Technical Requirements for Interconnection to the BPA Grid

Revision 9 Updates

(Network Planning Standard: STD-N-000001-00-09)

Required Voltage and Frequency Control Performance Commissioning Tests

Revision 1 Updates

(Supporting Document STD-N-000001-01-01)

Eric Heredia (Transmission Planning)
Elliott Mitchell-Colgan (Transmission Planning)

Overview

- The "Technical Requirements for Interconnection to the BPA Transmission Grid" document to identify technical requirements for connecting transmission lines, loads and generation resources into the BPA Grid as required by NERC FAC-001.
- Included are the Balancing Authority Area (BAA) requirements for generation connected to a utility system located within BPA's BAA.
- The requirements are expected to change periodically based on technology changes, industry events, and evolving standards.

New Revisions will be posted on the BPA Interconnection Site

- https://www.bpa.gov/energy-and-services/transmission/interconnection

Technical Requirements for Interconnection STD-N-000001 Revision 9

- Updates to BPA's Technical Requirements for Interconnection (STD-N-000001 Revision 9) are focused on specifications for inverter-based resources (IBRs) and improving clarity of performance requirements for all interconnections.
- IBR technology continues to evolve.
- The Technical Requirements will have future revisions focusing on continued improvement for IBRs and all interconnections.

Updates for IBRs

- BPA STD-N-000001 Revision 9 applies selected clauses from the IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems (IEEE Std 2800-2022).
- The IEEE Std 2800 clauses applied shall be in addition to the BPA requirements *such that an IBR facility meets the IEEE Std 2800 and the BPA STD-N-000001 requirements*.

Updates for IBRs

IEEE Std 2800 clauses applicable to IBRs

4. General interconnection technical specifications and performance requirements

5. Reactive power-voltage control requirements within the continuous operating region

6. Active-power—frequency response requirements

7. Response to TS abnormal conditions (in addition to NERC PRC-024)

10 Modeling data

Annex G, Recommendation for modeling data, shall apply to inverter-based resources

For additional information see IEEE Std 2800-2022:

https://ieeexplore.ieee.org/servlet/opac?punumber=9762251

Updates for IBRs

Battery Energy Storage System (BESS)

- BPA requires Grid Forming Control (GFM) for IBR connected BESS.
- This includes:
  - Standalone BESS
  - BESS portion in AC-coupled hybrid plants
  - BESS portion in DC-coupled hybrid plants

Variable Energy Resources (VER) and New Technologies 3 MVA and Greater

- Require SCADA indication and control of the breakers to be able to disconnect the project as needed for reliability.
- For multiple technology types (wind, solar, battery, fuel cell, etc.), BPA prefers separate control of each technology type.
- DC connected multiple technology types are not subject to separate breaker control requirements.
- No more than 5 breakers at a project site shall be setup for SCADA Indication and Control to drop a generation site under the same Energy Management System controller.
- If more than 5 breakers are used for the feeders at a project site, then breakers on the low side of the main step-up transformers shall be installed with SCADA Indication and Control.

Remedial Action Scheme (RAS)

- All new interconnections, generation or load, more than 300 MW will require installation of RAS equipment and communications.
- RAS for interconnections less than 300 MW will be determined by the interconnection studies.
- Breakers used for tripping generation or load in RAS need to be as close to the plant as possible and as few breakers as possible to accomplish the RAS action needed.

Energy Storage Remedial Action Scheme

- Provide telemetry on:
  - State of charge
  - Charging/pumping (storing energy)
  - Discharging/generating (providing energy)
- Has the ability to receive a RAS signal to take requested actions:
  - Increase energy injection
  - Reduce energy injection (ramp or trip) or increase energy absorption
- The RAS shall be fully redundant with no single point of failure.
- RAS is required on all energy storage, standalone and hybrid portions of a plant.

