AUSTRALIAN ENERGY MARKET COMMISSION

RULE

Draft rule determination

National Electricity Amendment (Improving the NEM access standards - Package 1) Rule 2025

Proponent
AEMO

5 December 2024

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About the AEMC

The AEMC reports to the energy ministers. We have two functions. We make and amend the national electricity, gas and energy retail rules and conduct independent reviews for the energy ministers.

Acknowledgement of Country

The AEMC acknowledges and shows respect for the traditional custodians of the many different lands across Australia on which we all live and work. We pay respect to all Elders past and present and the continuing connection of Aboriginal and Torres Strait Islander peoples to Country. The AEMC office is located on the land traditionally owned by the Gadigal people of the Eora nation.

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Summary

1 The Commission has decided to make a more preferable draft rule (hereafter 'draft rule') to improve the technical requirements for National Electricity Market (NEM) connection (known as access standards) contained in Chapter 5 of the National Electricity Rules (NER) and its accompanying schedules. It also makes a series of corresponding changes to Chapter 10 of the NER (the Glossary) and consequential changes to a number of clauses throughout the NER. This is in response to a fast-track rule change request submitted by the Australian Energy Market Operator (AEMO) on 4 April 2024.

2 The draft rule would make the NEM access standards more fit for purpose as we move towards a world where inverter-based resources are more prevalent in the NEM. It would also add more prescription and clarity to the access standards, which would help to reduce costs and time for connecting parties and NSPs in negotiations undertaken when connecting plant.

3 The NEM access standards define the permissible range of technical requirements that connection applicants need to meet before being allowed to connect to the NEM. However, some existing access standards are no longer fit for purpose in an increasingly inverter-based resources connected NEM. For example, some existing standards:

- unintentionally disincentivise beneficial grid-forming responses
- do not account for increasing connections at a sub-transmission or distribution level
- do not fully utilise available plant performance
- refer to defunct standards.

4 With the energy transition underway, the NEM needs to grow and change to continue delivering secure, reliable and affordable electricity to millions of Australians whilst achieving the government's emissions reduction targets. AEMO's 2024 Integrated System Plan (ISP) projects that on the optimal development path, grid-scale variable renewable energy would triple by 2030 and increase by six-fold by 2050. Utility scale batteries would increase by five-fold by 2030 and six-fold by 2040.[1]

5 To support this enormous growth and deliver the energy transition in accordance with the National Electricity Objective (NEO)[2], new NEM connections need to be approved at a much faster rate than at present to keep up with the pace of the transition. At the same time, it is also important that there is a continued focus on keeping the whole system stable and reliable throughout the transition.

6 The draft rule would improve the access standards to:

- better meet power system performance needs
- improve power system resilience with more fit for purpose standards
- streamline the connection process through better prescription and clarity
- support efficient investment in and operation of the NEM by ensuring plant connected is what is required
- remove impediments for and streamline connection of grid-forming inverters
- broaden their application to synchronous condenser connections, which are not currently considered

1 AEMO, 2024 Integrated System Plan, p 11.
2 Section 7 of the NEL.

- broaden their application to all HVDC links, which are not currently considered[3]
- account for potential impacts and beneficial capabilities of HVDC links, making these provisions fit for purpose.

7 We are seeking feedback on our draft determination and rule by **30 January 2025**.

The draft rule has been shaped by AEMO's review of technical requirements for connection

8 Under clause 5.2.6A of the NER, AEMO is required to conduct a review of the access standards at least once every five years. AEMO conducted its first such review in 2022-23, undertaking extensive public consultation (three rounds), and identified numerous opportunities to improve the current access standards and their application.

9 AEMO then submitted a fast track rule change request to the Commission to give effect to the final recommendations from its review.

10 In light of AEMO's extensive consultation, the Commission has decided to fast track this rule change request and has directly published this draft determination and draft rule in response, bypassing the consultation paper stage. The Commission has examined the feedback that AEMO received through its review process and AEMO's proposed solutions and considers that the package of reforms strikes the right balance of being responsive to stakeholder concerns and advancing the NEO. As such, the Commission's draft determination and rule broadly reflect AEMO's proposals in its rule change request.

The draft rule would be in the long-term interests of energy consumers

11 The Commission assessed the draft rule against the criteria outlined below and considers it would contribute to advancing the NEO by:

- **Supporting safety, security and reliability** — The improved access standards would increase power system resilience by better utilising already available plant capability to withstand disturbances, including for HVDC links, and broadening application to synchronous condensers needed for system security.
- **Contributing to emissions reduction** — The improved access standards would accelerate the connections process and signal new investment required to meet Australia's emissions reduction targets by making the access standards more prescriptive to minimise ambiguity and clarify their application to different technologies.
- **Promoting innovation and flexibility** — The improved access standards would promote innovation and flexibility in the power system by removing impediments for connecting grid-forming inverters and increase investment efficiency by broadening the options available for connection applicants under different circumstances.
- **Having low implementation costs and complexity** — The improved access standards would contribute to lowering overall connection costs for most applicants. They would also reduce the burden on network service providers (NSPs) and AEMO and simplify their function by streamlining the connections process, providing clarity and reducing the need for negotiations.

12 The Commission has made a more preferable draft rule because we have made various consequential amendments that seek to add clarity and ensure the draft rule reflects the intended policy outcomes and best advances the NEO.

3 HVDC - High Voltage Direct Current

The draft rule would amend the access standards to apply them by plant type

13 The draft rule would amend the access standards to apply them by plant type rather than by the registration category, which relates to the owner or operator of the plant, as is the case currently. The Commission considers that applying these standards by plant type would ensure a consistent approach to managing system security for similar types of connecting plant, irrespective of the persons connecting, especially considering the increasing variety of persons and plant connecting to the power system.

- Schedule 5.2 would apply to all generating systems, integrated resource systems and synchronous condenser systems (collectively known as schedule 5.2 plant).
- Schedule 5.3 would apply to all plant that consume electricity from a network, including a distribution network or a source of load within an integrated resource system (collectively known as schedule 5.3 plant).
- Schedule 5.3a would apply to any HVDC system with a power transfer capability of 5 MW or more (known as schedule 5.3a plant).
- The persons to which the obligations apply would be captured by new definitions of Schedule 5.2 Participant, Schedule 5.3 Participant and Schedule 5.3a Participant.

The draft rule would amend the access standards for generators, integrated resource systems and synchronous condensers

14 The draft rule would introduce a suite of reforms to the access standards for generators, integrated resource systems and synchronous condensers to align with best power system performance, streamline the connection process, improve power system resilience and support efficient investment.

