AEMC

Australian Energy Market Commission

Technical Working Group

Improving the NEM access standards – Package 2

20 July 2026

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Agenda for the TWG

1	Overview of the policies considered in this TWG meeting	Slides 6-9
2	We are considering ways to refine our proposed tiering framework	Slides 10-15
3	We are considering ways to refine the proposed disturbance ride-through access standards	Slides 16-35
4	We are considering ways to refine the proposed instability monitoring access standard	Slides 36-42

1

Introduction

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Background and context to the *Improving the NEM access standards – Package 2* rule change

The NEM access standards define the permissible range of technical requirements that connection applicants must meet to connect to the NEM. Under NER clause 5.2.6A, AEMO must review the technical standards at least once every five years.

In its first review completed in December 2023, AEMO identified numerous opportunities to improve the current standards and their application to ensure efficient plant performance and speedier, cost-effective NEM connections. On 4 April 2024, AEMO submitted a two-package rule change request to the AEMC to give effect to its review recommendations. Package 1 was completed via the fast-track process on 22 May 2025.

On 8 May 2025, the AEMC initiated Package 2 (the focus of this TWG), and we published a draft rule determination on 12 March 2026. We received over 30 submissions from stakeholders that provided helpful feedback on refining the proposed draft rule.

2023 to 2024
AEMO reviewed the technical requirements for connection and lodged a rule change request

8 May 2025
AEMC initiated AEMO's rule change request and published a **consultation paper**

Oct/Dec 2025
AEMC hosted three **TWG** meetings

submissions due

12 March 2026
AEMC published the **draft determination** and draft rule

submissions due

20 July 2026
AEMC hosts another **TWG** meeting

29 October 2026
AEMC is due to publish the **final determination** and final rule (if made)

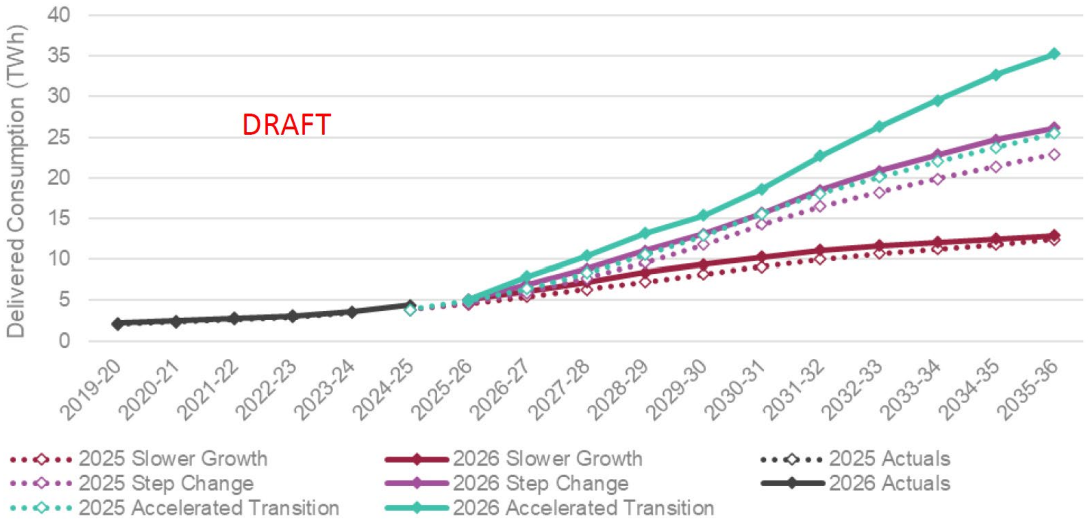
Our *Improving the NEM access standards – Package 2* draft rule seeks to modernise access standards for large inverter-based loads

The AEMC's draft rule modernises the NER to ensure large inverter-based loads (IBLs), including data centres, can connect to the NEM in a way that supports the ongoing secure and reliable operation of the power system. It introduces fit-for-purpose, proportionate technical requirements, establishes a clearer regulatory framework and streamlines the connection process.

With electricity demand from large IBLs forecast to increase rapidly over the coming decades, the regulatory framework must keep pace with evolving technologies while continuing to support investment in Australia's digital economy. As these loads become more prevalent, it is increasingly important that they respond predictably to network disturbances.

A centre-piece of the draft rule is therefore the introduction of new disturbance ride-through requirements to reduce the risk of unnecessary disconnection, helping to maintain a secure, stable and resilient power system.

AEMO, updated draft projections on data centre demand



May 2026 Forecasting Reference Group (FRG) meeting materials, slide 48.

The draft rule delivers three key outcomes

1. New access standards for large IBLs in relation to disturbance ride-through and managing power system instability
2. A clear regulatory framework for classifying large IBLs to ensure the proportionate application of technical standards
3. Targeted improvements to the broader access standards framework, including for compliance and enforcement

Focus for today's TWG discussion

The purpose of this TWG meeting is to explore ways to address the feedback to the draft determination on (1) the tiering framework, (2) the disturbance ride-through standards, and (3) the instability monitoring standard. This will help us with developing the final rule determination.

If stakeholders wish to discuss other policy matters relating to this project, please feel free to reach out.

2

We are considering ways to refine our proposed tiering framework

Today, we will:

- Provide a recap of the draft tiering framework
- Discuss key stakeholder feedback
- Consider options for refining the framework
- Discuss proposed aggregation and modelling principles
- Identify preferred policy direction and any remaining issues.

3

We are considering ways to refine the proposed disturbance ride-through access standards

Stakeholders broadly support the draft ride-through framework. Today's discussion focuses on three areas where feedback suggests the draft rule could be refined:

- Behaviour during disturbances: How should IBLs behave during and immediately after voltage disturbances?
- Under-voltage ride-through: Should the low-voltage ride-through requirements be strengthened to account for more slowly cleared faults?
- Over-voltage ride-through: Should the final rule include stronger over-voltage and transient over-voltage requirements?

4

We are considering ways to refine the proposed instability monitoring access standard

Today, we will discuss stakeholder feedback and consider:

- What guidance is needed, and who should provide it?
- Should phasor measurement units (PMUs) be mandatory for all IBLs over 100 MW?
- How can we clarify the modelling expectations for demonstrating that an IBL does not cause instability?

2

We are considering ways to refine our proposed tiering framework

Our draft determination proposed a three-tiered framework for determining the application of S5.3 access standards to DNSP connections

	Tier	Size	Plant type	Application of S5.3	Expected modelling
	Tier 1	< 30 MW	IBL connections to **distribution networks**	• NSP must apply the applicable S5.3 access standards to the extent that the plant would otherwise adversely affect the quality or security of network service *Note: this maintains the existing NSP discretion* *Note: **Non-IBL load connections to distribution networks**, regardless of MW size, would be considered as being like a Tier 1 connection, consistent with the existing framework* • Regarding the new disturbance ride through access standards under the draft rule, the NSP may apply them only to the extent that there may be an **aggregate** of Tier 1 loads that may have an adverse system security impact.	Low degree
LARGE IBL	**Tier 2**	30 – < 100 MW	Large IBL connections to **distribution networks**	• NSP must apply the applicable S5.3 access standards to the extent that the load would otherwise adversely affect the quality or security of network service. • Regarding S5.3 access standards that only apply to IBL, including the new proposed standards, **the NSP may apply those access standards to the extent it considers appropriate**, having regard to the expected impact of the connection on the quality and security of network services to other network users *Note: this maintains the existing NSP discretion*	Moderate degree
LARGE IBL	**Tier 3**	> 100 MW	Large IBL connections to **distribution networks**	• All S5.3 access standards automatically apply, including (for IBL) any IBL specific access standards. *Note: This removes existing NSP discretion* *Further note: all load connections to **transmission networks**, or registered loads, regardless of MW size, would be considered as being like a Tier 3 connection, consistent with the existing framework*	High degree

Stakeholder feedback broadly supported the framework and called for targeted refinements

	What we heard	Staff-level proposed response
1	Apply the tiering framework to all Schedule 5.3 plant connections across transmission and distribution networks, recognising that some transmission-owned assets operate at lower voltages (e.g. 132 kV), making ownership-based distinctions impractical.	Harmonise the application of the tiering framework to all S5.3 connections to harmonise the obligations, promote consistency, and recognise lower voltage IBL connections
2	Broad NSP discretion for Tier 2 may lead to inconsistent outcomes and adversely affect system security. Many stakeholders considered that S5.3 should automatically apply to large IBLs (Tier 2+)	Automatically apply S5.3 access standards from Tier 2 onward to provide consistency and regulatory certainty for large IBLs. We are considering the role of Tier 3 in this TWG.
3	Maintain NSP discretion on the application of S5.3 access standards for smaller, Tier 1 IBLs, recognising that alone, Tier 1 IBLs are less likely to present adverse risks to the power system	Retain Tier 1 as proposed in the draft determination, so that S5.3 access standards apply to IBLs < 30 MW at the NSP's discretion, with flexibility to consider aggregate impacts
4	There was strong support for ensuring the framework captures the aggregate impact of electrically integrated campuses, or clustered IBL connections	Introduce aggregation principles in the NER for NSPs to assess the cumulative load impacts and determine which tier applies to prevent projects from splitting to avoid higher tier obligations
5	Provide clear principles on modelling for demonstrating compliance with S5.3, whilst keeping detailed requirements in AEMO guidance to enable flexibility for evolving technologies	Embed high-level modelling principles in the NER, consistent with our tiering framework, with the details provided in AEMO guidelines, such as the PSMG
6	Clarify the treatment of hybrid, co-located and staged developments under Chapter 5 of the NER, and clarify how AEMO's advisory role applies across the tiering framework	We will publish an industry fact sheet to clarify when S5.2 and S5.3 would apply to connecting loads and IBLs, and better define AEMO's advisory function for S5.3 access standards

We are considering ways to refine the tiering framework – Option 1

Option 1 maintains the three connection tiers; however, S5.3 access standards would apply automatically from Tier 2 onward (rather than from Tier 3). The key difference between Tiers 2 and 3 would be the expected modelling required to demonstrate compliance.

