



Inverter-Based Resource Performance Requirements

Interconnection Process Working Group (IPWG)

August 8, 2023

Updated 8/8/23

- Slide 4: Updated tag to “previously presented at 1/31/23 IPWG”.
- Slide 6: Updated table to include frequency response IEEE subclause 7.3.2.3.

Purpose & Key Takeaways



Purpose: Propose Inverter-Based Resource (IBR) performance requirement implementation approach based on system reliability needs

Key Takeaways:

- The industry has identified an immediate need to specify IBR performance that supports system reliability.
- Following a stepped approach to adopt IEEE 2800-2022, MISO incorporated many stakeholder feedback suggestions in the revised Tariff redlines specifying IBR performance requirements.
- MISO is proposing additional flexibility in the proposed tariff language to address implementation concerns some stakeholders raised and requests additional stakeholder feedback before taking the proposal to the Planning Advisory Committee.

2023 IPWG and PAC Schedule: Considering IEEE 2800 Inverter-Based Resource Performance Requirements

		Date	Objective
IPWG	{	January 31	Inform and educate on need for action
		March 14	Propose performance requirements prioritization [Feedback]
		May 2	Review feedback and share implementation plan
		June 20	Propose Tariff redlines [Feedback]
		August 8	Post feedback responses and share revised Tariff language [Feedback]
PAC	{	August 30	Present revised draft Tariff redlines [Feedback]
		October 11	Post feedback responses and final Tariff language

NERC is sounding the alarm on need for “Immediate Industry Action on Inverter-Based Resources”

- NERC reports on IBR tripping events illustrate growing impacts and a need to improve IBR performance requirements
- FERC’s November 2022, IBR Notice of Proposed Rulemaking¹ included directives on the same underlying performance issues

Planned Upcoming Reports:

- BESS-Related Events in California in 2022



<https://www.nerc.com/pa/rrm/ea/Pages/Major-Event-Reports.aspx>

Image source: NERC, 2022 Odessa Disturbance: Overview, Key Findings, and Recommendations. January 4th, 2023.
Available at: https://www.nerc.com/comm/RSTC/IRPS/2022_Odessa_Disturbance_Webinar.pdf

MISO is still reviewing FERC Order 2023, which in part modifies the *pro forma* agreements to incorporate ride through