Measurement/Telemetering Updates

Generation within BPA's Balancing Authority Area (BAA):

- At hybrid plants *each technology type* (wind, solar, battery, other) requires separate metering and telemetering.
- All gen. resources 3 MVA and greater are required to have 24/7 real-time operator with contact phone number available to BPA Dispatchers.

Generating Facility Most Severe Single Contingency

- The automatic removal of a generating facility single branch, including transformers, collector system lines or cables, and tie line branches to the POI, shall not trip power greater than 1,500 MW.
- The design of the generating facility shall not create a Most Severe Single Contingency (MSCC) resulting in a resource loss of more than 1,500 MW.

Connection to Series Compensated Lines

- Series Compensated transmission lines are main grid lines that have series capacitors installed in one or more locations along the line.
- Each series capacitor bank is designed for the location where it is installed including such factors as the length of the line.
- By connecting into a Series Compensated transmission line, the line is effectively being broken into two (or more) shorter lines.
- *Substantial modification, if not complete replacement of the series capacitor platform will be required.*

System Strength

- BPA requires the short-circuit ratio (SCR) be 3 or higher for all POIs, for all lines in service and single branch outages.
- A single POI SCR calculation or a weighted SCR calculation may be applied where many new POIs in an area are being considered.
- On a case-by-case determination, an exception may be considered, allowing a POI with a SCR less than 3.

Reference Point of Applicability

Reference Point of Applicability (RPA) - The location where the interconnection and interoperability performance requirements apply. This definition is used in IEEE Std 2800-2022 (Adapted from IEEE Std 1547TM-2018).

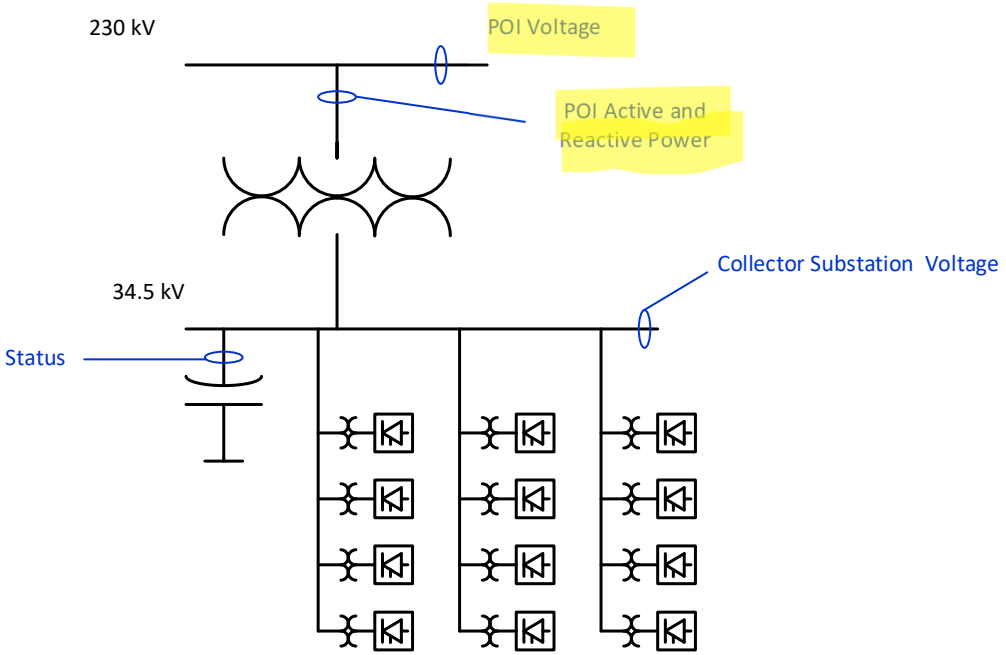
Point of Measurement (POM) - A point between the collector substation main transformer or generator substation transformer high-voltage bus of an energy source and the POI. This definition is used in IEEE Std 2800-2022 (Adapted from NERC Reliability Guideline – BPS-Connected Inverter-Based Resource Performance)