	Tier	Size	Plant type	Application of S5.3	Aggregate impacts	Modelling
	Tier 1	< 30 MW	IBL connections to **distribution and transmission networks**	• NSP must apply the applicable S5.3 access standards to the extent that the plant would otherwise adversely affect the quality or security of network service *Note: this maintains the existing NSP discretion* *Note:* ***Non-IBL load connections****, regardless of MW size, would be considered as a Tier 1 connection, consistent with the existing framework*	For the purposes of determining the applicable assessment tier and assessing compliance with Schedule 5.3, a Network Service Provider must have regard to the aggregate technical characteristics of two or more inverter-based loads where, having regard to their electrical configuration, connection arrangements and intended operation, it is reasonable to assess those loads collectively.	Low degree
LARGE IBL	**Tier 2**	30 – < 100 MW	Large IBL connections to **distribution and transmission networks**	• All S5.3 access standards automatically apply, including any IBL specific access standards. *Note: this removes the existing NSP discretion* *Further note: all registered loads, regardless of MW size or load plant type, would be considered as being like a Tier 2-3 connection, consistent with the existing framework*		Moderate degree
LARGE IBL	**Tier 3**	> 100 MW	Large IBL connections to **distribution and transmission networks**	• All S5.3 access standards automatically apply, including any IBL specific access standards. *Note: This removes existing NSP discretion* *Further note: all registered loads, regardless of MW size or load plant type, would be considered as being like a Tier 2-3 connection, consistent with the existing framework*		High degree

= proposed refinement

We are considering ways to refine the tiering framework – Option 2

Option 2 removes Tier 3, and the S5.3 access standards would apply automatically from Tier 2 onward (rather than from Tier 3). Expected modelling for demonstrating compliance would still be commensurate with plant size and system impact.

	Size	Plant type	Application of S5.3	Aggregate impacts	Modelling
Small IBL	< 30 MW	IBL connections to **distribution and transmission networks**	• NSP must apply the applicable S5.3 access standards to the extent that the plant would otherwise adversely affect the quality or security of network service *Note: this maintains the existing NSP discretion* *Note: **Non-IBL load connections**, regardless of MW size, would be considered as a Tier 1 connection, consistent with the existing framework*	For the purposes of determining the applicable assessment tier and assessing compliance with Schedule 5.3, a Network Service Provider must have regard to the aggregate technical characteristics of two or more inverter-based loads where, having regard to their electrical configuration, connection arrangements and intended operation, it is reasonable to assess those loads collectively.	Low degree
LARGE IBL **Large IBL**	> 30 MW	Large IBL connections to **distribution and transmission networks**	• All S5.3 access standards automatically apply, including any IBL specific access standards. *Note: this removes the existing NSP discretion* *Further note: all registered loads, regardless of MW size or load plant type, would be considered as being like a Tier 2-3 connection, consistent with the existing framework*		Moderate to high degree

= proposed refinement

We have developed staff-level policy thinking on the aggregation and modelling principles

Does the TWG consider it beneficial to include clear aggregation assessment options in the NER to address clustered connections?

We propose introducing a general principle in the NER for addressing aggregate connections when assessing the applicable S5.3 connection Tier.

The principle would be intended to achieve the following policy impact:

> *For the purposes of determining the applicable assessment tier and assessing compliance with Schedule 5.3, a Network Service Provider must have regard to the aggregate technical characteristics of two or more inverter-based loads where, having regard to their electrical configuration, connection arrangements and intended operation, it is reasonable to assess those loads collectively.*

Issue addressed	Where it matters	Example
Anti-avoidance	Tiering classification	Prevent splitting a 120 MW campus into four 30 MW applications
Cumulative network impacts	Tier 1 and Tier 2 assessment	Several clustered IBLs collectively behave like a large IBL through coincident reconnection or load ramp down
Technical interaction	Modelling assessment across the tiers	Common control systems, UPS interactions, common-mode disturbance response, coordinated restoration

Does the TWG consider that NER modelling principles could support better compliance outcomes and transparent expectations?

Many stakeholders called for greater clarity on modelling expectations and requirements for demonstrating compliance with S5.3 access standards.

We propose including modelling principles in the NER for AEMO to consider when developing modelling requirements for S5.3 plant, consistent with our proposed tiering framework.

Providing high-level principles in the Rules would establish the policy intent of the modelling framework while preserving AEMO's flexibility to determine the detailed technical requirements through consultation.

We have provided modelling principles below, and propose that AEMO/NSP modelling requests should include a rationale on how it meets the principles.

1. **Proportionality** – Graduated modelling requirements based on the tiering framework, scaled according to project size, complexity and system impact
2. **Materiality** – Modelling requirements should be limited to information reasonably necessary to assess compliance with the applicable access standards
3. **Consistency** – Equivalent IBLs (data centres, hydrogen electrolysers, etc.) should be subject to consistent modelling requirements regardless of connection location or NSP, where it is reasonably practicable
4. **Practicability** – Recognise evolving modelling capability and permit representative/generic models where appropriate
5. **Efficiency** – Streamline the connection process by avoiding unnecessary or duplicative modelling
6. **Transparency** – Clearly communicate modelling expectations and acceptance criteria

3

We are considering ways to refine the proposed disturbance ride-through access standards

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Stakeholders broadly support the draft disturbance ride-through standards and have identified opportunities for refinement

Stakeholders across industry sectors strongly support the introduction of disturbance ride-through requirements. Today's discussion focuses on areas where stakeholders suggested refinements and how we can address this feedback.

Most submissions to the draft determination were supportive of our proposed disturbance ride-through access standards or suggested improvements to specific aspects of the access standards.

This was consistent across TNSPs, DNSPs, data centre operators, technology providers, and AEMO.

We received specific feedback to refine the proposals for the voltage disturbance ride-through requirements, active power recovery, frequency ride-through, and multiple fault ride-through policies.

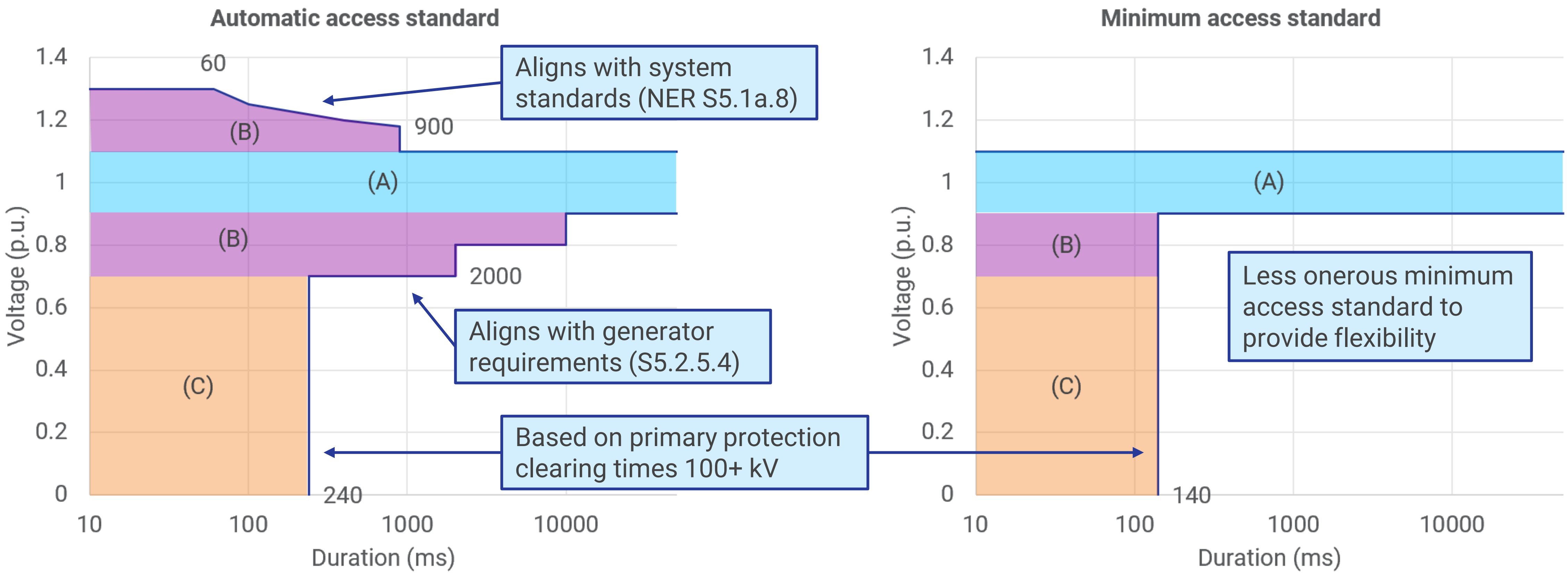
- Some submissions advocated for stricter access standards to better support system security.
- Some also considered that AEMO and NSPs should be able to impose more onerous location-specific performance standards, where system security requires.
- No stakeholders opposed the introduction of ride-through access standards.