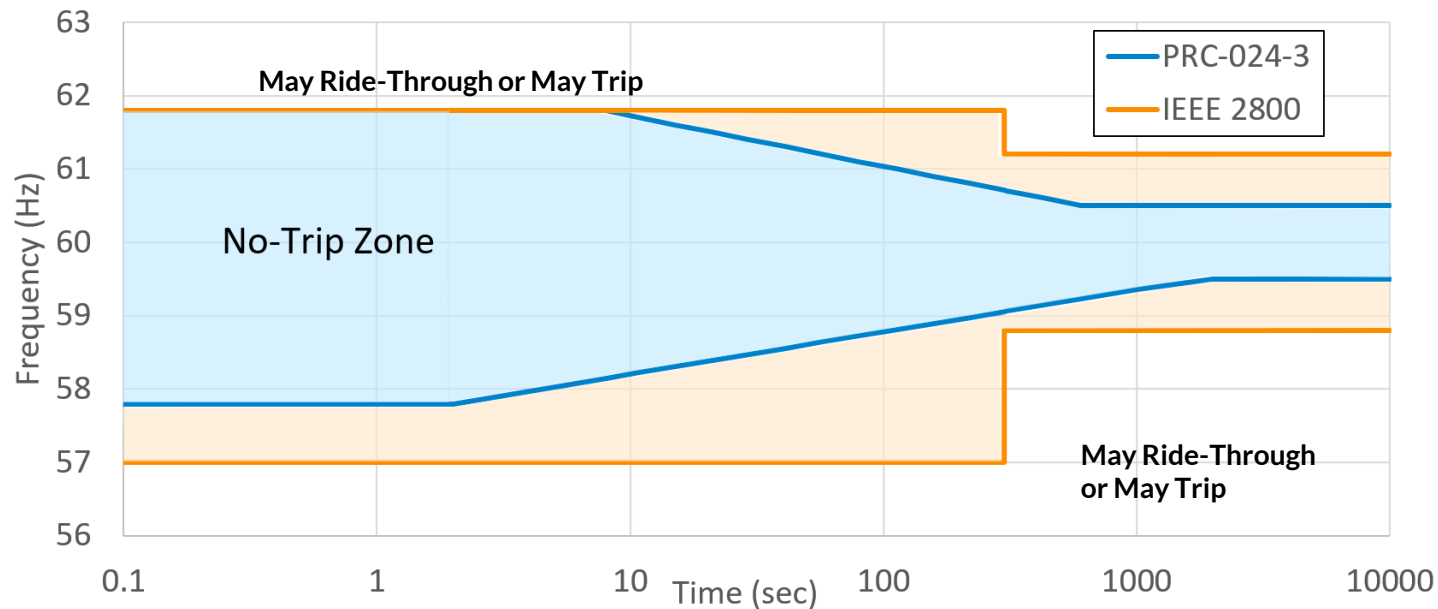
- Order 2003 requires additional ride through requirements when an IBR is in the “no trip zone” of PRC-024-3 or the successor standard. *Order 2023* at PP 1711–1735
- MISO is still investigating whether the requirements are specified in a manner suitable for industry conformance assessment frameworks.
- Further, MISO is investigating any impacts from language differences in how Order language usage of the term “ride through”, and the capability described in IEEE 2800-2022.
 - Order 2023 Pro forma LGIA at Section 9.7.3 [emphasis added]: *Interconnection Customer shall also implement under-voltage and over-voltage relay set points, or equivalent electronic controls, as required by the Electric Reliability Organization to ensure voltage “ride through” capability of the Transmission System.*
 - Order 2023 acknowledged the value of IEEE 2800-2022 but declined to expressly incorporate IEEE 2800-2022, noting that it was developed for a different purpose. *Order 2023* at P 1719

MISO's proposed redlines likely cover the ride through requirements in FERC's Order 2023

FERC Order 2023 ride through requirement	Mapping to IEEE 2800 / MISO requirement (IEEE 2800-2022 subclause in parentheses)
1. Continue active power production during disturbance and post disturbance at pre-disturbance levels. ¹	Current injection during voltage ride through (7.2.2.3.4) Frequency disturbances within the mandatory operation region (7.3.2.3)
2. Minimize reductions in active power and remain within dynamic voltage and current limits, if in reactive power priority mode. ¹	Current injection during voltage ride through (7.2.2.3.4) Frequency disturbances within the mandatory operation region (7.3.2.3)
3. Not artificially limit dynamic reactive power responses during disturbances.	Current injection during voltage ride through (7.2.2.3.4) Frequency disturbances within the mandatory operation region (7.3.2.3)
4. Return to pre-disturbance levels without artificial ramp rates if active power is reduced. ¹	Restore output after voltage ride through (7.2.2.6)

MISO is still reviewing this substantial order to fully understand the contents, compliance obligations, and any potential need for independent entity variations

IEEE 2800 frequency disturbance ride-through capability requirements are performance-based and extend beyond the NERC PRC-024-3 “No Trip Zone”



NERC Staff submitted a Standard Authorization Request to revise PRC-024, which was accepted by the Standards Committee on April 19, 2023.

The SAR in part said of PRC-024 that **“this standard is serving little to no value in ensuring BPS-connected inverter-based resources remain connected and support the BPS during grid disturbances”**

Specific IBR performance requirements are needed now as NERC standard development for IBR advances over the coming years

NERC Recommendation¹:

“NERC strongly encourages all Transmission Owners, Transmission Service Providers, ISO/RTOs, Reliability Coordinators, Balancing Authorities, and other relevant transmission entities to consider an appropriate yet comprehensive implementation of IEEE 2800-2022.”

NERC's Inverter-based Resource Performance Subcommittee (IRPS) updated its workplan in August 2022, showing 11 major initiatives planned to address IBR integration needs relevant to reliability.

The IEEE 2800-2022 and IEEE P2800.2 leadership has indicated adoption of the IEEE 2800 standard is possible now, but flexibility should be considered to ease conformance uncertainties.