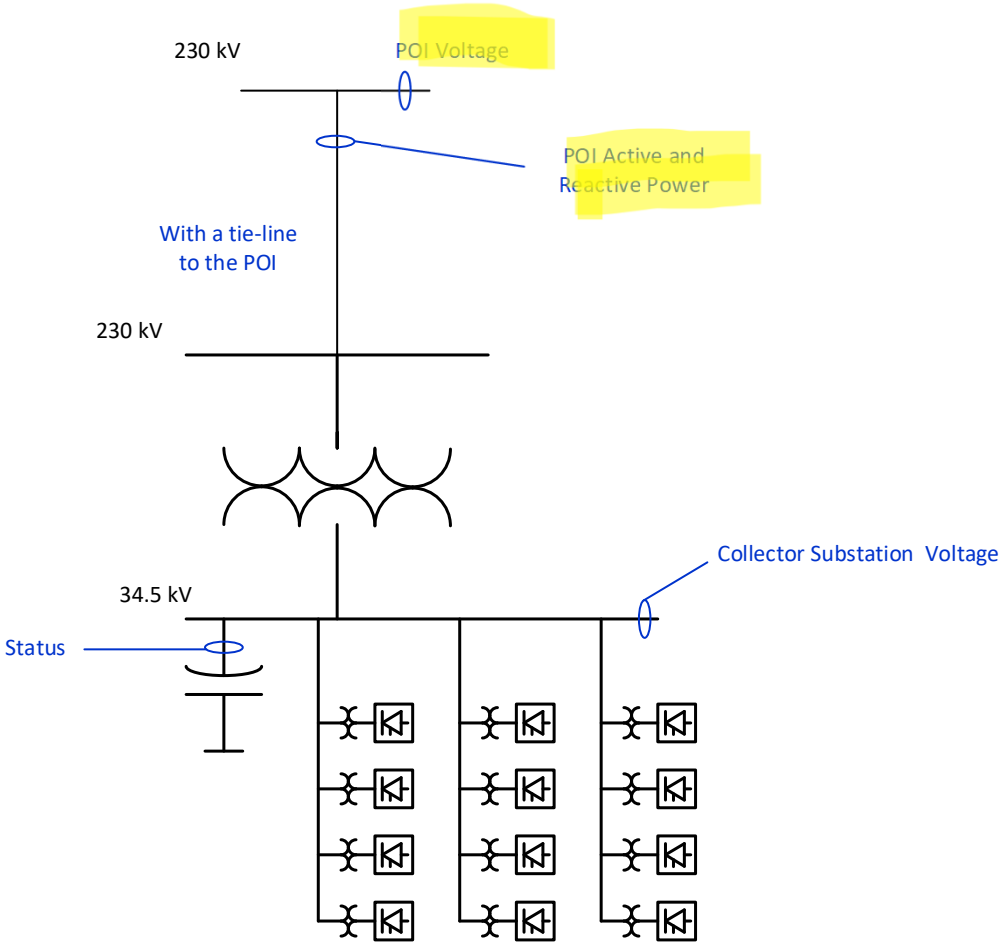
Point of Interconnection (POI) – the physical location an interconnection connects to facilities owned by BPA, change of ownership.

Reference Point of Applicability

- The Point of Interconnection (POI) will be the default Reference Point of Measurement (POM) and Reference Point of Applicability (RPA).
- The default locations are established by the POI: POI = POM = RPA.
- On a case-by-case determination, the POI, POM, and RPA locations may be different.

