SOP-RTMKTS.0125.0130
Process For Developing and Maintaining the Reactive Capability D-Curve

Contents

1. Objective

The purpose of this procedure is to define the process an Operations Support Services (OSS) engineer uses to develop and maintain Generators' Reactive Capability Curves (D-Curves). The D-Curves are used by both the ISO and Local Control Center (LCC) Energy Management System (EMS). There is a difference between a D-Curve and the manufacturer's Nameplate Reactive Capability Curve. The difference is that a D-Curve provides the actual Resource limits imposed by operating conditions.

2. Background

It is important to recognize the difference between the Nameplate Reactive Capability Curve and the D- Curve. The Nameplate Reactive Capability Curve which is submitted for a Resource by the Lead Market Participant (Lead MP) on Form NX-12D Generator Reactive Data only represents the theoretical reactive capability of the Resource and does **not** take into account the auxiliary equipment, transformer characteristics, strength of the transmission system to which the Resource will be connected, the transmission operating voltage and protection settings. Unrealistic values of reactive capability may result in misleading power flow results and errors in state estimation. D-Curves provide realistic reactive capability. Realistic values of reactive capability results in more accurate results in power flow and the state estimator.

A D-Curve is developed for each new Resource after at least 6 months of commercial operation.

Each existing Resource that submits a new Normal Reactive Capability Curve with either higher or lower values and has an existing D-Curve shall keep the existing D-Curve until sufficient data is collected to justify an update.

Any change in reactive capability of an existing Resource is monitored by the OSS engineer and reviewed by the Voltage Task Force (VTF). After the VTF reviews a Resource's MVAR test result, its D-Curve is reviewed and updated if necessary. Each applicable LCC is required to approve any new or updated D-Curve before it is implemented in the EMS.

3. Responsibilities

NOTE

Any OSS engineer has the authority to take action(s) required to comply with this procedure.

1. The Director, OSS is responsible for verifying this procedure is adhered to and that each applicable LCC reviews and approves the new D-Curve within the approval timeframe described in the instructions section.

2. The OSS engineer is responsible for developing and updating the D-curve.

3. The OSS engineer is responsible for reviewing all D-Curves with the VTF and tracking LCC approval.

4. The OSS engineer is responsible for providing the new or updated D-Curve(s) to the ISO Power System Modeling Management group (PSMM) for deployment.

4. Controls

1. Biennial review of this SOP shall be performed by the Procedure Owner (or designee).

5. Instructions

5.1 D-Curve Review Timeline

Wholesale Review

The OSS engineer shall review the D-Curves of existing Resources at least once every two years. This wholesale review ensures that D-Curves have been regularly updated to reflect a Resource's current capability.

Post MVAR Test Review

MVAR test results of Resources are reviewed bi-monthly by the OSS engineer and the VTF at each VTF meeting. For each Resource that has recently tested its reactive capability, the OSS engineer will evaluate the Resource's D-Curve to determine if a new D-Curve is warranted.

5.2 D-Curve Coordination Timeline

A D-Curve's EMS implementation timeline depends upon:

- any discrepancy between the D-curve and latest MVAR test results
- the impact on the EMS Real Time Network (RTNET) solution

The assigned OSS engineer shall determine which of the following two magnitude categories applies to the updated D-Curve:

Critical:

Considerations for determination:

Often, PSMM identifies a critical D-Curve change. When a Resource demonstrates a higher reactive capability than modeled in the current EMS D-Curve, a mismatch of ≥ 25 MVAR between SCADA & RTNET will trigger an automatic alert to PSMM. PSMM will then send an email to the OSS engineer, requesting the OSS engineer to revise the current D-Curve.

The OSS engineer may also determine a critical D-Curve change based upon the discrepancy between the latest MVAR test and the existing D curve.

Critical D-Curve development by the OSS engineer shall be within two (2) Business Days of identification.

Critical D-Curve approval by the LCC shall be within two (2) Business Days of notification to the LCC.

Critical D-Curve changes shall be updated in the EMS within ten (10) Business Days of identification.

Next Model Release: A "next model release" D-Curve change is for all other reactive capability changes.

