NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Technical Rationale

Project 2021-01 Modifications to MOD-025 and PRC-019
Reliability Standard MOD-025-3 | April 2023

MOD-025-3 – Verification of Real and Reactive Power Capability for BES Facilities

Introduction

This document is the technical rationale and justification for Reliability Standard MOD-025. It includes the rationale for changes in the current proposed version – MOD-025-3.

The intent of this document is to provide stakeholders and the ERO Enterprise with an understanding of the revisions, technology, and technical concepts of Reliability Standard MOD-025-3, as well as the rationale or justifications for such revisions, both the currently proposed and historical revisions from previous versions, if applicable. This is not a Reliability Standard and should not be considered mandatory and enforceable.

Background

The current industry need for this project is that industry implementation of MOD-025-2 has not resulted in useful unit capability data being provided for planning models of generating resources and synchronous condensers (i.e., the purpose statement of the standard). The primary reliability benefit of this project will be to correct these issues such that suitable and accurate data can be established through the verification activities performed by respective equipment owners. Bulk power system (BPS) planning assessments rely on accurate data, including machine active and reactive power capability, to identify potential reliability risks and develop mitigating actions for those risks.

The current MOD-025-2 verification testing activities require significant time, expertise, and coordination. However, they typically do not result in data that should be used by planners for modeling purposes because those tests may be limited by transmission system constraints. The current standard does allow for optional calculations to be performed to help facilitate better information sharing; however, these calculations are not required nor can they be used in many cases when auxiliary equipment limits or system operating conditions prohibit reaching the actual machine capability or limiters. This project will address these issues.

Additionally, the System Analysis and Modeling Subcommittee developed the *Applicability of Transmission-Connected Reactive Devices* white paper and an associated standard authorization request (SAR), which was approved by the Planning Committee on February 11, 2020. The SAR outlined recommended revisions to MOD-025-2 to augment the applicability section and requirement language to include (non-generation) transmission connected dynamic reactive resources – such as flexible alternating current transmission system (FACTS) devices and high voltage direct current (HVDC) terminal equipment.

Rationale for Applicability Section

Functional Entities

The purpose of the MOD-025-3 standard is to ensure that accurate information on Bulk Electric System (BES) Facilities' Real and Reactive Power capability is available for planning models used to assess BES reliability. The three functional entities that play a role in MOD-025-3 requirements and have an obligation to comply with them are:

- Generator Owner
- Transmission Owner
- Transmission Planner

The Generator Owner and Transmission Owner are responsible for providing verification of the Facility's Real Power and Reactive Power capability, as described in Requirements R1 and R2. Additionally for Requirement R4, when receiving a notification of technical concern from the Transmission Planner, the Generator Owner or Transmission Owner must update the capability information, provide a plan to update the capability information, or give a technically justified reason to maintain the information as-is.

The Transmission Planner is responsible for reviewing the information submitted by the Generator Owner or Transmission Owner and responding whether or not there are technical concerns identified in their review, as described in Requirement R3.

Facilities

Facilities that meet the characteristics defined by the NERC BES Definition Inclusion I2 and I4 for generating facilities, Inclusion I5 for dynamic reactive resources (e.g., synchronous condenser and FACTS devices), or for HVDC facilities which meet the requirements in this standard are to be considered an "applicable unit." FACTS is defined by the Institute of Electrical and Electronics Engineers (IEEE) as "a power electronic based system and other static equipment that provide control of one or more AC transmission system parameters to enhance controllability and increase power transfer capability. This will include any Real and/or Reactive Power resource connected to the BES and that meets the unit rating criteria set by the BES definition. This Facilities Applicability is consistent with most other NERC reliability standards related to BES-qualified units. The proposed standard links Applicability to the BES definition (as opposed to defined rating or other thresholds) to be sure that now and in the future, should the BES definition be modified, the standard is consistent with applicable BES facilities. This avoids the need to modify the standard if definitive thresholds are specified and the BES definition is modified.