Reference Point of Applicability





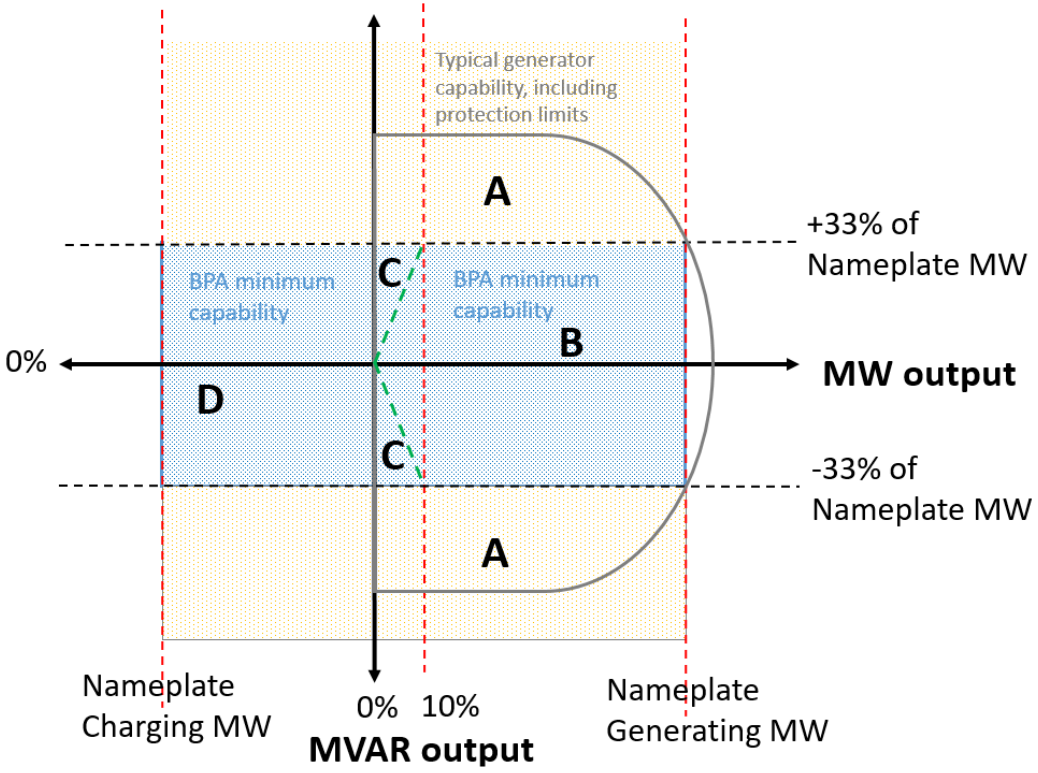
Reactive Power Requirements

Item	Requirement
Reactive Capability	Resources are required to **provide +/-33% of the plant's nameplate MW in dynamic reactive at the POI**. See Figure on the next slide for minimum required reactive power deliverable at the POI.
Reactive/Voltage droop control*	The **2% reactive droop** is defined at the POI, such that a +/- 2% change in POI voltage from the voltage schedule will result in a full reactive response from the generating facility, or reactive injection/absorption at the POI equal to 33% of the plant's nameplate MW.
Maximum step response time and overshoot	**Step response time < 5 seconds (from 0 to 90%)** **Overshoot < 10%**
Damping	Positively damped, ratio not specified at this time

*Voltage is normalized to typical voltage schedule targets (540 kV, 240 kV, 118 kV) and reactive power is normalized to maximum reactive capability (33% of plant real-power maximum).

Reactive Power Requirements

Min. Mvar Power Capability at the POI



Revision 9 Update: the min. reactive was required for POI voltages 0.95 to 1.05. Now the min. reactive is adjusted for POI voltage as shown on the next slides.