Based on the stakeholder feedback received, today's TWG discussion will focus on the following topics:

1. **Topic 1:** Active power recovery, and the behaviour of IBL during disturbances (slides 20-26)
2. **Topic 2:** Design of the low voltage ride-through curve (slides 27-32)
3. **Topic 3:** Design of the high voltage ride-through curve and transient over-voltages (slides 33-35)

The draft rule proposed over-voltage and under-voltage ride-through requirements for IBL

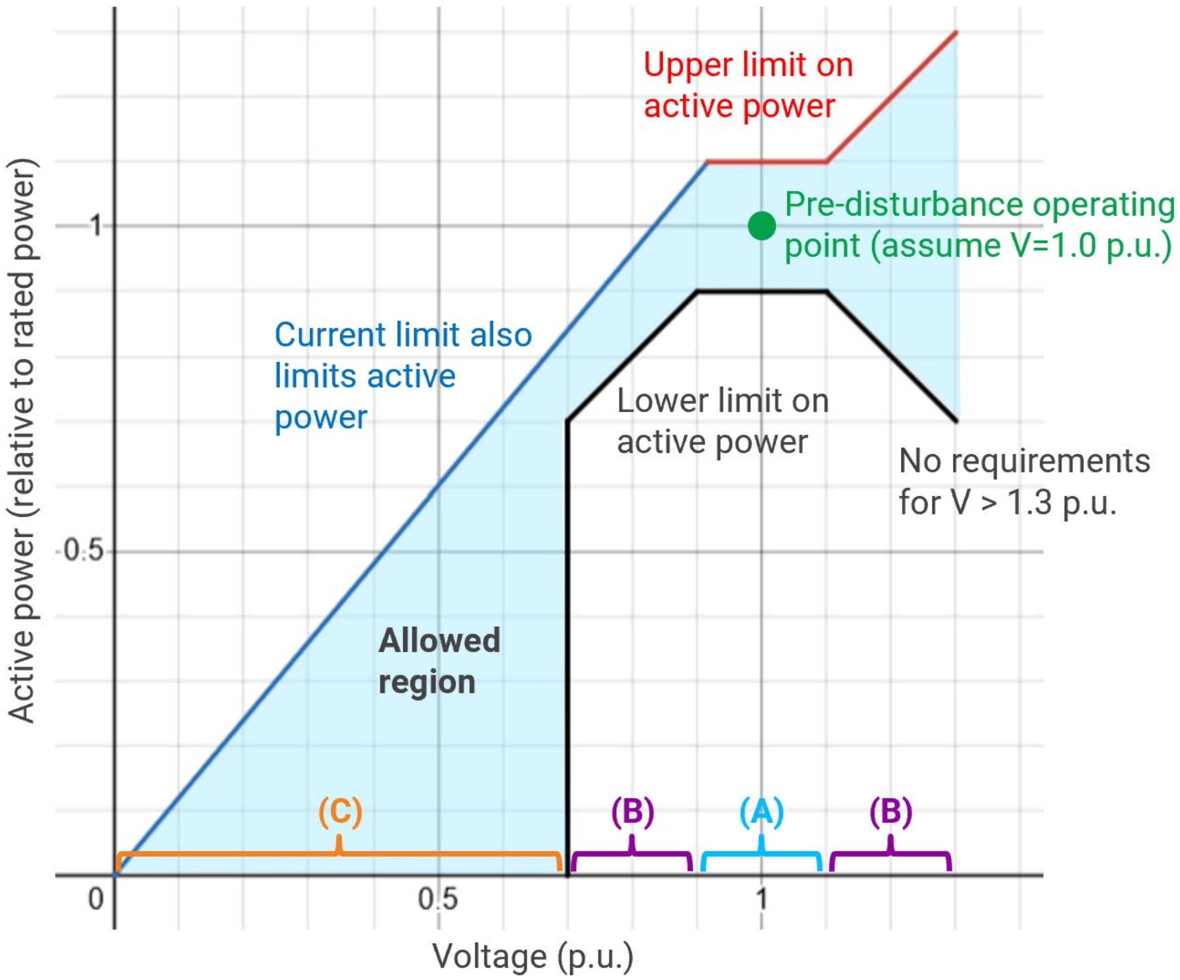
Overview



Region A: Plant must not disconnect during a disturbance. Active power and current limits apply.
Region B: Plant must not disconnect during a disturbance. Active power limits, current limits, and post-fault active power recovery apply.
Region C: Plant is permitted to disconnect, but post-fault active power recovery applies.

The draft rule specified active power response requirements during disturbances and post-fault recovery

Active power operating envelope during voltage disturbances



Active power and current limits

During a voltage disturbance, IBL must stay connected and comply with the active power and current limits shown by the shaded region.

- IBL must not increase its current by more than 20% of the rated current during a disturbance
- Other active power limits are relative to the pre-disturbance active power level.

These limits are subject to the ride-through curves on slide 18. For example, the limits would no longer apply if the voltage dropped to 0.7 p.u for more than 2000 ms.

Post-fault active power recovery

For a disturbance within regions B or C on slide 18, IBL must return to within 90-110% of its pre-disturbance active power level within:

- 500ms (automatic access standard)
- 1000ms (minimum access standard)

after the end of the disturbance.

There is flexibility for NSPs/AEMO to provide an exemption from the minimum access standard if the IBL cannot meet this standard.

Compliance is measured at the connection point. The computational workload does not matter if the IBL plant consumes active power – this could be achieved by charging a battery, for example.

1

Behaviour of IBL during and after voltage disturbances

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Topic 1 overview: Behaviour of IBL during and after voltage disturbances

In today's meeting we will be discussing the feedback we have received on how the draft rule regulates the behaviour of IBLs during and after voltage disturbances.

Why we included active power limits and recovery in the draft rule

- Generators usually need to remain in continuous uninterrupted operation (CUO) as defined in the NER during voltage disturbances, but we consider that this definition (in full) would not work well for loads.
- We considered simply requiring the load to stay connected to the network.
- However, staying connected is not sufficient to address the risks of large IBL disconnections, because loads may reduce their active power (potentially to zero) without strictly disconnecting.
- The active power limits and recovery requirements describe the behaviour that we need from IBL during and after disturbances to address the system security risks we identified.

Submissions to the draft determination provided feedback on how we can improve this aspect of the draft rule

- Some stakeholders were concerned that the post-fault recovery requirement may not be effective in all circumstances or may have unintended consequences.
- Some also considered that there was not enough evidence to support the choice of specific recovery times and specific limits from a power system security perspective.

In this section, we will discuss:

1. What are the risks and impacts of IBL disconnection due to a (deep) voltage disturbance?
2. How can post-fault active power recovery address those risks? Are there unintended consequences, and what is their impact?
3. How else could we regulate the behaviour of IBL during and after disturbances? For example, by:
   - Improving on the draft rule for active power and current limits
   - Requiring a form of continuous uninterrupted operation for IBL, instead of active power limits and/or temporary disconnection

Active power recovery: AEMO study on active power recovery impact on export limits

Some submissions requested more evidence for the choice of active power recovery times for the draft rule. We note that AEMO conducted studies to quantify the sensitivity of the Victoria-NSW transient stability export limit to the recovery time of data centre loads following a transmission system fault, which supports the 500 ms automatic access standard.

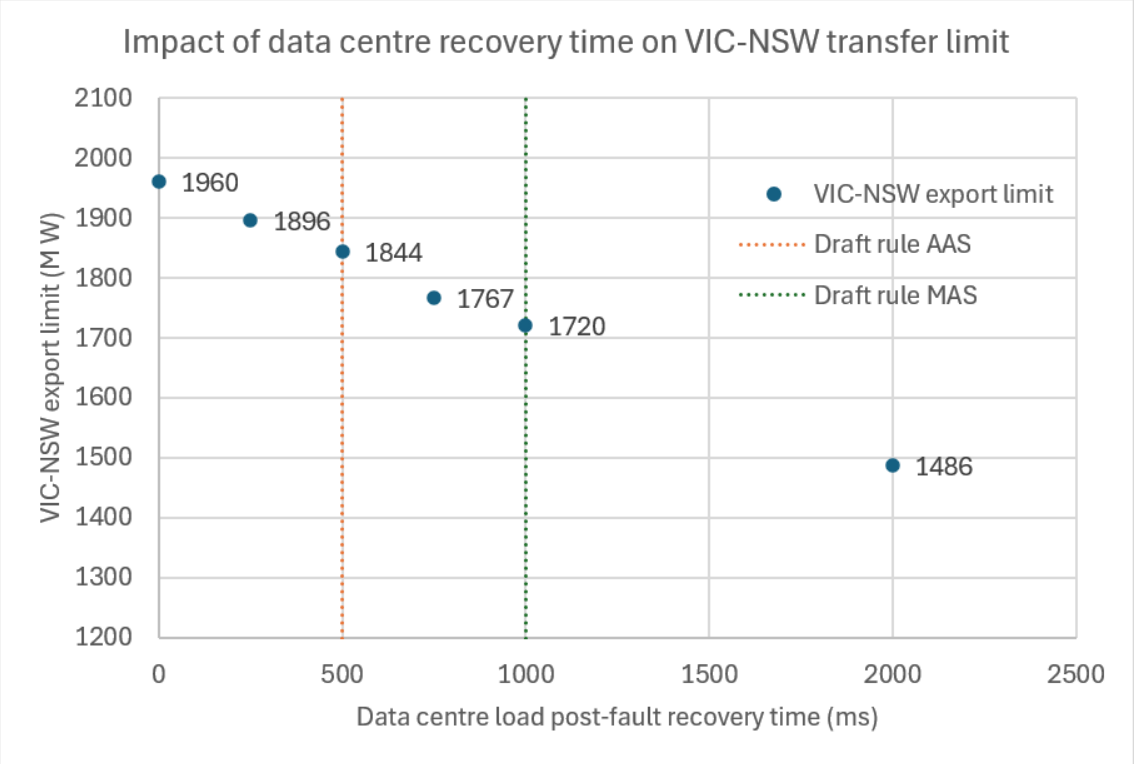
Details of AEMO's study

AEMO's study applied a two-phase-to-ground transmission fault near Hazelwood and determined the impact on the Victorian transient export limit for different load recovery times.