- In clause S5.2.5.1:
  - Reduce the voltage range for full reactive power requirements.
  - Clarify and amend reactive power capability requirements considering temperature derating.
  - Clarify requirements for the compensation of reactive power when units are out of service.
- Simplify standards for small connections (less than 30 MW in the mainland and less than 7 MW in Tasmania) unlikely to have material adverse impacts on the power system.
- In clause S5.2.5.2, delete a reference to a superseded Australian Standard.
- In clause S5.2.5.4:
  - Allow the point of application for overvoltage requirements to be negotiated for medium and low voltage connections.
  - Bound requirements for over-voltages above 130% and introduce obligations to minimise recurring switching surges.
  - Clarify the meaning of 'continuous uninterrupted operation' for moderate voltage disturbance requirements.
- In clause S5.2.5.5:
  - Define the end of a disturbance for multiple fault ride through.
  - Refine compliance requirements for multiple fault ride through.
  - Relax the continuous uninterrupted operation requirement for fault level below minimum for which the plant is tuned.

    - Delete reference to a metallic conducting path.
- Move parts clause S5.2.5.5 into a new clause S5.2.5.5A and:
    - Amend the requirements for active power recovery after a fault.
    - Amend rise time, settling time and commencement time requirements for reactive current injection.
    - Amend arrangements for the commencement of reactive current injection and provides clarity on reactive current injection location.
    - Clarify the response requirements for balanced and unbalanced faults, and recognise negative sequence current responses.
- In clause S5.2.5.7:
    - Limit its application to synchronous generation only.
    - Clarify the meaning of continuous uninterrupted operation.
- In clause S5.2.5.8:
    - Strengthen and streamline emergency over-frequency response requirements.
    - Require plant protection settings to be set to maximise capability to ride through disturbances.
    - Move the vector shift requirement from clause S5.2.5.16 to clause S5.2.5.8.
- In clause S5.2.5.10, add new requirements for instability detection and response.
- In clause S5.2.5.13:
    - Remove impediments to unit-level voltage control.
    - Prioritise stability over the speed of a plant's response across a range of system impedances.
    - Add materiality thresholds on settling time error bands.
    - Amend and clarify requirements for multiple modes of operation and treatment of voltage settling time for reactive power and power factor modes.
    - Recognise system strength services provided by system strength service providers.
- In Chapter 10, amend the definitions of continuous uninterrupted operation, rise time and settling time.

The draft rule would amend the access standards for HVDC links

15 The draft rule would amend the access standards for HVDC links contained in schedule 5.3a to align them with those applicable to schedule 5.2 plant.

16 The Commission considers that modern HVDC links have similar power system impacts and capabilities as inverter-based generation and integrated resource systems. Hence, similar requirements for reactive power, disturbance ride through, response, recovery, remote monitoring and control would apply to HVDC links as schedule 5.2 plant. Applying consistent requirements to all schedule 5.2 and schedule 5.3a plant at a low incremental cost would improve clarity for the design of HVDC links, promote investment certainty and more efficiently support reliability of supply in a coordinated manner.

The draft rule would make other consequential NER amendments

17 In its rule change request AEMO also proposed several other amendments to the NER. These are either related to AEMO's proposed amendments to the schedule 5 access standards, or seek to

clarify the intent of the existing rules where ambiguity may have created confusion or uncertainty.

18 The draft rule would make consequential amendments to support the intent of the draft rule by clarifying inconsistencies, removing redundant provisions and reducing duplication. Such changes would promote the long-term interests of consumers by making the draft rule clear for stakeholders to understand and follow, minimising confusion. These consequential amendments are made to Chapters 3, 4, 5, 5A, 6A, 7, 9 and 10.

The draft rule includes transitional arrangements that would ensure that any disruption to ongoing connections processes is minimised

19 The indicative commencement date for the draft rule would be **10 April 2025**. The transitional provisions in the draft rule would apply new or old Chapter 5, depending upon which stage of the connections process a connection applicant is at, on the commencement date.

20 If the connection applicant has made a connection enquiry or has lodged its connection application with the network service provider before the commencement date, then new Chapter 5 of the NER would apply to that connection.

21 However, for those connection applicants who had lodged a connection application before the commencement date there would be a choice. They could choose to continue negotiating their performance standards in accordance with the old Chapter 5 during a transitional period (which would indicatively end by **30 October 2025**).

22 If the connection applicant has received an offer to connect from the NSP by the commencement date, then old Chapter 5 would continue to apply. The draft rule would not affect any connection agreements that have been executed before the commencement date.

23 The Commission considers that these transitional provisions would balance the benefits that can be gained from applying the rule as soon as possible, while minimising the impact or disruption that could be caused by changes to the access standards.

24 In addition, network service providers would be required to determine, document and advise AEMO of the performance standards of any existing schedule 5.2 plant or schedule 5.3 plant (such as synchronous condensers or HVDC links owned or operated by the network service provider), within 12 months of the commencement date.

25 This transitional provision would align with other proposed changes to the application of the access standard framework and would promote power system security by ensuring that AEMO has visibility of all plant performance standards, regardless of the owner or operator of the plant.

How to make a submission

We encourage you to make a submission

We are seeking written submissions in response to this draft determination and rule. Stakeholders can help shape the solution by participating in the rule change process. Engaging with stakeholders helps us understand the potential impacts of our decisions and contributes to well-informed, high quality rule changes.

How to make a written submission

Due date: Written submissions responding to this draft determination and rule must be lodged with Commission by **30 January 2025**.

How to make a submission: Go to the Commission's website, www.aemc.gov.au, find the 'Lodge a submission' function under the 'Contact Us' tab, and select the project reference code **ERC0393.**[4]

Tips for making submissions on rule change requests are available on our website.[5]

Publication: The Commission publishes submissions on its website. However, we will not publish parts of a submission that we agree are confidential, or that we consider inappropriate (for example offensive or defamatory content, or content that is likely to infringe intellectual property rights).[6]

Next steps and opportunities for engagement

The Commission is due to publish a final determination and rule by 13 March 2025. Consistent with the fast track process and given that AEMO undertook extensive consultation, we do not have plans for technical working groups or other public engagements. However, there are other opportunities to engage with us, such as one-on-one discussions. We are happy to meet bilaterally with any interested party, or answer any questions or discuss feedback at any stage.

You can also request the Commission to hold a public hearing in relation to this draft rule determination.[7]

Due date: Requests for a hearing must be lodged with the Commission by 12 December 2024.

How to request a hearing: Go to the Commission's website, www.aemc.gov.au, find the 'Lodge a submission' function under the 'Contact Us' tab, and select the project reference code **ERC0393.** Specify in the comment field that you are requesting a hearing rather than making a submission.[8]

For more information, you can contact us

Please contact the project leader with questions or feedback at any stage.

Project leader:	Achint Jain
Email:	achint.jain@aemc.gov.au
Telephone:	(02) 8296 0643

4 If you are not able to lodge a submission online, please contact us and we will provide instructions for alternative methods to lodge the submission.

5 https://www.aemc.gov.au/our-work/changing-energy-rules-unique-process/making-rule-change-request/submission-tips

6 Further information about publication of submissions and our privacy policy can be found here: https://www.aemc.gov.au/contact-us/lodge-submission

7 Section 101(1a) of the NEL.

8 If you are not able to lodge a request online, please contact us and we will provide instructions for alternative methods to lodge the request.