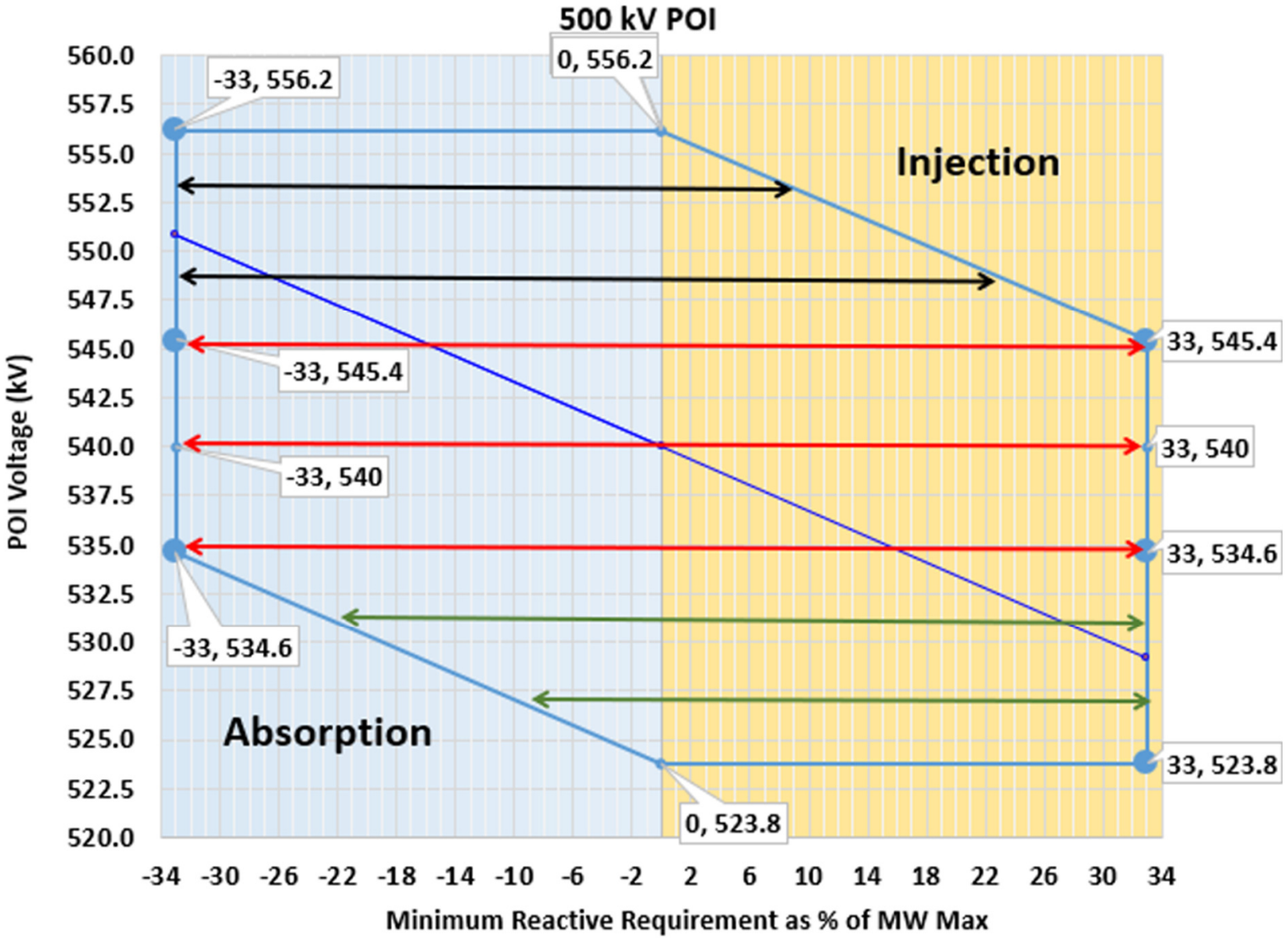
- A: Plants can exceed the minimum reactive capability.
- B: Resources are required to provide +/-33% of the plant's nameplate MW in dynamic reactive at the POI.
- C: Plants with technology unable to meet the minimum reactive capability at real power levels of 10% or less may request an assessment to determine if an exception is allowable.
- D: Energy storage components must provide +/-33% for its range of operation from injecting to absorbing real power.

