief description of the reason(s) for the entry shall be provided in the Revision Comments field. It will provide a written record of the change and clearly identify the equipment changes made in the field and/or other reasons that necessitated the update of the NX-9C form. For example: New equipment installation.

This data is utilized by ISO in the NX-9C form review and approval process.

VI. EQUIPMENT NOTES

The Equipment Notes field is used to provide explanations of data or other pertinent or operational information. For example: Rating is for phase shifter only. Refer to NX-9A for cable rating that is in series with this phase shifter and may be more limiting.

Fields are provided for both ISO and MP/TO notes. An additional private field is available to the MP or TO for internal notes that can be edited and viewed only by the MP or TO owning the record.

Equipment notes are carried forward when an NX-9C form is updated. MPs and TOs should review and modify or delete any MP or TO note that is no longer pertinent. ISO is responsible for maintaining ISO notes.

EXAMPLE 1, NX-9C PHASE SHIFTING TRANSFORMER

ISO New England Equipment Rating, Characteristic, and Operational Data Implementation Form
Phase Shifter (NX-9C)

Reference 9999 **Participant ID** Station1PST
Participant Test Company **ISO ID** STATION1 PS01
Form State Approved **Ckt** 1

Terminal A Station1115kV **Bus #** 111222 **EMS** STATION1
Terminal B Station1PST115kV **Bus #** 112233 **EMS** STATION1

Default Summer 90 F

	MVA	Limiting Device / Description	Location
Normal	165	Phase Shifter - Phase Shifting Transformer	Station1
LTE	205	Phase Shifter - Phase Shifting Transformer	Station1
STE	265	Phase Shifter - Phase Shifting Transformer	Station1
DAL	265	Phase Shifter - Phase Shifting Transformer	Station1

Default Winter 50 F

	MVA	Limiting Device / Description	Location
Normal	190	Phase Shifter - Phase Shifting Transformer	Station1
LTE	225	Phase Shifter - Phase Shifting Transformer	Station1
STE	285	Phase Shifter - Phase Shifting Transformer	Station1
DAL	285	Phase Shifter - Phase Shifting Transformer	Station1

	Tap Number	Impedance Tap Correction Multiplier
Up /	16A	2.03
	0	1
Down /	16R	2.03

Name Plate kV 115 / 115 **Step Size (Deg)** 2.6 **Max Angle (Deg)** 40.1 **Min Angle (Deg)** -40.1
Type Non-Auto **Auto Mode Tap Switch Delay**
Normal Operating Mode Manual-Remote **Normal Heavy Load Tap Number** 0
Impedance Data (%) (100 MVA Base) **Normal Light Load Tap Number** 0
R 0 **X** 7.061 **Advancing Tap Increases MW Flow From Terminal A to Terminal B** N

Revision Comments This entry is being submitted to represent the installation of the new PST phase shifter.

Equipment Notes Open field available for Participant to supply pertinent information about the equipment or the manner in which it is operated.

Data Revision Number 0 **Date Created** 04/10/2009 **Prepared By** ParticipantUsername
Requested Effective Date 07/31/2009 **Date Received** 04/23/2009 **Approved By** ISO Username
Actual Effective Date 05/27/2009 **ISO EMS Implementation Date** 05/27/2009