- “Adoption of IEEE 2800 is not contingent upon publication/adoption of IEEE P2800.2”²
- “Needs consideration of enforcement date, grandfathering/flexibility for IBR Plants being built at the time of adoption”²

[1] NERC, IEEE 2800 OEM Readiness, October 2022.

Available at: <https://www.esig.energy/download/session-2-ieee-2800-oem-readiness-aung-thant/>

[2] IEEE PES, IEEE Std 2800-2022 presentation. May 2022.

Available at: https://www.nerc.com/comm/RSTC/IRPS/IEEE_2800-2022_EPRI-NAGF-NATF-NERC_May_3-2022_Joint_Webinar.pdf

MISO's proposal takes a stepped approach, prioritizing only the highest priority performance for adoption now

- MISO is proposing to **adopt roughly 1/3 of the major performance requirements** in IEEE 2800-2022.
 - MISO proposes adoption of 12 of the 37 major requirements.
- MISO limited the proposal to **items directly related to reliability and past IBR performance issues**.
 - Industry cannot wait several more years, as some stakeholder comments suggested (e.g., wait for IEEE P2800.2), to improve IBR performance requirements.

MISO is not alone in adopting IEEE 2800 now to address potential IBR performance gaps

Electric Power Research Institute (EPRI) is tracking which entities are currently adopting IEEE 2800 and what approach each entity is taking.

General Reference

- Florida Power and Light
- Salt River Project

Detailed Reference

- MISO
- New York ISO
- ISO New England
- Duke Energy
- Southern Company

Full Specification

- ERCOT
- Ameren IL

Questions or comments

Several key themes emerged through stakeholder feedback responses

- Weak grid condition considerations.
- Enter service criteria and performance preferences.
- Mixed feedback on defining Point of Interconnection (POI) as the Reference Point of Applicability (RPA).
- OEM readiness with respect to MISO's implementation proposal.

MISO made several substantive draft redline Tariff changes based on stakeholder input

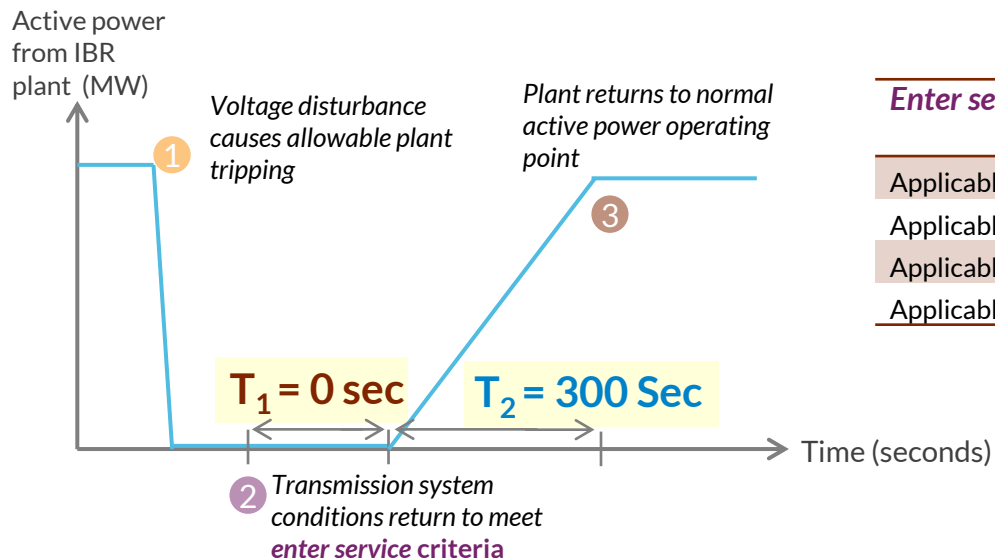
Stakeholder suggested change or question	MISO proposed redlines
For the minimum intentional delay performance, as defined in Subclause 4.10.3, b), use a default value of 0 seconds	Adopted the 0 second default value.
For the duration of the enter service period, as defined in Subclause 4.10.3, c), use a default value 300 seconds.	Adopted the 300 seconds default value.
Add language to clarify Transmission Owner Local Planning Criteria supersede MISO default requirements.	Added language to the opening paragraph to clarify.
Add exception for plants undergoing repowering with non-conforming equipment already on order.	Added Language to the new section F (Applicability) to document this exception.
Add footnote by the Enter Service Criteria table to state the defaults can be modified by TOs.	Added a footnote with the stakeholder suggested language.
Add language for exceptions for weak grid conditions.	Added footnote to call out weak grid issues. Since MISO adopted the standard by reference, all weak grid exceptions are adopted. MISO is avoiding replicating language for consistency.
Question on where nominal voltage is memorialized.	Added language clarifying nominal voltage specification in IEEE 2800, Subclause 4.3, is specified in Appendix C.