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1 The Commission has made a draft determination to improve the NEM access standards

This draft determination is to make a more preferable draft rule (hereafter 'draft rule') in response to a fast-track rule change request submitted by AEMO. The draft rule would improve the technical requirements for NEM connection (known as access standards) contained in Chapter 5 of the NER and its accompanying schedules. It also makes a series of corresponding changes to Chapter 10 of the NER (the Glossary) and consequential changes to a number of clauses throughout the NER. We are seeking feedback on this draft rule.

1.1 The draft rule would make the NEM access standards more fit for purpose and reduce connections costs and time

The access standards contained in schedules 5.2, 5.3 and 5.3a of the NER define the permissible range of technical requirements that connection applicants need to meet (see Box 1 below for a detailed overview).

Box 1: Overview of access standards for the connection process

To establish a new connection under Chapter 5 of the NER (following the process in rule 5.3 or 5.3A), a connection applicant and the connecting NSP must agree on a set of performance standards for the connecting plant within the parameters set by the access standards in the applicable schedule (schedules 5.2, 5.3 or 5.3a). Each access standard relates to a technical requirement for the performance of the connecting plant, regarding its impact on the broader power system. Most (but not all) access standards have two components:

- **Automatic access standard (AAS)** — connection cannot be refused if the plant meets this.
- **Minimum access standard (MAS)** — connection must be refused if the plant doesn't meet this.

This format with a permissible range of access standards was established after a 2001 review by the then National Electricity Code Administrator (NECA), which found that mandatory fixed access standards were inefficient. NECA noted that the cost of meeting those standards will vary dramatically for different types of plant. Some could significantly overachieve against a mandatory standard at low cost, while others may only be able to achieve that standard at prohibitive costs. In addition, the need for plant to meet a mandatory level of technical performance was likely to vary between different locations within the NEM. In light of this, NECA introduced flexibility in access standards by specifying a negotiating range, subject to a mandated minimum.

The negotiation framework in the NER requires a connection applicant to propose standards that are as close as practicable to the automatic access standards. A proposed standard below the automatic access standards, down to and including the minimum access standards, is a negotiated access standard (NAS). AEMO reviews and provides advice to NSPs on negotiated access standards for several technical requirements, where there is potential to impact power system operation. These are referred to as 'AEMO advisory matters', as defined in Chapter 10 of the NER.

Once the proposed access standards are agreed (with AEMO approval where required), they become the performance standards for the relevant plant, and are included in the binding connection agreement between the connection applicant and the NSP. Where applicants are (or will be) registered participants, the performance standards must be registered with AEMO and an ongoing compliance regime will apply under rule 4.15.

The Commission's draft rule would improve the access standards to:[9]

- **Align them with best power system performance** — Redefine some automatic access standards to make them less onerous and improve guidance on negotiated access standards to better align with power system needs. This would ensure that automatic access standards are achieved on a more consistent basis, leading to better power system performance, compared with a negotiated access standard. This would reduce the need for lengthy negotiations, and save time and costs.
- **Improve power system resilience** — Better utilise already available performance capability to improve power system resilience to contingency events. This would reduce the risk of interruptions to electricity supply, without material additional cost.
- **Streamline the connection process** — Minimise ambiguity in the access standards and clarifying their application to different technologies would accelerate the connection of new generation. This acceleration is necessary to bring on new renewable and battery projects to deliver Australia's emissions reduction targets and deliver associated benefits for electricity consumers.
- **Support efficient investment in and operation of the NEM** — Allow access standards to be better tailored to power system performance needs and broadening the options available for connection applicants under different circumstances. This would increase investment efficiency by only requiring capability that is necessary for the power system and allowing for more cost-effective alternatives, thereby resulting in longer-term cost benefits for consumers.
- **Remove impediments for connection of grid-forming inverters** — Improve access standards to facilitate the connection and operation of grid-forming inverters, in a way that best utilises their capabilities. This would support power system security as traditional forms of synchronous generation retire by allowing for beneficial grid-forming inverter responses, such as response to phase angle jumps and inertial response.
- **Broaden their application to synchronous condenser connections** — Apply appropriate access standards to standalone synchronous condensers (i.e. not part of a generating or integrated resource system) to allow clear and consistent regulation of their performance. This would support efficient provision of system security services.
- **Broaden their application to all HVDC links** — Broaden the application of schedule 5.3a to include all future HVDC links to promote certainty for investment in HVDC links as to what technical standards they would have to meet. This would have flow on effects of helping to effectively and efficiently support the reliability of supply in a coordinated manner.
- **Account for potential impacts and beneficial capabilities of HVDC links** — Account for the significant power system impacts as well as benefits of improved capabilities of modern HVDC links in the access standards. This would provide clarity for the design of HVDC links, in coordination with network planning, to achieve overall efficient investment and power system operation.

For further details, refer to:

- **Chapter 2** for how the draft rule would advance the National Electricity Objective (NEO)
- **Chapters 3**, **4**, **5** and **6** for detail on how the draft rule would improve the NEM access standards
- **Appendix A** for the Commission's rule change process.

9 For a detailed overview of how AEMO considers its rule change request would advance the NEO, refer to section 3 of AEMO's rule change request document: Overview of rule change proposals to improve NEM access standards, available from the AEMC website.

1.2 The draft rule has been shaped by AEMO's review of technical requirements for connection

Clause 5.2.6A requires AEMO to conduct a review of some or all of the technical requirements set out in schedules 5.2, 5.3 and 5.3a at least once in every five year period (AEMO may conduct a review more frequently if it considers necessary). Clause 5.2.6A allows AEMO to exercise its discretion to set the scope of its review to address the most pressing needs of the power system.

AEMO conducted its first ever such review in 2022-23, undertaking extensive public consultation (three rounds).[10] Specifically, AEMO held multiple technical industry workshops and bilateral / multilateral meetings with several stakeholders, including NSPs, generators, developers, original equipment manufacturers (OEMs), Clean Energy Council, Energy Users Association of Australia, Australian Energy Council, Energy Networks Australia, and the Reliability Panel. This consultation was staged over the course of a year and comprised of:

- Issues scoping and approach paper (October 2022)
- Draft report (March 2023)
- Update report and proposal for draft NER amendments (July 2023)
- Final report (December 2023)

AEMO's review identified numerous opportunities to improve the current access standards and their application. AEMO then submitted a fast track rule change request to the Commission to give effect to the final recommendations from its review. In light of AEMO's extensive consultation on the nature and content of the rule change request, the Commission has decided to fast track this rule change request in accordance with section 96A of the NEL and has directly published this draft determination and draft rule in response, bypassing the consultation paper stage.

The Commission has examined the feedback that AEMO received through its review process and AEMO's proposed solutions and considers that the package of reforms strikes the right balance of being responsive to stakeholder concerns and advancing the NEO. As such, the Commission's draft determination and rule broadly reflect AEMO's recommendations in its rule change request. These recommendations recognise that some existing access standards are no longer fit for purpose in an increasingly inverter-based resources connected NEM. They may unintentionally disincentivise beneficial grid-forming responses, refer to defunct standards or do not account for increasing connections at a sub-transmission or distribution level. The Commission's draft rule would seek to address all of these issues.