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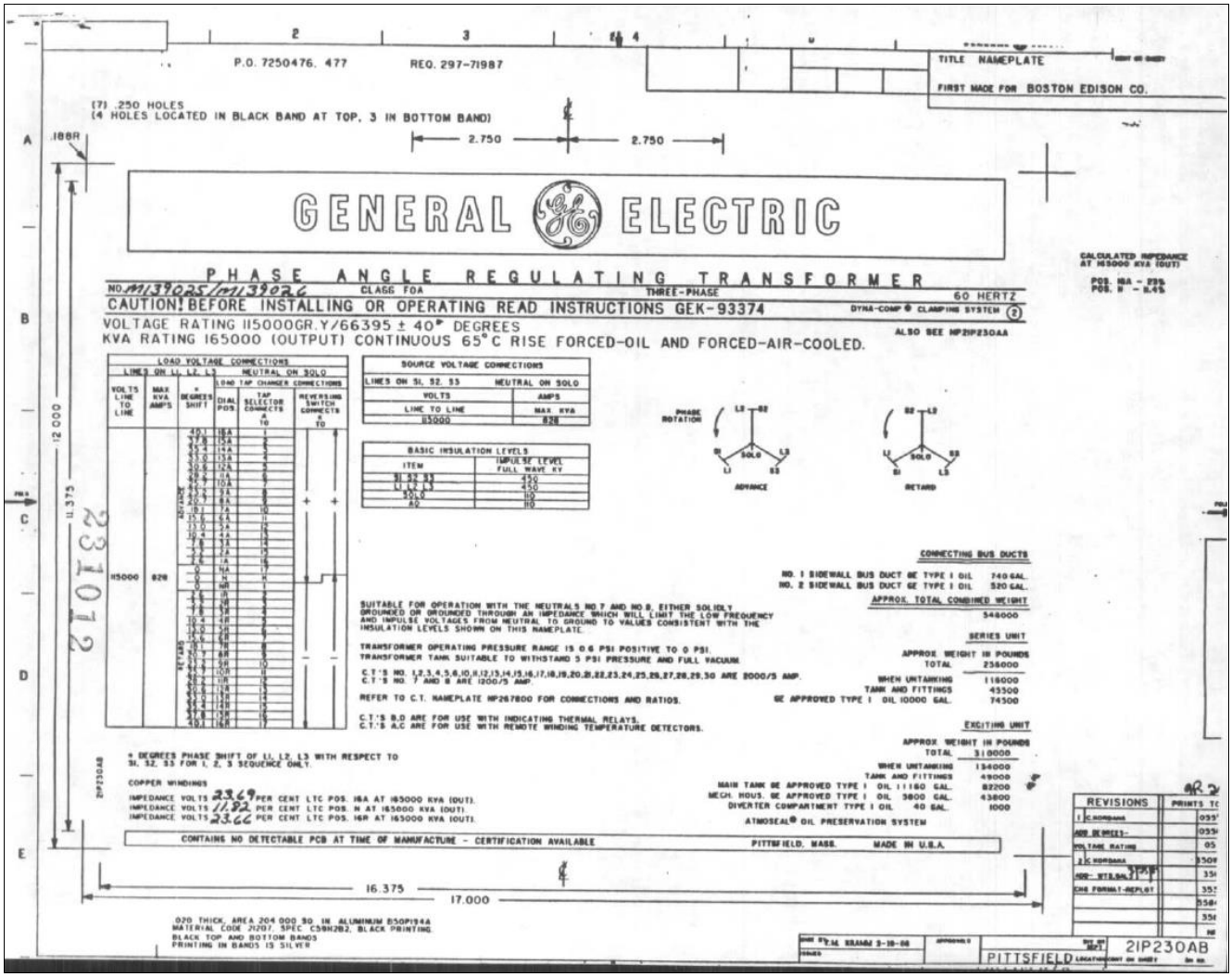
EXAMPLE 1 (CONTINUED), NX-9C PHASE SHIFTING TRANSFORMER



VII. OP-16 APPENDIX C 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
- -	10/26/23	For previous revision history, refer to Rev 10 available through Ask ISO.
Rev 11	10/26/23	Periodic review performed by procedure owner; Add footnote to define “relay loadability limits” as used in this Appendix; Update Normal Operating Mode field labels from Manual + SCADA to Manual-Local + Manual-Remote as previously requested by the Reliability Committee; Replace Example 1 NX9C screen-shot.
Rev 11.1	10/23/25	Biennial review by procedure owner requiring no changes; Made administrative changes required to publish the Minor Revision.