- The transient export limit reduces approximately linearly with recovery time.
- If all data centres complied with the draft rule automatic access standard, export capacity would be reduced by 6% (compared with instantaneous recovery).
- We consider this reduction is manageable and therefore the study results support an automatic access standard of 500ms.

Conditions and assumptions

- Fault location: Hazelwood – South Morang No.2 500kV line near Hazelwood (VIC).
- Fault clearance time: 80ms at Hazelwood, 100ms at South Morang.
- System loading and generation: aligned with recent typical conditions where the Victorian transient export limit was binding.
- Total data centre load: 1577MW in western metropolitan Melbourne, based on forecasts.
- Planned transmission network augmentation to 2030/31, including VNI West, is included.
- All data centre loads have the same recovery behaviour.



Key takeaway

Increasing post-fault recovery times progressively reduces the secure VIC–NSW transfer limit. AEMO found that the draft rule's proposed automatic access standard of 500 ms recovery time results in only a modest (approx. 6%) reduction in export capability – an appropriate trade-off between system security and network capability.

The chart shows total data centre recovery = varying wait time + 20ms ramping time.
Exception: 0ms recovery time = 0ms wait + 0ms ramping.
Wait time commences when the voltage recovers to 0.9 p.u.

Active power recovery: Summary of stakeholder feedback

While AEMO’s study helps support the proposed automatic access standard, stakeholder feedback suggests that the draft rule recovery time of 500ms may not fully resolve the system security impacts that it seeks to address – or may have unintended consequences.
We have grouped this feedback thematically and seek further consideration from TWG members.

Unintended consequences

- Active power recovery in accordance with the draft automatic access standard could lead to an unstable system response if poorly coordinated, for example, if multiple IBLs recover in a synchronised manner.
- Data centres reconnecting too fast could “create secondary frequency and voltage swings” (AusNet). The recovery of large loads could cause voltage to drop again after a disturbance, whereas the recovery of generators injects power and helps to keep the voltage up.

Question for the TWG: What is the likelihood and impact of these outcomes if the draft rule is implemented?

Location dependence

- The optimal post-disturbance behaviour sometimes depends on where the load is connected, for example, due to local system strength, network topology, damping, interconnector limits, rate of active power recovery, and interactions between active power and voltage.
- In particular, active power recovery may not be appropriate for the South Australian system if the total IBL in the regions reaches the order of ~1GW. This is because emergency control schemes may operate in less than 300ms after a large loss of load, and the subsequent recovery of load could then destabilise the system.

Question for the TWG: How can we provide flexibility to enable NSPs to account for the context of each IBL connection?

Other approaches

- Stakeholders suggested considering staged reconnection of IBL and/or fast-acting VAR support in certain cases.
- The NSP would be responsible for implementing mitigation schemes if IBL recovery capability is not sufficient.

Question for the TWG: Are there other approaches to address the risk of IBL disconnection (either with or instead of active power recovery)?

We are considering ways to improve the active power recovery minimum access standard

We are seeking your feedback on our staff-level approach to improve the minimum access standard for post-fault active power recovery.

In the draft rule, we proposed:

- IBLs must recover to within 90-110% of the pre-disturbance active power level within 1000ms of the end of a voltage disturbance.
- A voltage disturbance is taken to end when the voltage returns to within 0.9-1.1 p.u.
- The draft rule provides some flexibility for negotiating a level of performance below this minimum access standard to (draft rule S5.3.14(f)).

We have developed a staff-level alternative proposal to address stakeholder feedback	

What we propose	• Allow the S5.3 participant to agree with the NSP and AEMO on a process to recover following a disturbance. The participant may, for example:
	  ◦ Recover over 1000 ms or 2000 ms
	  ◦ Reconnect in a staged manner, or
	  ◦ Reconnect manually on instruction from AEMO (if appropriate)

Key benefits	• This approach is more flexible, as there is no fixed minimum time in the standard • It is simpler, with one broad approach for all connections negotiated below the automatic access standard • Does not compromise system security outcomes compared to the draft rule. Assuming most new IBLs perform at or close to the automatic access standard, we consider that a 1000ms minimum access standard offers no real security benefit compared to this more flexible alternative.
Consistent with the NER	• Clauses S5.2.5.1(b2) and S5.2.5.8(b) use a similar approach to provide some flexibility in the minimum access standards.
Safeguards	• Per the existing framework, a negotiated access standard should only be used when the plant cannot practically meet the automatic access standard of 500ms recovery. • Any negotiated access standard would still be required to be as close to the automatic access standard as possible, and would only be accepted if it does not pose a risk to system security.

Would TWG members support this change to the draft rule? Do you have any further feedback on how we might better achieve flexibility in the minimum access standard?

We are considering ways to improve the active power and current limits

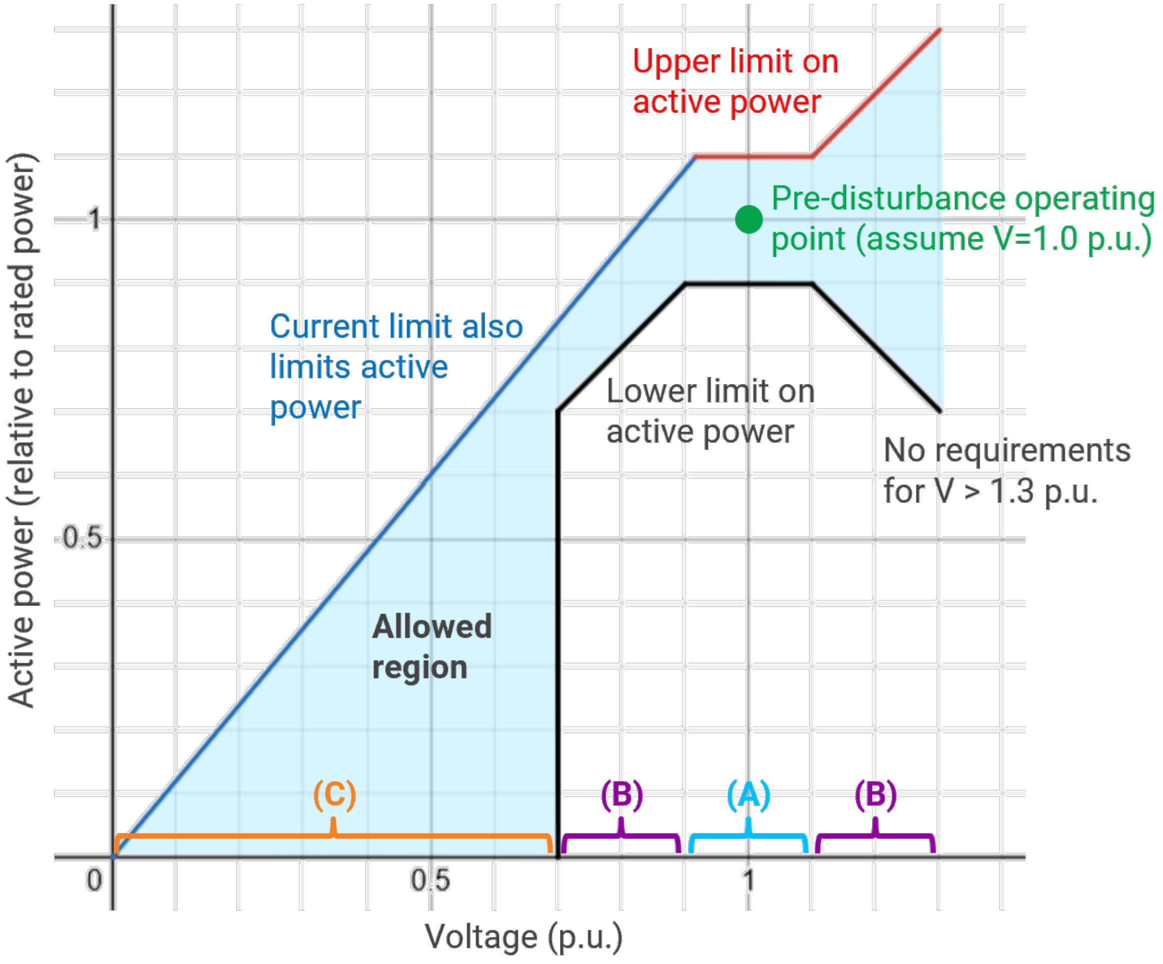
We are seeking your feedback on the active power and current limits included in the draft rule ride-through requirements.