Rationale for Requirement R1

MOD-025-3 Requirement R1 combines MOD-025-2 R1 (Real Power capability) and MOD-025-2 R2 (Reactive Power capability). MOD-025-3 Requirement R1 provides the Transmission Planner with the verified Real and Reactive Power capability of an applicable Facility and the associated documentation through which the verified capability was determined. The revisions of Requirement R1 include: i) combining the Real and Reactive capability verification into one Requirement, ii) changing the submittal timeline to 30 days from the verification date as specified by the GO instead of the previous 90 days from the test date, and iii) modifying the required submittal documentation to include the composite capability

curve and applicable verification data. The Real and Reactive capability Requirements are combined because the verification no longer relies solely on discrete testing data points. The verification method now produces a continuous composite capability curve where Real and Reactive capability are interrelated. The standard drafting team (SDT) determined that it was appropriate to shorten the submittal timeline to 30 days from the date of verification, because the date of verification will be the date that the engineering analysis is complete, is specified by the GO and is no longer linked to the date that test or operational data was recorded. Adding the composite capability curve and associated analysis documentation to the submittal requirement provides the Transmission Planner with the appropriate data to be able to accurately model the resource based upon the new verification method.

Rationale for Requirement R2

MOD-025-3 Requirement R2 is similar to MOD-025-2 R3, which applies to Transmission Owner applicable facilities. MOD-025-3 Requirement R2 provides the Transmission Planner with the verified Real and Reactive capability of an applicable Facility and the associated documentation through which the verified capability was determined. The revisions of Requirement R2 include: i) combining the Real and Reactive capability verification into one Requirement, ii) changing the submittal timeline to 30 days from the verification date as specified by the TO instead of the previous 90 days from the test date, and iii) modifying the required submittal documentation to include the composite capability curve and applicable verification data. The Real and Reactive capability Requirements are combined because the verification no longer relies solely on discreet testing data points. The verification method now produces a continuous composite capability curve where Real and Reactive capability are interrelated. The SDT determined that it was appropriate to shorten the submittal timeline to 30 days from the date of verification, because the date of verification will be the date that the engineering analysis is complete, is specified by the TO and is no longer linked to the date that test or operational data was recorded. Adding the composite capability curve and associated analysis documentation to the submittal requirement provides the Transmission Planner with the appropriate data to be able to accurately model the resource based upon the new verification method.

Rationale for Requirement R3

MOD-025-3 Requirement R3 is a new requirement, which applies to the Transmission Planner. MOD-025-3 Requirement R3 provides for a feedback mechanism for the Transmission Planner to inform the applicable entity of any technical issues that it identifies with the Real or Reactive Power capability information. The addition of this requirement is warranted because it encourages dialogue between entities to ensure that verifications are accurate and appropriate for the needs of the Transmission Planner.

Rationale for Requirement R4

MOD-025-3 Requirement R4 is a new requirement, which applies to the Generator Owner and Transmission Owner. MOD-025-3 Requirement R4 ensures the Generator Owner/Transmission Owner addresses any technical issues identified by the Transmission Planner under Requirement R3. The disposition can be done by updating the capability information, developing an agreed upon plan to address the issues identified, or provide a technical justification to leave the capability information as-is.

Rationale for Attachment 1, Section I – Periodicity

This intent of this section is to specify the initial and recurring periodicity for when the applicable entity must perform the verification of BES Facility Real and Reactive Power capacity. The Real and Reactive Power capability validation performed in MOD-025 no longer strictly relies upon actual test or operational data. Therefore, the verification date will no longer be directly associated with the dates of those two data points. Instead, the verification date will be a date selected by the applicable entity. This verification date should represent the ending of the engineering analysis (including any required reviews) performed to validate the capability of the resource. This chosen verification date is the basis for the recurring periodicity requirement.

Since MOD-025 provides data to the Transmission Planner for use in planning assessments, the SDT evaluated the current periodicity of five years for Real and Reactive Power validation by comparing the periodicity of MOD-025 validation with other similar validations performed in MOD-026 and MOD-027. The SDT determined that MOD-025 periodicity was not in-line with the MOD-026 and MOD-027 10-year periodicity requirement and determined that the MOD-025 periodicity should be changed to every 10 years for existing operational resources because the collected data was similar to MOD-026 and MOD-027.