MISO proposes using the discussion in IEEE 2800 Annex C to conceptually define system strength and weak grid as a starting point for case-by-case consideration

- MISO thanks the TO Sector for drawing attention to stability concerns that may occur in weak grid systems.
- The Renewable Integration Impact Assessment that MISO published discusses some of these issues in detail.
- MISO anticipates that weak grid considerations will occasionally drive departures from default settings associated with active and reactive power responses.
- Some IEEE 2800-2022 sections adopted by MISO offer exceptions for weak grid conditions and MISO clarified tariff language surrounding the Transmission Owner's option to use non-default values.

MISO adopted stakeholder feedback for *enter service* criteria and performance as defined by IEEE 2800

The Transmission Owner sector offered default values for Enter Service Performance (i.e., T_1 , T_2) which, given no other stakeholder opposition, were adopted by MISO



<i>Enter service criteria</i>	Default Proposal	Range of allowable settings
Applicable voltage, minimum value	0.90 p.u.	0.9 p.u. to 0.95 p.u. ¹
Applicable voltage, maximum value	1.05 p.u.	1.05 p.u. to 1.10 p.u. ²
Applicable frequency, minimum value	58.8 Hz	58.8 Hz to 59.4 Hz
Applicable frequency, maximum value	60.12 Hz	60.12 Hz to 61.2 Hz

- Stakeholders shared various perspectives on the MISO proposal.
- MISO considers further adjustments to be most appropriate on a case-by-case basis.

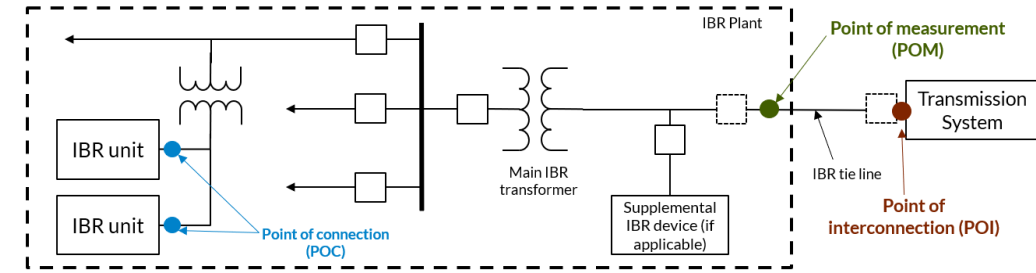
T_1 represents the **intentional adjustable minimum delay**, with a *range of allowable settings* from 0 s to 60 s.
 T_2 represents the **duration of *enter service* period**, with a *range of allowable settings* from 1 s to 1000 s.

[1] Transmission Operator or Transmission Owner and IBR Operator may agree on different minimum voltage value for weak grid interconnections.