Potential adjustments to the active power and current limits could include:

- Changing the level of any of the limits
- Removing limits for some voltage ranges, where ‘stay connected and continue operating’ is more likely to be sufficient
- Removing some or all of the upper limits, because increases in IBL active power are not the key risk we have identified
- Not permitting a reduction to zero active power (see slide 26 on continuous uninterrupted operation)

We received some feedback suggesting that the active power and current limits may be too complex, or may not be necessary

- Do TWG members have feedback on the draft rule’s overall approach to IBL behaviour during disturbances? (That is, applying active power and current limits as shown.)
- Do TWG members have specific feedback on the parameters of the active power and current limits?



We are considering introducing a 'continuous uninterrupted operation' requirement for IBL

Topic 1

We are considering whether requiring IBL to remain in 'continuous uninterrupted operation' (CUO) during disturbances may be a better approach than applying active power and current limits.

AEMO considered defining a light-handed form of CUO for loads in its review of the technical requirements for connection to the NEM.

AEMO's final recommendation was as follows:

When in continuous uninterrupted operation, a load must not:

- *Disconnect for the specified conditions, except as permitted by the relevant performance standard,*
- *Operate unstably,*
- *Change its active power except as permitted or required under its performance standards following the disturbance,*
- *Materially exacerbate or prolong the disturbance or cause a subsequent disturbance for other connected plant, except as required or permitted by its performance standards.*

At a staff level, we do not yet have a preferred definition of CUO – we are seeking feedback on the general concept.

At the time, stakeholders had mixed views on:

- The requirement not to materially exacerbate or prolong disturbances
- Whether there should be a specific requirement for changes in active power, e.g. must not change by more than 20%

Advantages	Disadvantages
• Simpler, describes one desired outcome for all parts of the ride-through curve. • May improve system security outcomes if IBLs are required to remain in CUO through deep disturbances instead of temporarily disconnecting and recovering.	• Less clear-cut than active power limits, as it would use words like 'materially' or 'substantially'. We would also need to consider that IBL active power may change during a disturbance due to changes in the underlying computational workload, since most IBLs are not scheduled. • May be difficult for IBLs to meet in deep disturbances, needing more negotiated access standards and creating an inefficient connections process.

Discussion questions for the TWG

- What are TWG members' views on the CUO approach now?
- Do you have feedback on this proposed definition?
- What are the advantages and disadvantages compared to the active power limits approach (slide 25)?

2

Under-voltage ride-through requirements

AEMC

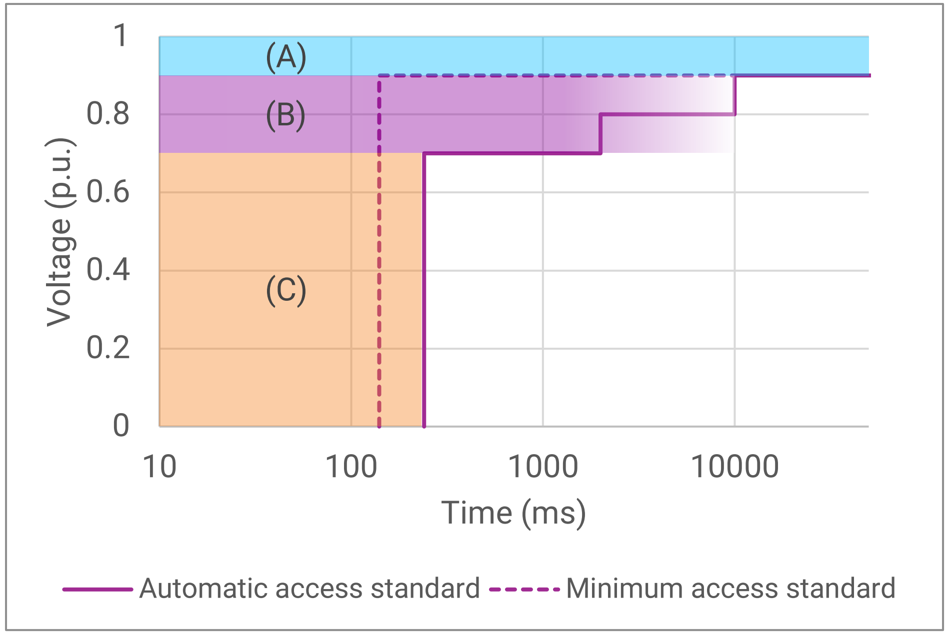
Topic 2 overview: Stakeholder feedback raised potential gaps with the under-voltage ride-through standard

Stakeholder submissions to the draft determination highlighted that the proposed ride-through curve might not cover disturbances we expect IBL to withstand and could be broadened to include additional fault scenarios.

Stakeholders have identified two potential issues with the draft rule low voltage ride-through requirements.

1. The draft rule does not cover faults that are cleared by **back-up or breaker fail protection** (non-credible contingency events).
2. The draft rule does not account for faults in the **distribution network**, which can take longer to clear.

Draft rule access standards for under-voltage ride-through



We designed the under-voltage automatic access standard ride-through curve by:

- Aligning the requirements for 0.7-0.9 p.u with those that apply to generators (S5.2.5.4)
- Adding a requirement for active power recovery after disturbances to <0.7 p.u lasting up to 240ms. This is based on the longest clearing time for primary protection on the remote portion of a line at 100 kV or above (Column 3), plus 20ms for the voltage to stabilise.

The minimum access standard only requires:

- Capability to operate for voltages down to 0.9 p.u
- Active power recovery after disturbances lasting up to 140ms (longest clearing time for primary protection on the near half of a line at 100 kV or above (Column 2)).

Nominal voltage at fault location	Time (ms)		
Column 1	Column 2	Column 3	Column 4
400kV and above	80	100	175
At least 250kV but less than 400kV	100	120	250
More than 100kV but less than 250kV	120	220	430
Less than or equal to 100 kV	As necessary to prevent plant damage and meet stability requirements		

From NER S5.1a.8, S5.1a.9.

Options for improving the under-voltage ride-through automatic access standard

We have developed options for the low-voltage ride-through curve to address the concerns raised by stakeholders.

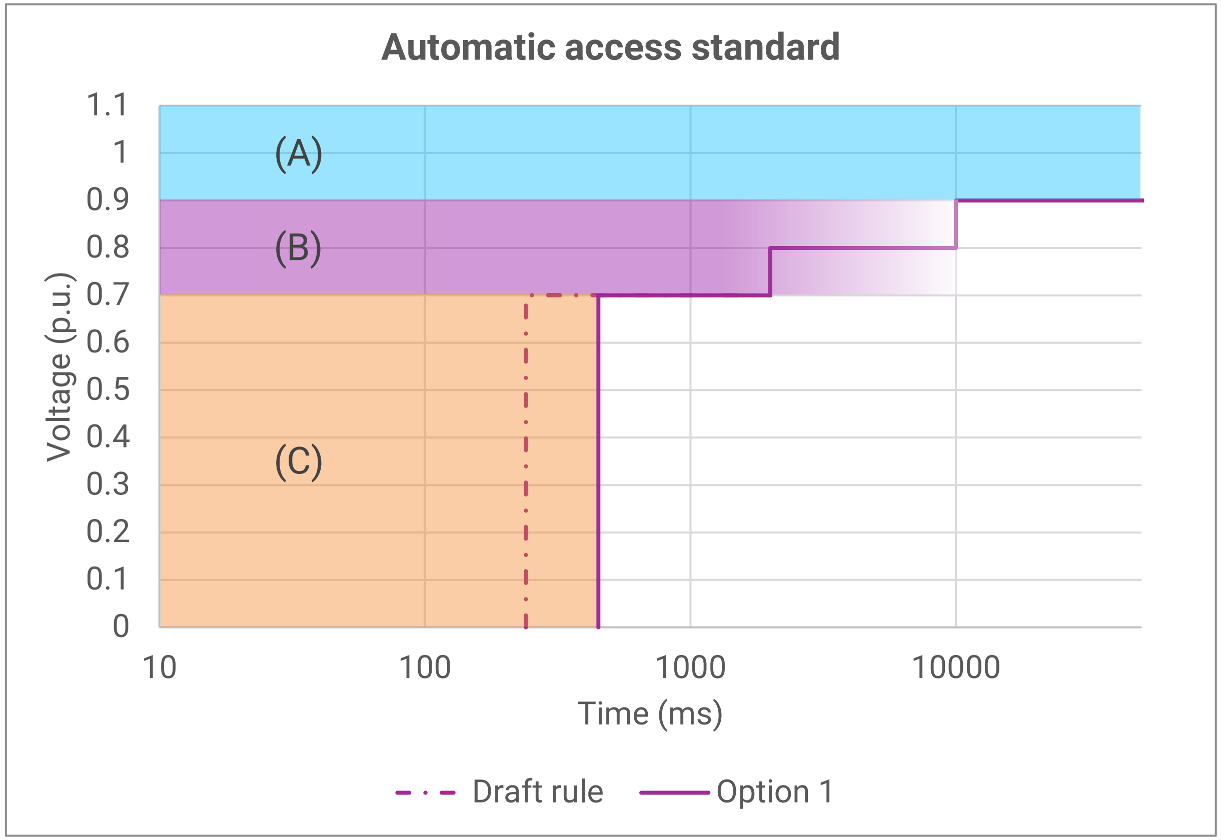
Option 1: Extend the deep disturbance duration in the automatic access standard to 450ms

Advantages of this option

- Extending to 450ms would account for faults cleared by breaker fail protection on lines at 100kV and above.
- It would likely cover a greater proportion of, but not all, distribution faults.