1.3 The draft rule would support the broader connections reform agenda and contribute to meeting Australia's emissions targets

The draft rule would support the AEMC's and AEMO's broader connections reform agenda:

- In 2021, AEMO and the CEC established the Connections Reform Initiative (CRI) to address concerns with delays and increasing complexity in NEM connections. Recommendations to improve the connections process have (such as the 2024 *Enhancing investment certainty in the R1 process* rule change[11]) and are expected to continue to stem from the CRI process. This draft rule would further the CRI agenda by seeking to increase NEM connection speed by simplifying and streamlining the access standards. The draft rule would also seek to adapt access standards to better accommodate the increasing complexity in the NEM.

10 See AEMO review of technical requirements for connection (NER clause 5.2.6A) for more information on AEMO's review and the consultation process.

11 AEMC, Enhancing investment certainty in the R1 process, Rule determination, 27 June 2024.

- The Commission's 2024 *Enhancing investment certainty in the R1 process* rule change made several reforms to a key component of connections, known as the R1 process. The R1 process refers to connection applicants demonstrating to AEMO and the NSP that its plant is capable of meeting or exceeding its performance standards so that it may be registered as a participant in the NEM. The final rule:
  - formalises the commencement and conclusion of the R1 process through timely notifications by NSPs and AEMO[12]
  - clarifies the obligations of all parties during the R1 process and introduced a time frame for AEMO to determine whether it is satisfied of a plant's capability to meet or exceed its performance standards[13]
  - removes barriers to sensible revisions of a generator's performance standards by amending clause 5.3.4A(b)(1A) which sets out the requirements for a negotiated access standard
  - requires AEMO and NSPs to provide written reasons for additional data and information requests during the R1 process[14]
  - allows AEMO to conditionally register connection applicants, subject to terms and conditions as explained in its *registration and information resource guidelines*[15]
  - requires AEMO to add new information in its *registration and information resource guidelines* to describe how it assesses plant capability and considers adverse power system impacts during the R1 process.[16]
- Along with the current rule change request, AEMO has also submitted another rule change request ('Package 2') that it considers should be progressed along a standard rule change process.[17] It seeks to amend schedule 5.3 to introduce a set of requirements with sufficient flexibility to monitor and manage any material adverse impacts of prospective large load projects that are currently at various stages of planning and development. The Commission has not yet initiated the Package 2 rule change, but we note that it is closely related to this rule change ('Package 1') and would be informed by it.
- AEMO intends to conduct further in-depth reviews of the access standards for loads and grid-forming inverter technology, as noted in AEMO's current rule change request.[18] Any such reviews would need to consider the access standards applicable at the time, including any that would be implemented through this rule change.

Furthermore, the draft rule is consistent with a broader shift in the connections process, from NSPs dealing with only a handful of connection applications at a time a decade ago, to handling hundreds of applications simultaneously nowadays.[19]

This increased volume of projects in the connections queue can slow down the connections process due to:

12 Clause 5.3.7A.
13 Ibid.
14 Ibid.
15 Clauses 2.1.3(b)(4), 2.1.3(d)(2A) and 5.3.7A(j)(2).
16 See clause 11.171.2.
17 AEMC, Improving the NEM access standards — Package 2.
18 AEMO, rule change request, p 19.
19 For example, AEMO's September 2024 Connections Scorecard shows a total of 638 projects in the connections queue, from enquiry to commissioning.

- broad range of plant types and configurations seeking connection across the NEM, which may sometimes necessitate complex remodelling and simulations during the negotiation of performance standards
- shortage of power engineers across the energy industry.

To promote efficient and secure investment for new projects connecting to the NEM, the draft rule would make some access standards slightly more prescriptive to:

- better manage the surge in connection applications received by NSPs
- reduce reliance on technical expertise and judgement of NSPs and AEMO, given the shortage of power engineers.

Importantly, by reducing connection time and costs, the draft rule would accelerate new renewable deployment and incentivise new investment, thereby contributing to meeting Australia's emissions reduction targets.

1.4 The draft rule includes transitional provisions to minimise disruption and ensure regulatory consistency to contribute to the NEO

1.4.1 The draft rule would provide for a transition period to effectively implement changes to the access standards

To ensure that the benefits of the changes to the access standards can be realised as soon as possible, appropriate transitional provisions should be put in place to minimise any additional costs that may be associated with:

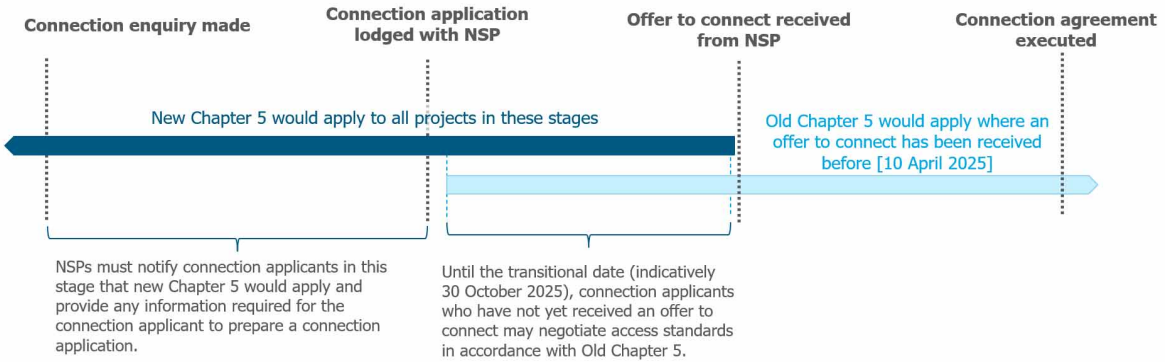
- connection applicants who have submitted a connection enquiry facing new schedule 5.2 access standards, which can significantly affect the costs of procuring and purchasing equipment
- the ongoing negotiation of access standards before a connection agreement has been executed
- NSPs, AEMO and connection applicants agreeing upon which version of Chapter 5 will be in force for a connection application or alteration.

The draft rule would adopt similar transitional provisions to the Commission's *Generator technical performance standards* 2018 rule.[20] As many parties would be familiar with the transitional provisions from the 2018 rule, the Commission considers that adopting similar provisions would minimise disruption and would be good regulatory practice.

The application of new or old Chapter 5 would depend upon which stage of the connections process a particular connection applicant is currently in, as of the commencement date. The indicative commencement date for the draft rule is 10 April 2025, while the indicative transitional date is 30 October 2025. See Figure 1.1 for an overview of which version of Chapter 5 would apply under the draft rule.

20 AEMC, *Generator technical performance standards*, Rule determination, 27 September 2018, pp 256-269.

Figure 1.1: The draft rule's transitional provisions for the application of new or old Chapter 5



Note: The diagram indicates which version of chapter 5 would apply to projects in the connections process on the commencement date. See clauses 11.[XXX].1 to 11.[XXX].6 of the draft rule for more information.