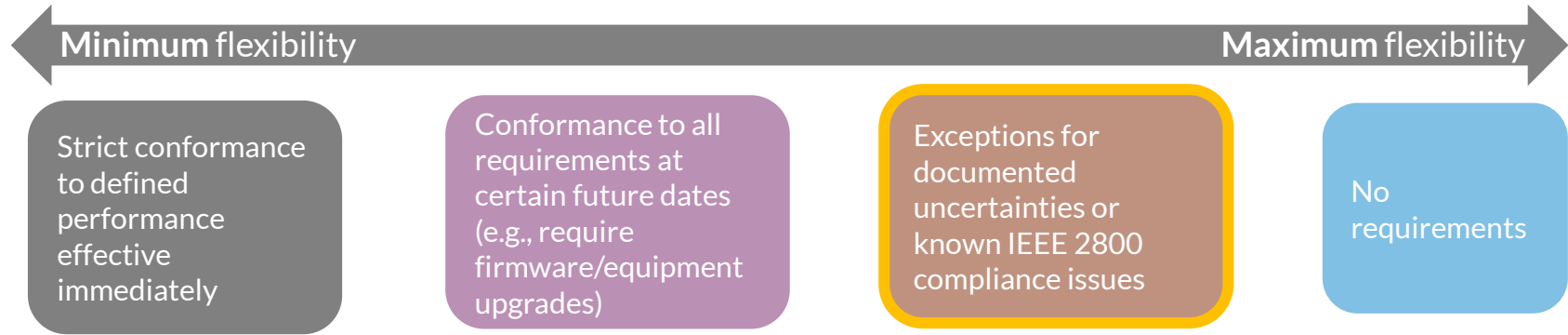
[2] Voltages above 1.05 p.u. may be outside of the current interrupting capability of fault-interrupting devices rated based on ANSI C84.1.

MISO views the RPA at POI selection as the best reliability-supporting selection

- Stakeholder feedback was mixed on MISO's proposal for the RPA to be at the POI.
- Some stakeholder feedback was based on current application of NERC standards, though MISO views the specific standard language as requiring flexibility.
 - PRC -024-3: "When evaluating protection settings, consider the voltage differences between where the protection is measuring voltage and the high side of the GSU/MPT."
 - VAR-002-4.1: "Generator Operators that do not monitor the voltage at the location specified in their voltage schedule shall have a methodology for converting the scheduled voltage..."
- FERC has established precedent for performance requirements at the POI
 - FERC SGIA (RM16-1-000): "to design its generating facility to maintain a composite power delivery at continuous rated power output at the Point of Interconnection at a power factor¹ of 0.95 leading to 0.95 lagging, or a different range if adopted by the Transmission Provider..."
- MISO understands potential POI substation implications and is requesting additional feedback



MISO views a degree of flexibility for DPP-2022 performance requirements as striking a balance between facilitating needed reliability attributes while managing uncertainties



MISO proposes offering exceptions to specific IEEE 2800-2022 capabilities and performance requirements through documented evidence of conformance uncertainties or shortfalls.

MISO proposes new flexibility for standard adoption and is requesting additional stakeholder feedback

DPP-2022

For the DPP-2022-Cycle, MISO proposes that Interconnection Customers request exceptions to specific IEEE 2800 subclauses adopted by MISO based on documented OEM uncertainties or known inability to meet certain performance specifications.

- MISO will accept the OEM-documented exceptions in good faith and memorialize as enduring exceptions to the currently proposed IBR requirements in Appendix C of the GIA.
- Firmware-related conformance issues shall be addressed within 60 calendar days of firmware becoming commercially available.
- Exception requests for GIAs executed on or after January 1, 2025, will not be granted.

DPP-2023

For the DPP-2023-Cycle, based on feedback, MISO proposes full compliance with all MISO-adopted IEEE 2800 requirements.

- While some stakeholder preferred to wait for completion of IEEE P2800.2, most agreed that plants would have little issue conforming with this DPP cycle, if not an earlier one (e.g., 2022).

Questions or comments

Next steps

- MISO will continue to assess potential interactions between FERC Order 2023 and MISO's proposed tariff redlines.
- Stakeholders are invited to share feedback on MISO's revised tariff redlines, with particular focus on the new paragraph on conformance flexibility.
- MISO will respond to stakeholder feedback and adjust Tariff redline language as needed prior to presenting the proposed changes to PAC.
- As the Tariff redlines are finalized, MISO is continuing to evaluate whether BPM changes are needed.