Limitations of this option

- IBLs could still respond to any disturbances below 0.7 p.u by temporarily disconnecting, then recovering.
- 450ms is the length of time that an IBL would need to remain 'ready to recover' if it has reduced/stopped active power due to the disturbance. The total time for the disturbance and recovery would be up to 950ms in the automatic access standard.
- Note that for a shorter disturbance (e.g. 200ms), IBLs would still have to recover within 500ms from the end of the disturbance.



Discussion questions for the TWG

- If we proceed with Option 1, is 450ms appropriate or should it be shorter or longer?
- Would 450ms be feasible for UPS and other power electronic interfaces to comply with?
- Could the deep disturbance duration be made dependent on connection voltage, or left up to the NSP?

Options for improving the under-voltage ride-through automatic access standard

We have developed options for the low-voltage ride-through curve to address the concerns raised by stakeholders.

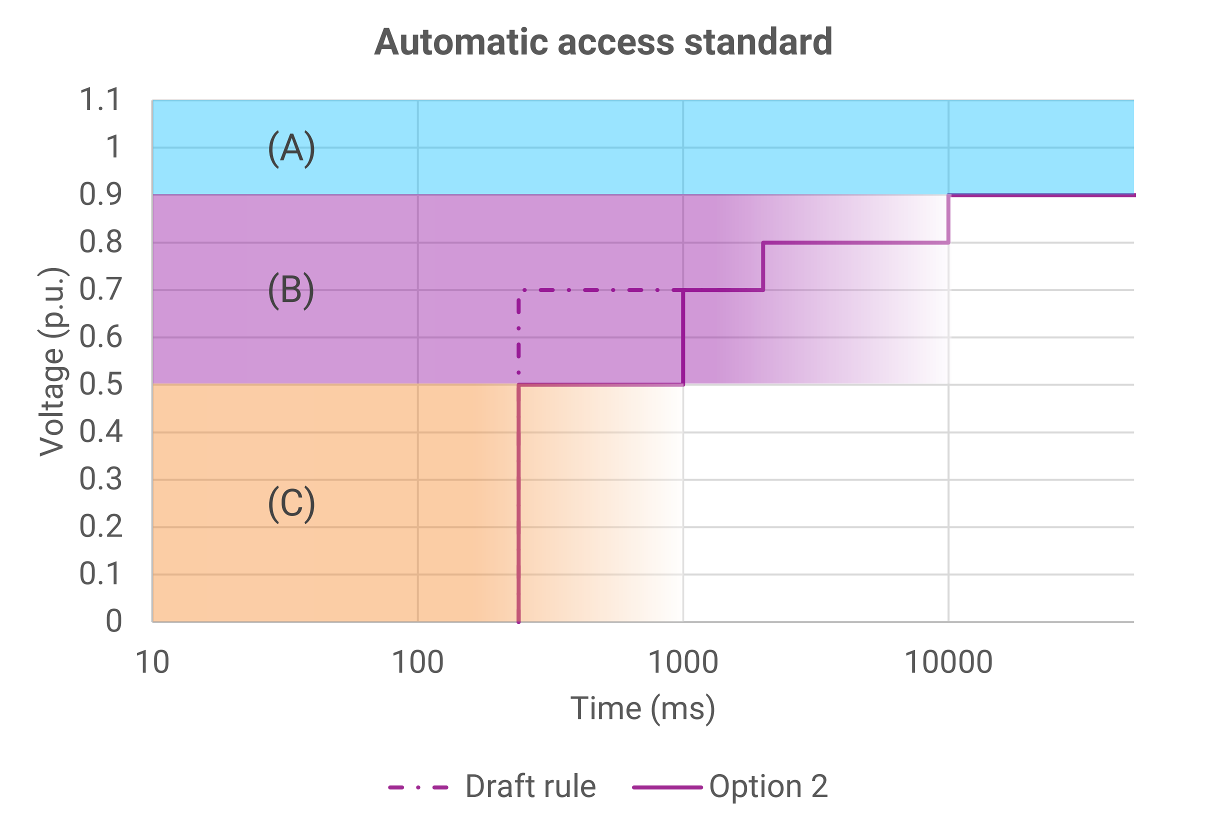
Option 2: Lower the temporary disconnection threshold to 0.5 p.u (require IBL to continue consuming active power down to 0.5 p.u)

Advantages of this option

- Bringing the threshold down from 0.7 p.u. to 0.5 p.u. for up to 1000ms would require IBLs to ride through more voltage disturbances caused by distant faults, or faults at lower connection voltages.
- This is because the size of the voltage disturbance reduces with distance and with transformer impedance.

Limitations of this option

- There is still a risk that distribution-connected IBLs complying with the automatic access standard would not ride through nearby faults lasting longer than 240ms, but this is likely to be manageable for the broader system.
- Only some UPS models can withstand 0.5 p.u voltage, whereas almost all can withstand 0.7 p.u. Where the plant cannot withstand 0.5 p.u, participants would need to negotiate a different performance standard.



Discussion questions for the TWG

- If we proceed with Option 2, is 0.5 p.u. the right threshold level?
- How feasible is this for UPS and other power electronic interfaces to comply with?
- Is 1000ms an appropriate duration corresponding to 0.5 p.u?

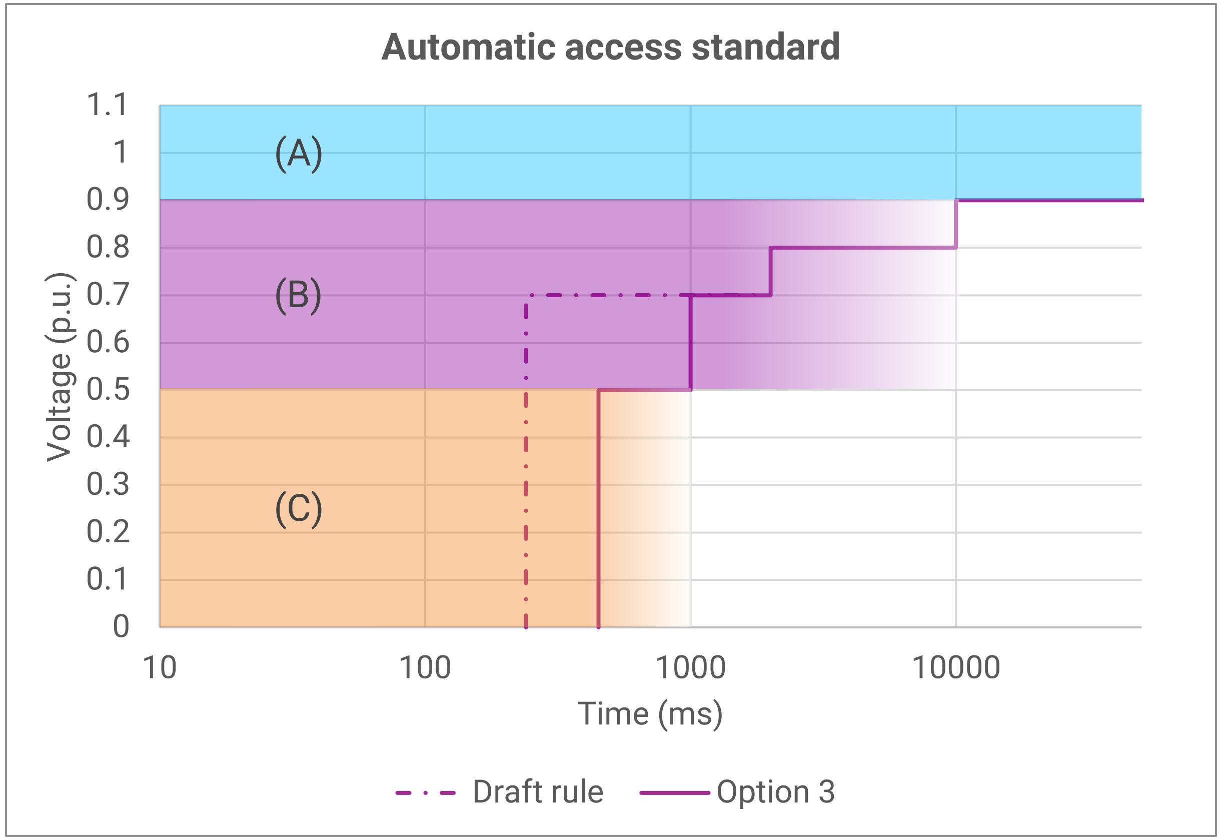
Options for improving the under-voltage ride-through automatic access standard

We have developed options for the low-voltage ride-through curve to address the concerns raised by stakeholders.