From the commencement date, new Chapter 5 would apply to all projects that have not yet submitted a connection application. If a connection enquiry has been made before the commencement date, then NSPs would be required to:

- within 10 business days after the commencement date, provide written notice to the connection applicant that new Chapter 5 would apply for its plant[21]
- within 20 business days after providing the notice above, provide the connection applicant with any information that would enable the connection applicant to prepare a connection application under new Chapter 5.[22]

If a connection application has been submitted to the NSP before the commencement date, but an offer to connect has not yet been made by the NSP to the connection applicant, then:

- the NSP would be required to notify the connection applicant that new Chapter 5 would apply, and provide any information needed to enable it to prepare an offer to connect[23]
- despite the above, connection applicants may choose to negotiate access standards in accordance with old Chapter 5, but only until the transitional date.[24]

If an offer to connect has been received from the NSP or a connection agreement has been executed before the commencement date, then old Chapter 5 would apply.[25] Similarly, old Chapter 5 would apply to all 5.3.9 alteration processes that commenced before the commencement date, unless the NSP, AEMO and the Schedule 5.2 Participant agrees otherwise.[26]

The Commission welcomes any stakeholder feedback on how the transitional provisions can be improved to better balance the benefits that can be gained from applying the rule as soon as possible, while minimising the impact or disruption that could be caused by changes to Chapter 5.

21 Draft rule, clause 11.[XXX].3(b)(3)(i).
22 Draft rule, clause 11.[XXX].3(b)(3)(ii).
23 Draft rule, clause 11.[XXX].4(b).
24 Draft rule, clause 11.[XXX].4(e).
25 Draft rule, clauses 11.[XXX].5 and 11.[XXX].6.
26 Draft rule, clause 11.[XXX].6(c). However, any 5.3.9 processes that begin after the commencement date would be subject to new chapter 5.

1.4.2 Network service providers would be required to determine and document performance standards for its plant and advise AEMO of those performance standards

Under the proposed changes to the access standard application framework, detailed in chapter 3, network service providers would be required to determine and document performances standards applicable to any schedule 5.2 or schedule 5.3a plant that it may seek to connect after the commencement date of the rule.[27] Typical examples of these plant may include an NSP's synchronous condensers or its HVDC links.[28]

To ensure that AEMO has full visibility of the performance standards of all schedule 5.2 and 5.3a plant in the power system, the draft rule includes a transitional provision that would require NSPs to determine and document performance standards for its existing schedule 5.2 or schedule 5.3a plant.[29] NSPs would have 12 months from the commencement date of the rule to determine and document these standards, as well as to advise AEMO of the performance standards. We welcome stakeholder feedback on whether 12 months is an appropriate length of time for this transitional provision.

This provision would ensure regulatory consistency across all plant across the power system, regardless of owner or operator, and would minimise the risk of adverse power system effects due to unknown performance standards of certain plant.

1.5 Outline

The remainder of this draft determination is structured as follows:

Chapter 2: The draft rule would contribute to the energy objective — Sets out how this draft determination would contribute to the advancement of the NEO.

Chapter 3: The draft rule would amend the access standards to apply them by plant type — Describes the elements of the draft rule that would support the application of the access standards based on the nature and impact of connected plant, rather than the category or registration status of the person who owns, operates or controls the plant.

Chapter 4: The draft rule would amend the access standards for generators, integrated resource systems and synchronous condensers — Describes the elements of the draft rule (primarily in schedule 5.2) that would improve the access standards for generators, integrated resource systems and synchronous condensers.

Chapter 5: The draft rule would amend the access standards for HVDC links — Describes the elements of the draft rule (primarily in schedule 5.3a) that would improve the access standards for HVDC links.

Chapter 6: The draft rule would make other consequential NER amendments — Describes other elements of the draft rule that are intended to either align the function of specific rules with their intent, reduce ambiguity, or improve outcomes consistent with the NEO.

27 Draft rule, clause 5.2.3(c1).

28 Note that this transitional provision and clause 5.2.3(c1) would not apply to any plant or network equipment that is not schedule 5.2 plant or schedule 5.3a plant, such as static var compensators (SVCs) or static synchronous compensators (STATCOMs).

29 Draft rule, clause 11.[XXX].2.

2 The draft rule would contribute to the energy objective

Box 2: Overview

The Commission is satisfied that the draft rule would promote the NEO through:

- Lowering connection costs by increasing investment efficiency and reducing costly delays, which would contribute towards lowering the cost of electricity for consumers.
- Improving power system resilience by better utilising already available plant performance capability, which would reduce the risk of interruptions to electricity supply.
- Streamlining the connections process by minimising ambiguity in the access standards, which would accelerate the connection of new generation necessary to deliver on Australia's emissions reduction targets.

2.1 The Commission must act in the long-term interests of energy consumers

The Commission can only make a rule if it is satisfied that the rule will or is likely to contribute to the achievement of the relevant energy objective.[30]

For this rule change, the relevant energy objective is the NEO. The NEO is:[31]

> to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to—
>
> (a) price, quality, safety, reliability and security of supply of electricity; and
>
> (b) the reliability, safety and security of the national electricity system; and
>
> (c) the achievement of targets set by a participating jurisdiction—
>
> (i) for reducing Australia's greenhouse gas emissions; or
>
> (ii) that are likely to contribute to reducing Australia's greenhouse gas emissions.

The targets statement, available on the AEMC website, lists the emissions reduction targets to be considered, as a minimum, in having regard to the NEO.[32]

2.2 We must also take these factors into account

2.2.1 We have considered whether to make a more preferable rule

The Commission may make a rule that is different, including materially different, to a proposed rule (a more preferable rule) if it is satisfied that, having regard to the issue or issues raised in the rule change request, the more preferable rule is likely to better contribute to the achievement of

30 Section 88(1) of the NEL.
31 Section 7 of the NEL.
32 Section 32A(5) of the NEL.

the NEO.[33] For this rule change, the Commission has made a more preferable draft rule (hereafter "draft rule"). The reasons are set out in section 2.3 below.

2.2.2 We are still considering how the rule would apply in the Northern Territory

In developing the draft rule, the Commission noted that, while most of the amendments relate to rules in the NER that do not currently apply to the Northern Territory, some amendments relate to rules currently in effect in that jurisdiction. The Commission has been considering how the draft rule should apply to the Northern Territory according to the following questions:

- Should the NEO test include the Northern Territory electricity systems? For this rule change request, the Commission is still considering whether the reference to the "national electricity system" in the NEO includes the local electricity systems in the Northern Territory or only the national electricity system.
- Should the rule be different in the Northern Territory? The Commission is still considering whether a uniform or differential rule would be appropriate and would welcome submissions on this. The Commission will continue to consult with the Northern Territory Government.

See appendix C.4 for more details on the Commission's considerations and the legal requirements for making electricity rules in the Northern Territory.

2.3 How we have applied the legal framework to our decision

The Commission must consider how to address the opportunity to improve the NEM access standards against the legal framework.