Voltage Adjusted Minimum Reactive Power

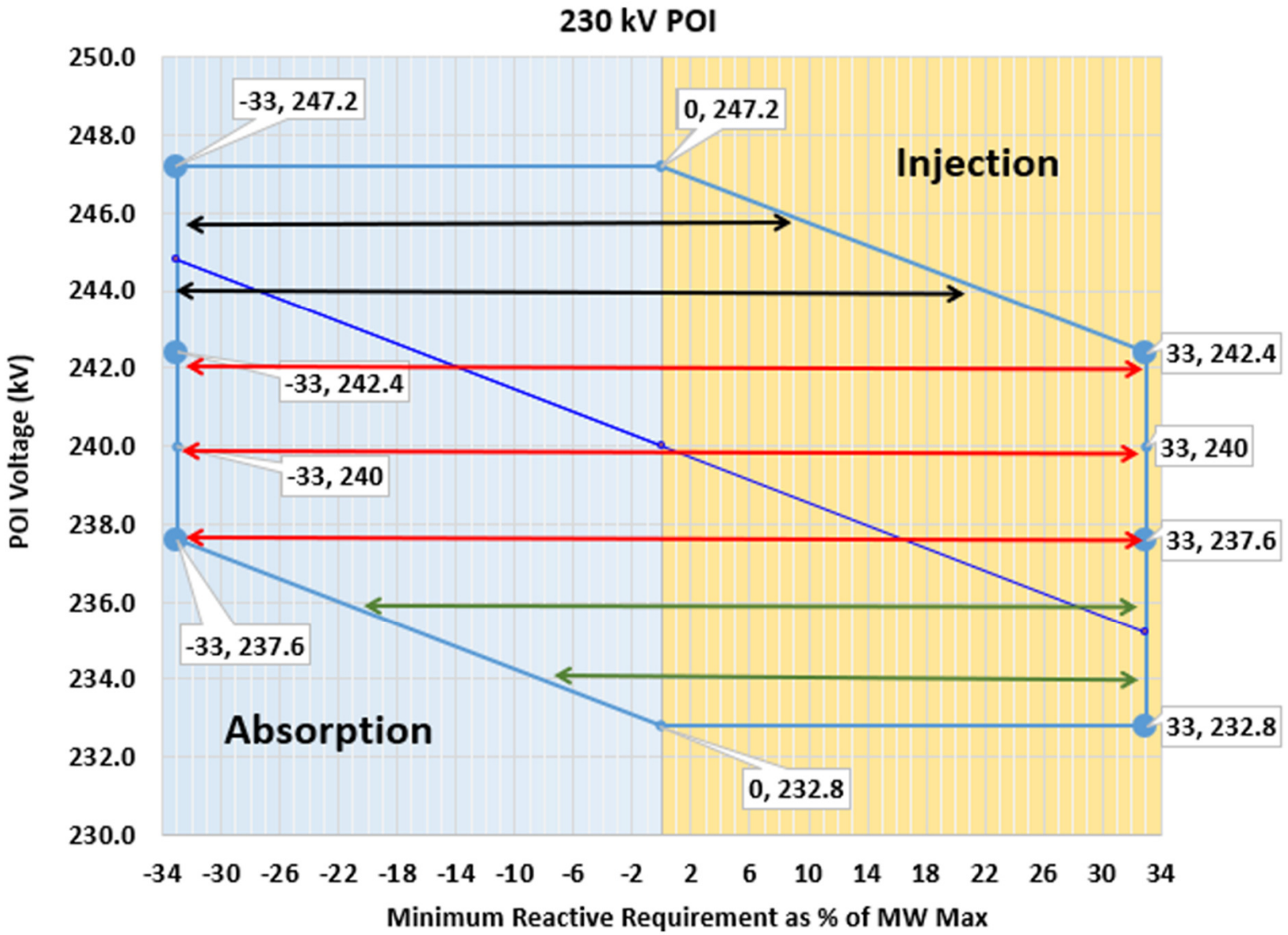
The Minimum Plant Reactive Capability requirements are to ensure a deliverable reactive capability for the defined POI voltage schedule and system conditions.