Option 3: Combination of Options 1 and 2

- Our staff-level preferred approach is to combine Options 1 and 2 by extending the deep disturbance duration and lowering the temporary disconnection threshold.
- We consider Option 3 is likely to have **greater system security benefits** than Options 1 or 2, and to be **feasible for most IBL to comply with**.
- Where an IBL cannot comply with the automatic access standard requirements, the Schedule 5.3 Participant would be able to negotiate a lower level of performance.

We are seeking your feedback on this approach, including the parameters we have proposed (450ms, 0.5 p.u., and 1000ms).



Slides 29-31 have focused on the automatic access standard. See slide 32 for a discussion of proposed changes to the minimum access standard.

Options for improving the under-voltage ride-through minimum access standard

We are considering changes to the minimum access standard from the draft rule to better support system security.

Draft rule

The draft rule minimum access standard requires:

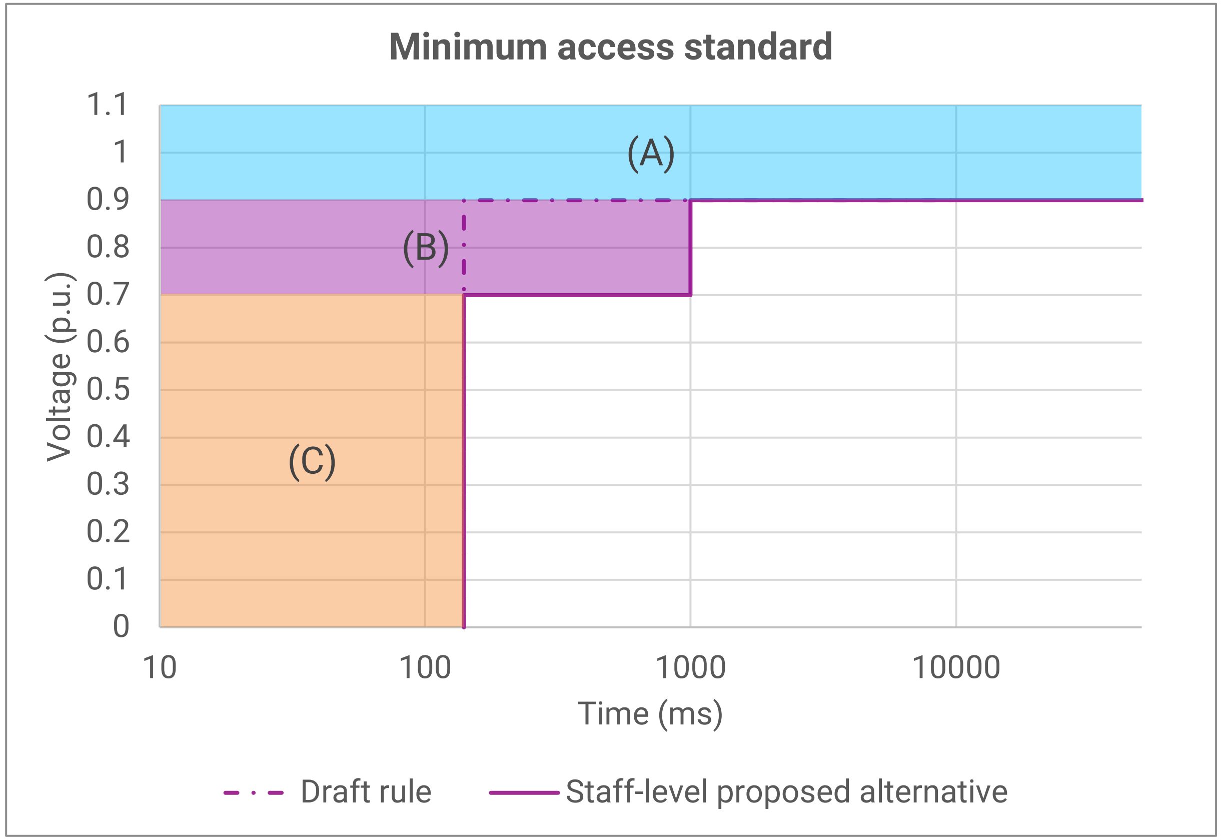
- Capability to operate for voltages down to 0.9 p.u
- Active power recovery after disturbances lasting up to 140ms

Staff-level alternative proposal

- The minimum access standard would require IBLs to continue operating (consuming some level of active power) through a voltage sag down to 0.7 p.u lasting up to 1000ms.
- This would help ensure IBLs can ride through a wider range of faults, without being too onerous.

Discussion questions for the TWG

- Do TWG members support requiring ride-through of voltage disturbances down to 0.7 p.u for 1000ms in the minimum access standard?
- Does the deep disturbance duration of 140ms remain appropriate for the minimum access standard?



3

Over-voltage ride-through requirements

We are considering ways to improve the over-voltage ride-through requirements

We are considering increasing the over-voltage ride-through requirements to better support system security that addresses stakeholder feedback to the draft determination.

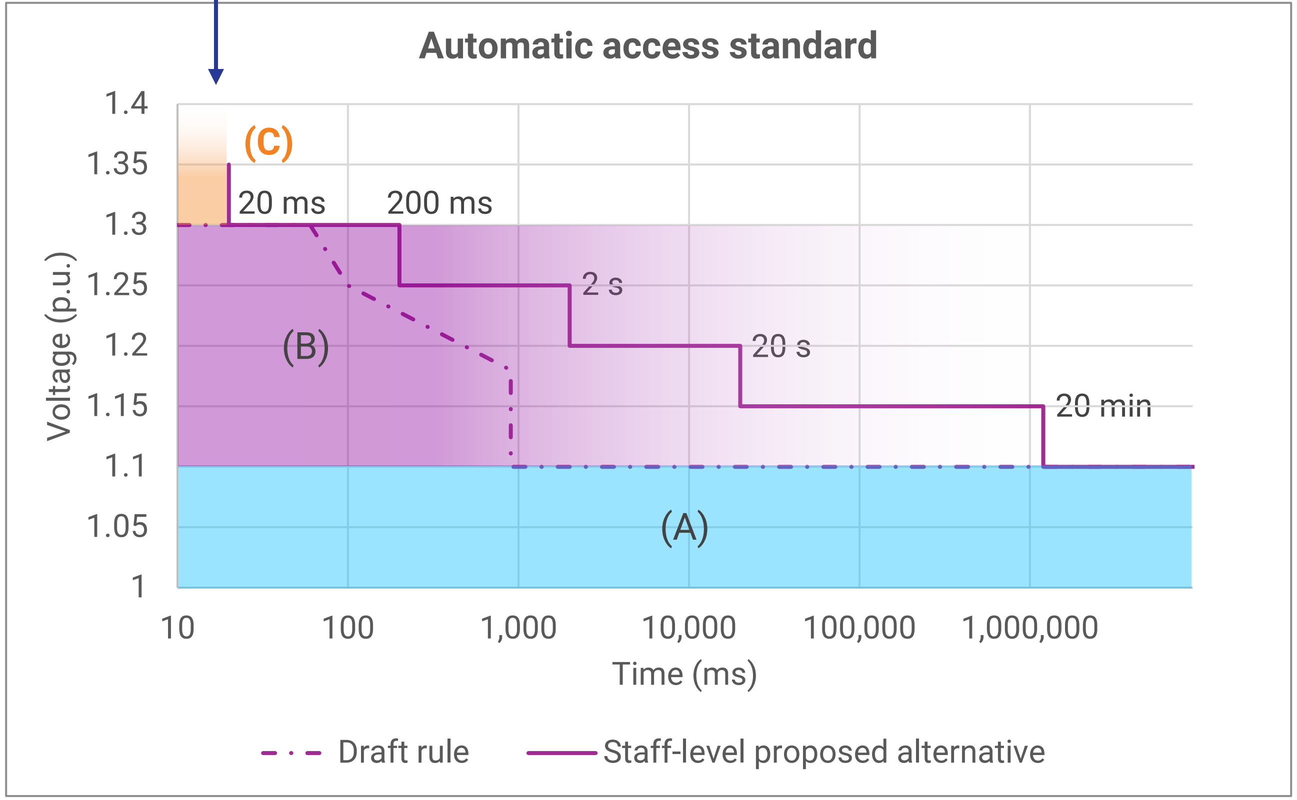
Proposed alternative over-voltage ride-through curve

- Some stakeholders suggested more onerous over-voltage ride-through requirements for IBL.
- For example, Transgrid suggested raising the level of the over-voltage curve to align with S5.2.5.4, instead of the system standards.
- This would ensure that IBLs can ride through (some) non-credible contingency events as well as credible ones.
- For voltages above 1.3p.u, IBLs would be permitted to temporarily disconnect, provided that they recover in accordance with active power recovery requirements.

Discussion questions

- What are the benefits (or disadvantages) of this approach?
- Would it be feasible for IBLs to meet this higher performance standard?

IBL must meet active power recovery requirements following voltage swells ‘at least marginally exceeding 130%’ for 20ms. (Same wording as S5.2.5.4.)



Options to address feedback on transient over-voltage ride-through

Topic 3

We are considering whether the final rule should include ride-through requirements related to voltage transients to address stakeholder feedback to the draft determination.

What we said in the draft rule

- The draft rule would require IBLs to withstand a range of disturbances in the RMS voltage, to help prevent instability and cascading outages.
- However, IBLs may also disconnect due to voltage transients, and this would create a similar risk to the power system.
- For this reason, some stakeholders suggested the final rule should include ride-through requirements for voltage transients.