We identified the following criteria to assess whether the proposed rule change, no change to the rules (business-as-usual), or other viable, rule-based options are likely to better contribute to achieving the NEO:

- **Safety, security and reliability** – This criterion was selected to consider the safe reliable, and secure operation of the power system. The operational security of the power system depends on whether connecting plant and equipment can operate within the technical access standards contained in the NER, and not present significant system security risks. Improving access standards can ensure alignment with the best system performance and improve power system resilience.
- **Emissions reduction** – This criterion was selected as the efficiency of the connections process, which relies on access standards being fit for purpose and applied appropriately, has an impact on timely connection of renewable energy generation and storage to the power system. Accordingly, the market and regulatory arrangements for grid connections should efficiently contribute to the achievement of government targets for reducing Australia's greenhouse gas emissions.
- **Innovation and flexibility** – This criterion was selected as the Commission considers innovation and flexibility important principles for improving the access standards. This is both from the perspective of process innovations and innovations in finding solutions to system security issues uncovered through application of the access standards.
- **Implementation considerations** – This criterion was selected to assess the potential benefits versus costs of this rule change, including timing and interrelationships with other reforms and processes. Further, we consider that the cost and complexity of implementation and ongoing regulatory and administrative costs to all market bodies, participants and consumers

33 Section 91A of the NEL.

must be balanced. This includes being clear on the roles for market bodies and participants, supporting efficient investment and operational decisions, and promoting transparency and predictability.

These assessment criteria reflect the key potential impacts – costs and benefits – of the rule change request, for impacts within the scope of the NEO. The Commission has undertaken regulatory impact analysis to evaluate the impacts of the various policy options against the assessment criteria. Appendix B outlines the methodology of the regulatory impact analysis.

The Commission's draft rule is consistent with the proposed amendments to the access standards in AEMO's rule change request. However, this draft rule is a more preferable rule since the Commission has made various consequential amendments that seek to add clarity and ensure that the rule reflects the intended policy outcomes. This would better support the assessment criteria listed above than the proposed rule by increasing the likelihood that these criteria may be met. The rest of this section explains why the draft rule best promotes the long-term interest of consumers when compared to other options, including those proposed by AEMO and the status quo.

2.3.1 The draft rule would support safety, security and reliability

The Commission's draft rule would improve the access standards to better utilise already available plant performance capability to increase power system resilience to contingency events, without material additional cost. For multiple fault ride through requirements, the improved access standards would also allow carve-out for plant specific limitations to be recorded, where the automatic access standard is not practically achievable or may place an unmanageable risk on the participant. Incentivising disclosure of known limitations would enable risk mitigation plans to be in place, resulting in a more resilient power system. Refer section 4.5.2 of this draft determination for further details on amendments to clause S5.2.5.5 pertaining to multiple fault ride through requirements.

The draft rule would also apply appropriate and consistent regulation to synchronous condensers across the NEM. This would advance the NEO by enhancing power system security and electricity supply reliability that depend on continuous support from synchronous condensers. Refer to chapter 3 for more details on how the draft rule would broaden the application of access standards to synchronous condensers.

Furthermore, the draft rule broadens the application of schedule 5.3a to all future HVDC links, and amends the access standards to account for the significant power system impact and benefits of improved capabilities of modern HVDC links. This would advance the NEO by promoting investment certainty for HVDC systems to support supply reliability in a more efficient and coordinated manner, and improve power system security. Refer to chapter 5 for more details on how the draft rule improves access standards for future HVDC links.

2.3.2 The draft rule would contribute to emissions reduction

The Commission's draft rule would make the access standards more prescriptive to minimise ambiguity and clarify their application to different technologies, without compromising system security or supply reliability. This would reduce unnecessary delays and resources required for lengthy negotiations between connection applicants, NSPs and AEMO.

Clarified access standards with greater prescription would also provide more information and investment certainty to the market. These would advance the NEO by accelerating the connections process and signalling new investment for new generation, interconnection and

network support facilities required to transition to a net-zero energy system and deliver on Australia's emissions reduction targets. Refer to chapter 3 for more details on how the draft rule would clarify the application of access standards. Refer to chapter 4 and chapter 6 for more details on how the draft rule would reduce ambiguity in clause S5.2.5 together with some definitional changes in the Glossary.

2.3.3 The draft rule would promote innovation and flexibility

The Commission's draft rule would remove unnecessary technology-related restrictions for connecting grid-forming inverters. This would promote the NEO by supporting the delivery of an overall lower cost and lower emissions generation fleet, while maintaining power system security and reliability as traditional forms of synchronous generation retire. This would also promote efficient investment in, and utilisation and operation of, electricity infrastructure in the NEM (including new technologies), which is likely to result in longer-term benefits to consumers in line with the NEO.

2.3.4 The draft rule would have marginal implementation costs and complexity

The Commission's draft rule would reduce the overall costs for most connection applicants, although costs may increase for some applicants to comply with the new access standards. The draft rule would also reduce the burden on AEMO and NSPs and simplify their function by streamlining the connections process, providing clarity and reducing the need for negotiations. In this regard, the draft rule would be an important milestone in the broader connection reform agenda, as discussed earlier in section 1.3.

3 The draft rule would amend the access standards to apply them by plant type

Box 3: Overview of this chapter

- Currently, the technical requirements under schedules 5.2, 5.3 and 5.3a apply to different types of registered participants.
- AEMO has proposed that these schedules should each apply to different types of plant rather than to the registration category which relates to the owner or operator of the plant.
- AEMO considers that aligning these schedules by plant type would ensure a consistent approach to managing system security for similar types of connecting plant, irrespective of the persons connecting.
- The Commission agrees that it is important for technical requirements and obligations to apply by plant type, especially considering the increasing variety of persons and plant who are connecting and expected to connect to the power system.
- The draft rule would apply the requirements and obligations under schedules 5.2, 5.3 and 5.3a by plant type:
  - Schedule 5.2 would apply to all generating systems, integrated resource systems and synchronous condenser systems (collectively known as *schedule 5.2 plant)*
  - Schedule 5.3 would apply to all plant that consumes electricity from a network, including a distribution network or a source of load within an integrated resource system (collectively known as *schedule 5.3 plant)*
  - Schedule 5.3a would apply to any high voltage direct current (HVDC) systems with a power transfer capability of 5 MW or more (known as *schedule 5.3a plant*).
- The persons to which the obligations apply would be captured by new definitions of *Schedule 5.2 Participant, Schedule 5.3 Participant* and *Schedule 5.3a Participant* (see Table 3.1).
- The draft rule would also make various structural and clarifying amendments throughout Chapter 5.

Note: This chapter broadly relates to Section 4 of AEMO's rule change request.