The SDT acknowledged that, while Transmission Planners need accurate capability data for new resources, entities need sufficient time in order to gather data and perform the required verification on those resources. In order to balance these two needs, entities will be required to perform verification for a new resource within 180 calendar days of commercial operation.

Additionally, if a change is made to an existing Facility within the 10-year verification window that changes the capability of the Facility and is expected to last for a significant period of time, then a new capability verification needs to be performed so that the Transmission Planner is aware of the current capability of the Facility. The SDT determined that 180 calendar days provided the entity sufficient time to determine whether the Facility would be restored to full capability and, if not, perform the verification activities to verify the new capability.

In the event that a resource is placed into a long-term-shutdown condition and is not verified in the current 10-year verification window, that resource is treated as if it were a new resource for the purposes of MOD-025 periodicity; therefore, that resource capability must be verified within 180 calendar days of its return to service.

Rationale for Attachment 1, Section II – Verification specifications

The intent of this section is to define verification specifications for the various applicable facilities as defined in Section 4 of the Standard.

Section II, Item 1: The verification specification for individual resources greater than 20 MVA remains the same, in that the verification process is still on an individual basis.

Section II, Item 2: Resources 20 MVA or less that are part of a plant greater than 75 MVA can be verified either on an aggregate or individual basis as before. A slight change to this requirement is that when deciding to perform the verification process, the owner should attempt to consider applicable modeling requirements from the respective Transmission Planner. This revision is warranted because it encourages dialogue between entities to ensure that verifications are accurate and appropriate for the needs of the Transmission Planner.

Section II, Item 3: The simplified one-line diagram of Requirement R1 or Requirement R2 should be developed to identify where the composite capability curve and associated PQ data table is represented. The one-line diagram should also represent (in aggregate or individually) all interconnection and auxiliary equipment of a Facility during normal operation. While the new Attachment 2 form shows an example for the simplified one-line diagram, the applicable entity may develop a diagram that is more appropriate to represent their unit and interconnection layout.

Section II, Item 4: The clarification for no leading or lagging capability was added to this section. Previously, similar language was in Note 3 in MOD-025-2.

Section II, Item 5: The development of an accurate composite capability curve and associated PQ data table of Requirement R1 or Requirement R2 is paramount, so the data and information made available to Transmission Planners is more accurate. Overall, this helps improve the accuracy of the models used by Transmission Planners. In order to create the most accurate representation of Real and Reactive Power capability using the composite capability curve, a sound engineering methodology or methodologies must be employed. The applicable entity is given the option to use one or more of the following methodologies: i) an engineering review of all relevant unit capabilities, ii) utilization of test data along with engineering analysis, and/or iii) utilization of operational data with engineering analysis. This revision is part of the biggest change to the Standard. The verification no longer relies solely on discreet testing data points, and allows the applicable entity to develop an interrelated Real and Reactive power capability curve using engineering review/analysis of known data. The development of a composite capability curve should be more representative of the capability of the resource since the data points represented on the curve are not limited due to a system, plant, or auxiliary limitations encountered during testing.

Section II, Item 6: For resources being modeled on an individual basis, this item describes what should be considered when developing the composite capability curve and associated PQ data table of Requirement R1 or Requirement R2. This is a completely new section for the Standard. Providing the Transmission Planner with a composite capability curve representing the continuum of real and reactive power capabilities will provide the Transmission Planner with more representative information than the previous discreet testing values and allow the Transmission Planner the ability to directly use the provided data in the planning models.

Section II, Item 7: For resources being modeled on an aggregate basis, this item describes what should be considered when developing the composite capability curve and associated PQ data table of Requirement R1 or Requirement R2. This is a completely new section for the Standard. Providing the Transmission Planner with a composite capability curve representing the continuum of real and reactive power

capabilities will provide the Transmission Planner with more representative information than the previous discreet testing values and allow the Transmission Planner the ability to directly use the provided data in the planning models.