Stakeholder Feedback Request

- MISO is requesting feedback on the **Proposed IBR Performance Requirements** presented today by August 29, 2023.
 - Proposed changes to MISO's draft Generator Interconnection Agreement redline language with a focus on the new paragraph outlining flexibility based on specific OEM conformance issues.
 - Feedback from Transmission Owners on the feasibility of Interconnection Customer equipment being allowed at POI substations to further inform RPA at POI proposal.
- Feedback requests and responses are managed through the Feedback Tool on the MISO website: <https://www.misoenergy.org/stakeholder-engagement/stakeholder-feedback/>



Questions or comments?

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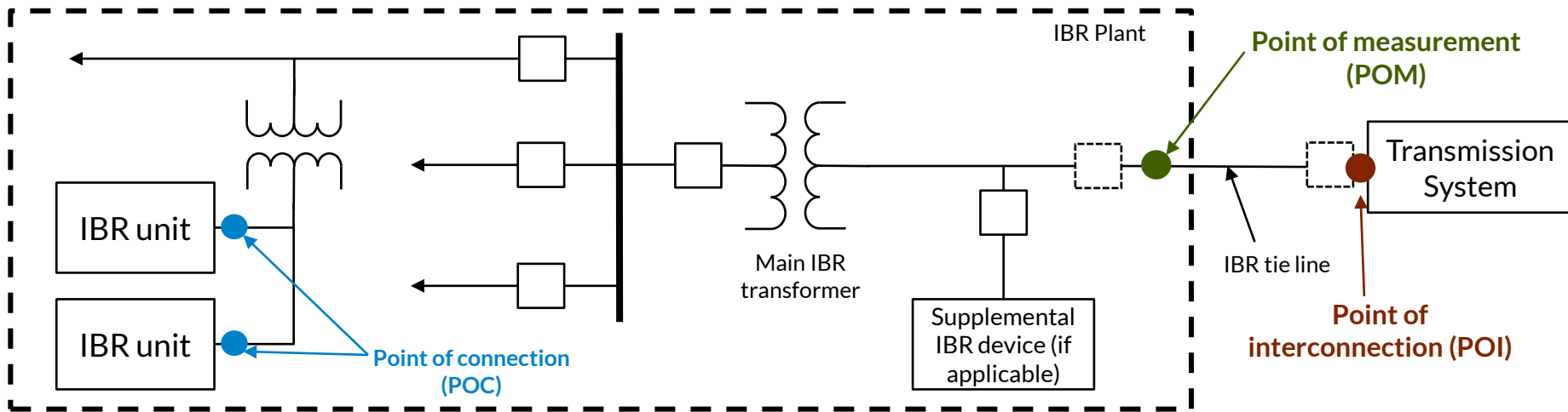
Appendix

In addition, MISO made several editorial redline Tariff changes based on stakeholder input

Stakeholder suggested change	MISO proposed redlines
Add header to existing section discussing applicability of Appendix G requirements.	Section moved to the end and labeled “F”. No changes were proposed to the existing language in that paragraph.
Suggest removing remaining reference to non-synchronous generation for consistency.	Reference removed and replaced with “IBR plants” for consistency.

MISO is proposing defining the reference point of applicability (RPA) as the point of interconnection for most requirements

- The RPA is location where capabilities and performance requirements apply in the standard.
- Default RPA is the **point of measurement (POM)** for all IBR plant ride-through requirements, which is the high side of the IBR plant main transformer.
- However, MISO is observing a trend in other regions in defining the RPA as the **point of interconnection (POI)** for most functions.¹
- MISO seeks stakeholder feedback on the proposal to define the RPA as the POI, as described in draft Tariff redlines.



Links to previous 2023 MISO presentations on IBR Performance:

- [January: 20230131 IPWG Item 04 IBR Performance Requirements.pdf](#)
- [March: 20230314 IPWG Item 05 IBR Performance Requirements.pdf](#)
 - [Stakeholder Feedback and MISO Responses](#) (Posted 4/3/23)
- [May: 20230502 IPWG Item 04 IBR Performance Requirements.pdf](#)
- [June: 20230620 IPWG Item 05 IBR Performance Requirements.pdf](#)
 - [Stakeholder Feedback and MISO Responses](#) (Posted 8/1/23)