3.1 The current access standards do not apply consistently to equivalent types of plant

In its rule change request, AEMO noted that the access standards in the NER are expressed as obligations on specified types of registered participant.[34] Currently,

- Schedule 5.2 applies to registered generators and integrated resource providers[35]
- Schedule 5.3 applies to market customers in respect of their market connection points, non-registered customers in respect of its connection to a network, and distribution network service providers (DNSPs) in respect of their networks[36]

34 AEMO, rule change request, p 20.
35 Clause S5.2.1.
36 Clause S5.3.1a.

- Schedule 5.3a applies to market network service providers (MNSPs) in respect of their market network service facilities.[37]

However, the application of access standards by the type of registration category means that there can be situations where equivalent plant do not face equivalent technical requirements and obligations. For example:

- A synchronous condenser that is operated by a Registered Participant as a Generator or Integrated Resource Provider is currently subject to schedule 5.2, while a stand-alone synchronous condenser that is operated either by an NSP or another party that is not required to register is not subject to schedule 5.2.[38]
- An integrated resource system with a source of load connected to the network through a market connection point is subject to schedule 5.3 as a Market Customer, but an equivalent integrated resource system with the same load that does not have a connection point classified as a market connection point may not be automatically subject to schedule 5.3.
- An HVDC system that is operated by a MNSP is subject to schedule 5.3a, but an equivalent HVDC system operated by a regulated or exempt network is not subject to schedule 5.3a.

The impact of a plant on the power system depends on its characteristics, and not by the registration status of the person who operates the plant. If consistent access standards are not applied to some plant due to their registration status, it may pose a significant security risk to the power system if AEMO or the AER has limited visibility of some plant's performance standards. Moreover, without consistent obligations, these plant could interact with the power system in a way that may cause damage to the network or to other plant, which degrades power system resilience and performance.

Throughout AEMO's review, stakeholders supported addressing this issue to ensure that the schedules are applied based on plant type, rather than registration categories.[39]

3.2 The draft rule would align the standards and obligations with the type of plant to which they apply

The Commission therefore agrees with AEMO's proposal to amend the access standards application framework so that they would apply based on the type of plant that is connecting, rather than the registration status of the owner or operator. The draft rule largely adopts AEMO's proposed rule and would:

- amend clauses S5.2.1, S5.3.1a and S5.3a.1a to define *schedule 5.2/5.3/5.3a plant*
- define the persons to which the obligations under each schedule apply as *Schedule 5.2/5.3/5.3a Participants*
- remove references to registration types (for example, *Generator, Integrated Resource Provider, Customer*) and replacing them with references to *Schedule 5.2/5.3/5.3a Participant*[40]

37 Clause S5.3a.1a.

38 A stand-alone synchronous condenser operated by an NSP is not required to register. However, it is currently unclear whether a stand-alone synchronous condenser operated by an existing Registered Participant is required to register, or can register as an Integrated Resource Provider. CS Energy has submitted a rule change request to the AEMC to create a new registration category for synchronous condensers. The AEMC has not yet initiated this rule change request. Regardless of the outcome of this rule change request, all stand-alone synchronous condensers would be subject to schedule 5.2 under the draft rule.

39 AEMO review of technical requirements for connection (NER clause 5.2.6A), Draft Report, p 25; Draft Recommendations Update Report, p 28; Appendix A1 to Draft Recommendation Update Report, pp 5-7, 63-65.

40 Some of these changes would affect existing civil penalty provisions in the NER, and may slightly affect the scope of persons to whom the civil penalty provisions apply. The Commission proposes that these amended clauses should continue being civil penalty provisions, but that their tiering remain unchanged. See appendix C.5 for more information.

- add provisions to cover cases where an NSP is a *Schedule 5.2 Participant* or a *Schedule 5.3a Participant* to allow NSPs to establish, document and apply performance standards for that plant (recognising that no negotiation process is necessary where an NSP is connecting to its own network).[41]

Table 3.1 summarises the proposed changes to the application of each schedule and explains the definition of schedule 5.2/5.3/5.3a plant and participants.

Table 3.1: Proposed changes to the access standard application framework under the draft rule

Schedule	Plant covered by schedule	The schedule would apply to these persons
Schedule 5.2	• generating systems • integrated resource systems (loads in an integrated resource system not essential to the operation of the system would be schedule 5.3 plant instead) • synchronous condenser systems	*Schedule 5.2 Participants* — that is: • any Connection Applicant who is, or intends to be, a Registered Participant for a schedule 5.2 plant • any Connection Applicant who has appointed, or intends to appoint, an intermediary for that schedule 5.2 plant • any Connection Applicant who has received, or intends to apply for, an exemption from registering as a Generator or Integrated Resource Provider, or who is entitled to an automatic exemption (but only to the extent that the NSP considers the connection would otherwise adversely affect other Network Users) • any Connection Applicant or NSP for a stand-alone synchronous condenser that 5 MVA or more • any other Connection Applicant in respect of a standalone synchronous condenser system, but only to the extent that the NSP considers the connection would otherwise adversely affect other Network Users
Schedule 5.3	• loads, both standalone and part of an integrated resource system • distribution networks	*Schedule 5.3 Participants* — that is: • any Connection Applicant who is, or intends to be, a Registered Participant for a schedule 5.3 plant, or who wishes to connect to a transmission network • any Connection Applicant who has appointed, or intends to appoint, an intermediary for that schedule 5.3 plant • any other Connection Applicant for schedule 5.3 plant, but only to the extent that the NSP considers the connection would otherwise adversely affect other Network Users

41 Draft rule, clauses 5.2.3(c1), S5.2.1, S.5.3a.1a. See also section 1.4.2 for more information on the transitional provision requiring NSPs to determine and document performances standards for its existing schedule 5.2 plant or schedule 5.3a plant.

Schedule	Plant covered by schedule	The schedule would apply to these persons
Schedule 5.3a	• HVDC links	*Schedule 5.3a Participants* — that is: • any person who is, or intends to be, the MNSP for an HVDC link • any NSP (or person exempted from the requirement to register as an NSP) whose HVDC link is, or will be, interfaced only with its own AC network or connected to the AC network of another NSP

Source: Draft rule, clauses S5.2.1, S5.3.1a, S.53a.1a, Glossary.
Note: This table is provided to aid stakeholders in understanding the draft rule. See the draft amending rule for more information on these definitions.

3.2.1 The draft rule would broaden the application of schedule 5.2 to include synchronous condenser systems

Recently, the Commission has completed several rule changes relating to the provision of system security services that are vital to ensuring that essential system services are provided throughout the energy transition. For example, the *Efficient management of system strength on the power system* rule change expanded the system strength framework to ensure that sufficient fault levels and stable voltage waveforms are provided throughout the power system.[42,43] These security services are expected to be provided by a mix of generators, integrated resource providers, network equipment and synchronous condensers.

As a result of these rule changes, the Commission considers that it is likely that the future power system may have more synchronous condensers connected to the NEM than in the past. It is vital that access standards are applied consistently to all future connecting synchronous condensers to ensure that they can provide network support, system strength and/or inertia safely and securely without adversely affecting other network users or the power system.

Under the draft rule, synchronous condensers (either as part of a generating system, an integrated resource system or stand-alone) would be subject to the access standards in schedule 5.2. This applies to all connecting synchronous condensers owned by a Registered Participant, by an NSP, by an intermediary or third party, or by a Connection Applicant who is not required or is exempt from registration.