Section II, Item 8: For dynamic reactive resources (FACTS devices) and HVDC equipment being modeled, this item describes what should be considered when developing the composite capability curve and associated PQ data table of Requirement R1 or Requirement R2. This is a completely new section for the Standard. Data for these types of devices is not required under MOD-025-2, creating an information gap in planning models. Providing capability data for dynamic reactive devices allows for more accurate resource modeling and planning.

Rationale for Attachment 1, Section III – Stage test and operational data specifications
The intent of this section is to provide an applicable entity direction of how to perform a stage test or collect operational data along with engineering analysis. The majority of this section is similar to MOD-025-2 Attachment 1 'Verification specifications for applicable Facilities'. While the recording of data is similar, the intent is for engineering analysis to be performed using the test or operational data as a starting point and then expanding on the test or operational data to develop the composite capability curve. In addition, Items 6 through 9 define which test points must be collected based on the various applicable Facilities of the standard.

Rationale for Attachment 2
MOD-025-3 Attachment 2 is a new attachment that includes a report form with example simplified one-line diagram from MOD-025-2 Attachment 2, while adding sample composite capability curve for a synchronous generator or condenser, a sample table containing PQ curve data, and a sample composite capability curve for an IBR Facility.

During the development of the revised standard, the SDT recognized that the final capability curve provided by the generator owner or transmission owner could be developed at different points within the Facility being verified. For example, the capability curves for individual synchronous generators have historically been applied at the generator terminals; whereas, an applicable Facility consisting of multiple small generators may apply an aggregate capability curve at the high-side of a step up transformer. IBRs, such as wind farms, often use a defined point of interconnection for regulatory or contractual requirements for power factor or reactive capability. In these cases, it may make more sense to provide a capability curve that is valid at the point of interconnection or an aggregated internal point such as where an off-shore cable transitions to land. The use of a simplified one-line diagram eliminates any ambiguity around the application of the capability curve. Accurate interpretation of the capability curve depends on the knowledge of how any auxiliary loads have been aggregated and where they are applied on the simplified one-line diagram. Modeling of a Facility can require that the auxiliary transformers and loads to be aggregated modeled, so providing those details on the simplified one-line assists in the development of planning models.

The sample composite capability curve is provided to show what is expected in order to comply with the standard. The curve shows expected maximum and minimum real and reactive power capability along with anything that may limit the use of that capability, including but not limited to excitation limiter settings.

Most of the curve is consistent with what has typically been provided as manufacturer-provided data. Since the verified curve can be developed using a combination of measured data and engineering analysis, the source of the data is also shown on the curve. One motive for the revision of MOD-25 is the inability of staged testing to determine equipment limits when system conditions prevent those limits from being reached. The use of engineering analysis to determine the actual limits is acceptable, but the SDT felt it useful to show the source of each data point on the curve. A separate data table with precise values from the curve is provided to simplify incorporating the capability curve data into software models. The location of points in the table is also shown on the curve.

Capability curves for IBR facilities have a slightly different structure from synchronous generators, so a sample IBR curve is provided in this attachment.

Rationale for Attachment 3

MOD-025-3 Attachment 3 carries over content from MOD-025-2 Attachment 2 for summarizing the results of staged test or operational data collected. The attachment includes a selectable list of data verified by staged testing or operational data, a table for recording measurements, and a summary sheet of the data associated with the staged testing or operational data.

The intent of Attachment 3 is to document the source of any measurements. It is possible that measured data will come completely from operational data, completely from staged test data, or a combination of the two. It is therefore possible that more than one copy of Attachment 3 is necessary to fully document the sources of measured data.

The final section of Attachment 3 allows for the entity to summarize the test or operational data. The summary section includes an item to describe any reasons that the test or operational data was unable to reach the resource's real or reactive limits. This item is intended to document any differences between the measured data and the resulting capability curve.