- **Scheduled Voltage** at the POI is sent to the plant.
- **Voltage Band** – around the scheduled voltage the full reactive capability is required. The band may range from 0 to +/-1.5% of the voltage schedule. *The default will be +/-1%*.
- **Adjusted Minimum Reactive Capability** – adjusts linearly from the edge of the band to zero at a percentage (+/-) from the scheduled voltage. The percentage can range from 2 to 5%. The defaults are +/-3% for 500 kV and 230 kV POIs and +/- 4% for 115 kV POIs.

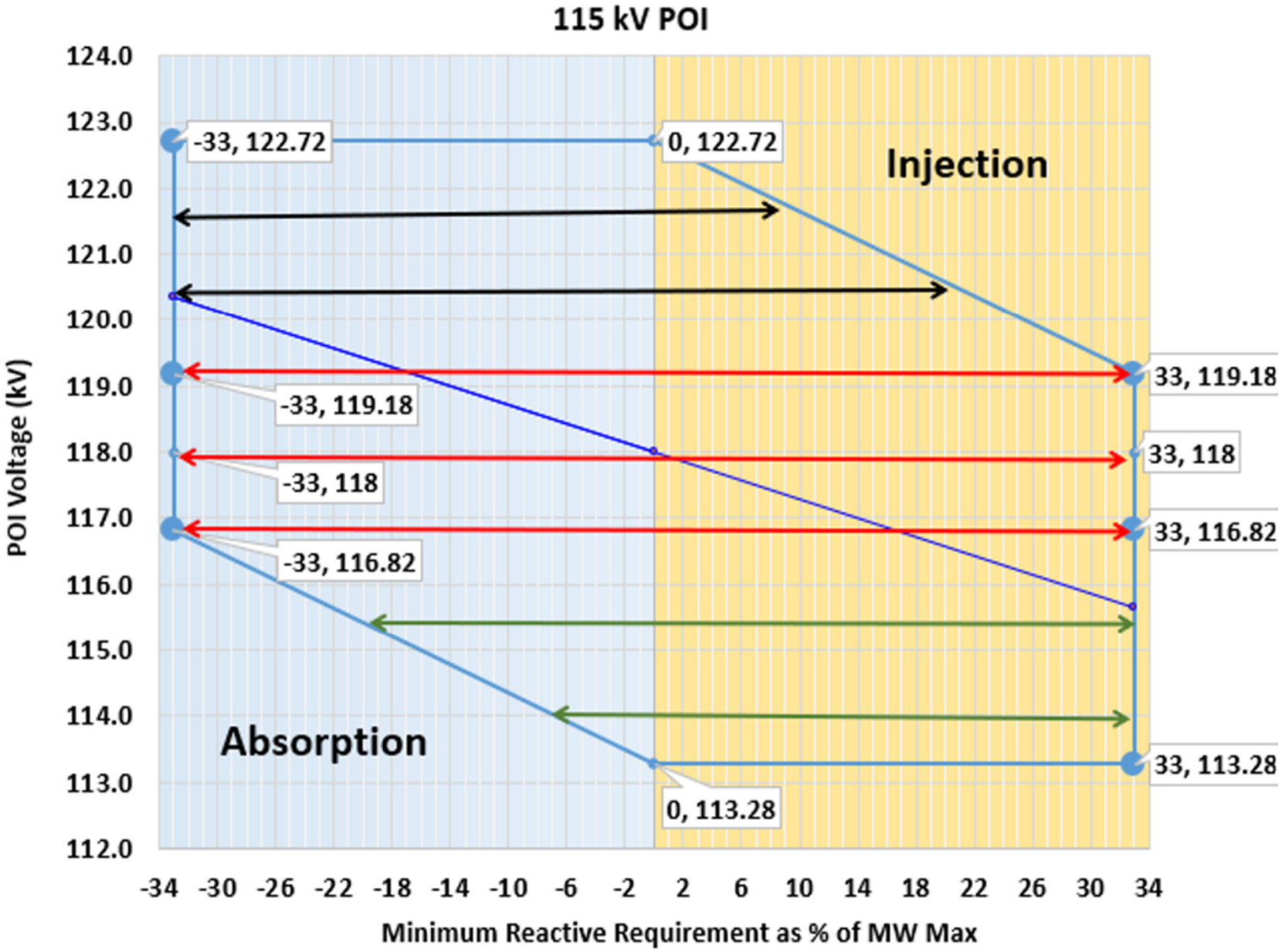
Voltage Adjusted Min. Reactive Power 500 kV POI