We are considering three policy options to address stakeholder feedback

Option 1: Draft rule

Maintain the draft rule approach, with no specific requirements for voltage transients.

Option 2: Light-touch

IBL must not include voltage protection that may commit to disconnect any operating plant within 20ms of the commencement of a transient over-voltage disturbance at the Connection Point. (automatic access standard only)

Option 3: More onerous

IBL must stay connected and continue operating for at least 20ms after the commencement of a transient over-voltage disturbance. (automatic access standard only)

What is a transient over-voltage?

Voltage transients are very brief high voltage conditions, for example caused by lightning strikes.

A **transient over-voltage disturbance** occurs if the instantaneous voltage exceeds 110% of the peak value of nominal voltage.

Discussion questions

- What is the likelihood and potential impact of IBL disconnection due to voltage transients?
- Which option(s) would TWG members support, and why?

4

We are considering ways to refine the proposed instability monitoring access standard

AEMC

Stakeholders broadly supported the instability detection and response access standard in the draft rule

Stakeholder submissions to the draft determination generally supported introducing a new access standard for instability detection and response by IBL. Stakeholders also proposed options for refining the policy, which we will discuss today.

Submissions to the draft determination generally supported the direction of the draft rule. There was broad agreement that large data centres can contribute to power system instability, for example by impacting transient voltage stability and oscillatory behaviour following contingencies.

However, some stakeholders wanted more guidance on how the rule would be implemented. For instance, stakeholders sought more information on:

- The implementation of instability detection systems, noting technologies are still maturing
- How AEMO and NSPs would assess an IBL's potential to contribute to instability
- The modelling that connection applicants would need to provide, as well as modelling AEMO and NSPs may undertake.

Based on the stakeholder feedback received, today's TWG discussion will focus on the following topics:

1. **Topic 1:** What additional guidance do stakeholders need to consistently implement the new instability monitoring access standard, and who should provide that guidance? (slide 40)
2. **Topic 2:** Should every IBL over 100 MW be required to install a PMU, or should AEMO and NSPs retain discretion to require one only where necessary? (slide 41)
3. **Topic 3:** The draft rule includes a provision to ensure that IBLs do not cause, worsen, or contribute to power system instability. Should the final rule clarify that applicants are responsible for providing models of their own plant, while the NSP is responsible for assessing potential broader interactions? (slide 42)

Overview of the proposed instability detection and response access standard

The draft rule would introduce a new access standard for large IBL to detect and respond to instability.

<table>
<tr><th>Access standard requirements</th><th>Automatic access standard</th><th>Minimum access standard</th></tr>
<tr><td></td><td>• Instability detection capability, including sharing data with AEMO/NSP
• Prompt execution of a configurable hierarchy of actions to manage instability if detected (as agreed with AEMO/NSP)
• Capability to disconnect the plant for unstable behaviour
• PMU which can send data to AEMO/NSP (100+ MW)
• Receive information from AEMO on own contribution to instability (100+ MW)</td><td>• Instability detection capability, including sharing data with AEMO/NSP
• A process to manage instability, agreed with AEMO/NSP (may be a simple process)
• PMU only required on AEMO/NSP request (slide 39)
• Receive information from AEMO on own contribution to instability (100+ MW)</td></tr>
<tr><td>General requirements</td><td colspan="2">• Controls/capabilities to avoid causing, exacerbating, or contributing to instability (see slide 42)
• Disconnection for instability (if available) should be a last resort
• Receive NSP remote tripping signal, if required</td></tr>
<tr><td>Additional information</td><td colspan="2">• This access standard only applies when AEMO/NSP considers the plant may contribute to instability (slide 39).
• In addition, some requirements only apply under certain conditions or if AEMO/NSP requires it (slide 39).
• AEMO may provide details on how plant can meet this access standard in the Power System Stability Guidelines (to be updated within 12 months of final rule).
• Where a single integrated facility has multiple connection points, this access standard applies to the whole facility as one.</td></tr>
</table>

Overview of the proposed instability detection and response access standard

The draft rule would introduce a new access standard for large IBL to detect and respond to instability.

To which IBL connections would the new access standard apply?

One stakeholder requested guidance on criteria for 'could contribute to instability' (see slide 40)

30MW or larger and could contribute to instability	100MW or larger	Can change voltage at its connection point by more than 1%	Automatic access standard	Minimum access standard
No	N/A	N/A	N/A	N/A
Yes	No	No	Excludes PMU requirement	N/A (minimum access standard is effectively zero)
Yes	Yes	No	Includes PMU requirement	PMU requirement only, at AEMO and NSP's discretion
Yes	No	Yes	Excludes PMU requirement	Excludes PMU requirement
Yes	Yes	Yes	Includes PMU requirement	Includes PMU requirement at AEMO and NSP's discretion

One stakeholder suggested removing AEMO/NSP discretion here (slide 41)

Topic 1

Instability detection and response: What guidance do stakeholders need?

We are seeking your feedback on what additional guidance is needed to support this new access standard and how that guidance can be provided.

Stakeholder feedback

The biggest theme in submissions to the draft rule was a call for more technical guidance on the implementation and application of the instability monitoring access standard, such as:

- How instability detection should be performed, including but not limited to:
  - Technical specifications of monitoring equipment
  - Data quality and accessibility
- Criteria for when the access standard is applied, especially the 'could reasonably contribute to instability' condition
- Type and extent of modelling required to demonstrate compliance, and alignment with the PSMG
- Compliance expectations after commissioning
- Whether large facilities need multiple measurement locations.

Stakeholders noted that providing more guidance could improve transparency and consistency across NSPs and connection applications.

Initial staff-level position

- Generally, the guidance stakeholders are seeking would be provided by AEMO's update to the Power System Stability Guidelines (PSSG). We consider this to be the appropriate document for guidance that addresses stakeholder feedback.
- The draft rule requires AEMO to update the PSSG within 12 months from the commencement of the final rule.
- The update process would include consultation with stakeholders.

Discussion questions

- What guidance or information is most important for the implementation of the rule?
- Is AEMO's PSSG the appropriate place to provide this guidance? (Alternatives are e.g. NSP guidelines, case-by-case basis).
- Should the final rule be more specific about the guidance that is to be provided?
- How can we support NSPs and connection applicants in applying this standard while the PSSG is being updated?

Instability detection and response: PMU requirement for IBLs over 100MW

We are seeking your feedback on when IBLs should be expected to have a PMU under the instability detection and response access standard.

What we said in the draft rule

- The draft rule automatic access standard requires PMUs for all IBL connections over 100MW that could reasonably contribute to instability.
- In the minimum access standard, PMUs may also be required for IBLs over 100MW, but only if requested by AEMO or the NSP.

Stakeholder feedback

- One stakeholder suggesting making PMUs mandatory in the minimum access standard for all IBLs over 100MW.
- In effect, this suggestion would remove AEMO and NSP's discretion on whether to require a PMU for IBL over 100MW.

Advantages and disadvantages

Advantages of this proposal

- Making PMUs mandatory over 100MW would simplify the access standard and make it more predictable while better supporting system security.

Disadvantages of this proposal

- The proposal would remove any room for negotiation of the PMU requirement for IBLs over 100MW (except as regards technical specifications of the PMU).

Additional information

- The other criteria for application of this access standard (slide 39) would still apply.
- The corresponding access standard for generators (S5.2.5.10) is very similar to the draft rule. The minimum access standard only requires PMUs for generators over 100MW if requested by AEMO or the NSP.

Discussion questions

- Do TWG members support the proposal to make PMUs mandatory for all IBL connections of 100MW and above?
- Can you think of any scenarios where a PMU would not be necessary for a 100MW+ IBL?

Topic 3

Instability detection and response: IBLs should not cause, exacerbate or contribute to instability

We are seeking your feedback on the draft rule requirement for capabilities and control systems to avoid causing, exacerbating or contributing to instability.

What we said in the draft rule

- The draft rule requires that "A schedule 5.3 plant must have plant capabilities and control systems sufficient to ensure that operation of the schedule 5.3 plant does not cause, exacerbate or contribute to instability (including hunting of tap-changing transformer control systems) that would adversely impact other Network Users." (Draft rule clause S5.3.14(e))
- The desired outcome is to reduce the risk that any IBL may become unstable, or contribute to instability caused by other equipment, and thus have a detrimental effect on power system security.

Stakeholder feedback

- One stakeholder raised a concern about the requirement for capabilities and control systems to avoid causing or contributing to instability.
- One of the mechanisms by which an IBL could contribute to instability is through interactions with other plant on the network – including control system interactions or interactions related to cyclic AI load patterns.
- In their own modelling, connection applicants are unlikely to be able to test whether the IBL can contribute to instability via these interactions, because they do not have access to models of other plant.

Staff-level proposed approach

- It is not our intent to require IBL connection applicants to directly model potential interactions of their plant with other network users' plant.
- Rather, the connection applicant should provide sufficiently detailed models to the NSP for the NSP to test for potential interaction instability.
- The objective of clause S5.3.14(e) is to prevent IBL from causing or contributing to instability as much as possible – to complement the requirements for detecting and responding to instability if it does occur.

Discussion questions

- Do TWG members have further feedback on this clause or the AEMC's initial position?