Next Model Release D-Curve approval by the LCC shall be within twenty (20) Business Days of notification to the LCC.

Once the D-Curve is updated, the OSS engineer communicates the revised D-Curve to the PSMM Supervisor based on the next occurring deadline:

- November 15th for February model release
- March 15th for May model release
- July 15th for September model release

5.3 D-Curve Development

Resources with Greater Than Six Months of Commercial Operation Data

This section applies to Resources with a minimum of 6 months of commercial operation and a minimum of 30 runs.

1. OSS engineer shall evaluate accuracy of the D-curve using any of the following data sources:

   A. OP-23 test data

   B. MOD-025 test data

   C. Plant Information (PI) data

   D. Phasor Measurement Unit (PMU) data

2. After the data is collected, the OSS engineer shall plot the MVAR values against the MW output of the Resource for the selected evaluation period. When possible, a year's worth of operational data is analyzed. A spreadsheet template for plotting D-Curve data is available here for OSS engineers:

   \\Iso-ne.com\shares\iso_top\Voltage Task Force\D-Curves

3. The OSS engineer shall create the D-Curve using a minimum of 6 points fitted around the data points obtained from the above data sources plus some margin, normally 5%. If the OSS engineer determines that additional points are necessary to better define the Resource's reactive capability, points may be incorporated into the D-Curve. Refer to Attachment A – D Curve Examples, for typical plots. The area bounded by the curve is regarded as the active and reactive operative region of the Resource. The curve shall be defined using the following points:

   A. Points 1,6: corresponds to the maximum MVAR lagging/leading capability at the lowest MW capability demonstrated over the evaluation period plus some margin, typically 5 %.

   B. Points 2,7: is the maximum MVAR lagging/leading capability near the intermediate load point MW demonstrated over the evaluation period plus some margin, typically 5%.

   C. Points 3,8: is the maximum MVAR lagging/leading capability beyond the intermediate load point MW demonstrated over the evaluation period plus some margin, typically 5%.

   D. Points 4,9: is the maximum MVAR lagging/leading capability at the break point MW demonstrated over the evaluation period plus some margin, typically 5%.

E. Point 5 (The nose point): is the point that crosses the MW axis at which the MVAR value is zero, also known as the unity power factor point. The Max MW value shall correspond to the market maximum claimed capability plus some margin. The margin is typically 5%.

F. Additional points may be incorporated to better define if deemed necessary.

Refer to Attachment A – D- Curve Examples, for typical plots.

5.4 Resources with Less than Six Months of Commercial Operation Data

NOTE

When new Resources achieve commercial operation, they are modeled in the EMS using the Normal Reactive Capability Curve submitted through the NX12D

1. Resources that are deemed ready to follow dispatch by ISO and do not have six months of Real-Time reactive data are modeled in the EMS using the Normal Reactive Capability Curve data submitted through the NX application.

2. At least 6 months after the Resource achieves commercial operation and has a minimum of 30 runs, the OSS engineer shall review the Resource's D-curve.

6. Performance Measures

This procedure is considered to be properly followed as evidenced by the following:

- D-Curves are reviewed for each Resource whose MVAR test results are reviewed at the VTF meeting. Any resulting D-Curves updates are then approved by the applicable LCC and communicated to PSMM.

7. References

NERC Reliability Standard VAR-001 - Voltage and Reactive Control

NERC Reliability Standard VAR-002 - Generator Operation for Maintaining Network Voltage Schedules

ISO New England Operating Procedure No. 14 - Technical Requirements for Generators, Demand Response Resources, Asset Related Demands and Alternative Technology Regulation Resources (OP-14)

ISO New England Operating Procedure No. 23 - Resource Auditing (OP-23)

8. Revision History

Rev No	Date	Reason	Contact
0	02/27/20	Initial draft procedure	Omar Sanchez
0.1	02/17/22	Minor revision to administratively extend "Valid Through" date to allow for full review and revision	Dean LaForest
1	05/25/22	Updated to reflect current practices	Audrey Newcomb
1.1	05/21/24	Biennial review by procedure owner with no changes required.	Dean LaForest

9. Attachments

Attachment A – D-Curve Examples