Voltage Adjusted Min. Reactive Power 230 kV POI



Voltage Adjusted Min. Reactive Power 115 kV POI



Frequency Control Requirements

(FERC ORDER 842, IEEE 2800, BPA STD)

Item	Requirement
Primary Frequency Response (FERC Order 842)	All new interconnecting generating facilities (large and small) shall install and enable primary frequency response capability as a condition of interconnection.
Real Power/Frequency droop control	**Droop should be set between 3% and 5%** with a total dead band (intentional plus unintentional) not to exceed **+/-0.06% of 60HZ (+/-36 mHZ)**.
Maximum step response time and overshoot	**Step response time < 5 seconds (0 to 90%)** **Overshoot < 10%**
Damping	Positively damped, ratio not specified at this time

Frequency Control Requirements

- When the step response time is not achievable due to physical limitations of the interconnecting plant, this requirement can be modified.
- The fastest response achievable by generating plant technology is required.
- It is expected that fast acting technologies, such as IBRs, should operate in less than 5 seconds and generation plants limited by slower prime movers, such as hydropower, may require a longer step response time.

Qualified Change

- NERC standard FAC-002-4, Facility Interconnection Studies, requirement 6 (R6) states that each Planning Coordinator shall maintain a publicly available definition of qualified change for the purposes of facility interconnection.
- Prior to a qualified change taking place, the facility owner must notify BPA of the qualified change and meet all interconnection requirements applicable to the qualified change.
- BPA will review the qualified change and determine the interconnection requirements applicable.

Qualified Change

- The Technical Requirements for Interconnection to the BPA Transmission Grid, Revision 9 defines qualified change for facility interconnections:
  - Qualified change for generation facilities and energy storage facilities
  - Qualified change for interconnection transmission facilities
  - Qualified change for end-user facilities

Commissioning Tests

- Revisions to STD-N-000001-01 “Required Voltage and Frequency Control Performance Commissioning Tests”
  - Clarified submission requirements
  - Clarified MW restrictions during testing - lessor of 25%, 40 MW
  - Added ramp rate restriction – 20 MW / minute
  - Requirement for “rise time” changed to “Response time”
  - New T2c test of inverter transitions, aligns with IEEE 2800 §5.1

- Will publish new version to BPA website

Changes to T1 – Voltage steps

- New overshoot requirement: <10%

- Voltage droop formula
  - Simplified numerator by removing ΔV_{step}
  - Different Mvar base → 3x change in value
  - Also increased required sensitivity moderately

Changes to T2 – Reactive Capability

- Added test T2c – maintain Q capability
  - Transitions available/unavailable power
- Clarified T2a, T2b
  - "…during times of no and low [MW] output…"
- Highlighted voltage swing requirement
  - No separate test, aligns with existing STD-N-1

Changes to T3 – Frequency steps

- Clarified response time requirement
- Edited example calc to conform with MW restrictions