However, some access standards in schedule 5.2 would not apply to synchronous condensers, while other access standards would apply, but with modifications. This is to recognise that synchronous condensers do not provide active power and so would not be able to meet certain requirements set out in the proposed access standards.[44]

In AEMO's review, stakeholders supported the broadening of schedule 5.2 to include synchronous condenser systems.[45] While some NSPs sought the discretion to choose to apply specific access standards to synchronous condensers in schedule 5.2, or to exclude synchronous condensers that are network assets from being subject to schedule 5.2 entirely, the Commission considers that

42 AEMC, Efficient management of system strength on the power system, Rule determination, 21 October 2021

43 In addition, the Improving Security Frameworks for the energy transition rule change aligned the inertia framework with the system strength framework so that transmission network service providers (TNSPs) may better coordinate their investments, while providing AEMO with the ability to enable system security contracts in operational time frames.

44 Where exclusions or modifications to the draft rule would apply to synchronous condenser systems, they are noted in the first paragraph of the sub-clauses in S5.2.5 and S5.2.6.

45 AEMO review of technical requirements for connection (NER clause 5.2.6A), Appendix A1 to Draft Recommendations Update Report, p 5; Appendix 2 to Final Report, p 10.

this could increase the likelihood that inconsistent requirements and obligations are placed on equivalent plant, depending on the person who owns the synchronous condenser.

Moreover, under the draft rule, NSPs would have the ability to determine and establish appropriate performance standards for their own synchronous condensers without the need for any negotiation process.[46] This would provide NSPs with the flexibility to determine performance standards for their condensers that would result in a cost-effective solution to address any particular network need.[47]

We consider that power system security would benefit from consistent technical requirements on all synchronous condensers, regardless of the owners or operators of the condensers.

3.3 The draft rule would make consequential structural amendments throughout Chapter 5 of the NER

In its review, AEMO identified that various clauses in Chapter 5 require substantial amendment to accommodate its proposed amendments to apply the access standards by plant type.[48] Its rule change request and proposed rule aims to clarify certain ambiguous issues and improve the legal drafting of Chapter 5.[49]

The Commission's draft rule adopts the vast majority of AEMO's proposed legal changes, but with some amendments.[50] The most substantive elements of the consequential amendments to Chapter 5 would:

- amend the table in clause 5.1.2 to more comprehensively cover the different types of connection or access sought
- consolidate several existing provisions that obliged Registered Participants to comply with their connection agreements into clause 5.2.2(e), which the Commission proposes to recommend being classified as a tier 1 civil penalty provision[51]
- amend clauses 5.3.7, 5.3.8, 5.3.9 and 5.3.12 to extend the requirements of establishing and changing performance standards, as well as notifying AEMO, to Schedule 5.2/5.3/5.3a Participants (which may include non-registered participants)
- amend clauses S5.2.4, S5.3.1 and S.5.3a.1 to extend confidentiality obligations to non-registered Schedule 5.2/5.3/5.3a Participants.

These amendments would ensure that the proposed changes to the access standard application framework do not cause unintentional consequences that could create barriers in the connection process.

46 Draft rule, clause 5.2.3(c1). Performance standards determined by NSPs for their synchronous condensers would be required to comply with all the usual requirements of a negotiated access standard in S5.2 and as described in clause 5.3.4A (for example, be no less onerous than the minimum access standard).

47 The draft rule also includes a transitional provision at clause 11.[XXX].2 that requires NSPs to determine, document and advise AEMO of the performance standards of its existing schedule 5.2 plant or schedule 5.3a plant. See section 1.4.2 for more information.

48 AEMO review of technical requirements for connection (NER clause 5.2.6A), Draft recommendations update report, pp 28-31.

49 For a summary of proposed structural changes to Chapter 5, see the rule change request, pp 22-25.

50 See AEMO's proposed draft rule.

51 Clause 5.2.2(e) of the draft rule consolidates obligations for each category of registered participant, some of which are currently tier 1 civil penalty provisions. The obligations that would be consolidated by draft clause 5.2.2(e) are clauses 5.2.3(b), 5.2.3(g1), 5.2.3A(d), 5.2.4(a), 5.2.4(f), 5.2.5(a), 5.2.5(c), 5.2.5A(a) and 5.2.5A(c). See appendix C.5 for more information on the Commission's proposal to recommend this clause as a tier 1 civil penalty provision.

4 The draft rule would amend the access standards for generators, integrated resource systems and synchronous condensers

This section outlines the Commission's draft NER amendments (primarily in schedule 5.2) to advance the NEO by improving the access standards for generators, integrated resource systems and synchronous condensers, based on the recommendations in AEMO's review and rule change request.[52,53]

4.1 Clause S5.2.5.1 — Reactive power capability

Reactive power is necessary to control voltages and enable power to flow from generation to load. Generating systems, integrated resource systems and synchronous condensers provide reactive power capability and absorb reactive power to reduce connection point voltages and inject reactive power to increase them. This capability allows plant to control voltages at their connection points thus facilitating the flow of power through the network. Reactive power is essential to enable active power flows from the point of generation to use by providing the out-of-phase power required to form the magnetic and electric fields necessary to move AC power through the network and transform it to beneficial end use.

4.1.1 The draft rule would reduce the voltage range for full reactive power requirements

Issues

Existing automatic access standard arrangements require generators, and integrated resource providers, to provide full reactive power capability, being 0.935 times the rated active power of the generating system, over a 20% voltage range for steady state operation being between 90% and 110% of normal voltage. This requirement ensures that irrespective of plant active power output, the plant is designed to inject or absorb this minimum amount of reactive power for any voltage within the normal operating voltage band.

The existing automatic access standard requirement is symmetric in that it requires the same capability to absorb and inject reactive power for voltages over the entire 20% range. Supplying reactive power at high voltages and absorbing reactive power at low voltages however are both undesirable for power system operation, as these actions will exacerbate high or low voltages. A full symmetric reactive power requirement, including the requirement to absorb reactive power at low voltages and supply reactive power at high voltages is therefore not aligned with power system requirements.

Reactive power capability requirements impose costs associated with the design of plant necessary to absorb and inject reactive power. Existing requirements for full reactive power capability over the entire voltage range may impose inefficient costs associated with capabilities that are not justified by benefits for power system requirements and system security needs.

Consequences

An automatic access standard that requires unnecessary capabilities increases connection costs and requires a negotiated access standard to align capabilities with power system needs. A

52 Refer to section 5 of AEMO's rule change request document: Overview of rule change proposals to improve NEM access standards, available from the AEMC website.

53 Detailed stakeholder feedback and AEMO's analysis can be found at AEMO review of technical requirements for connection (NER clause 5.2.6A).

negotiated access standard increases uncertainty associated with agreeing on performance standards. This leads to longer connection processes, higher costs, and higher resource requirements. An automatic access standard that doesn't reflect efficient outcomes in its design may therefore be inconsistent with efficient operations and investment in the long-term interests of consumers.

The Commission's draft rule

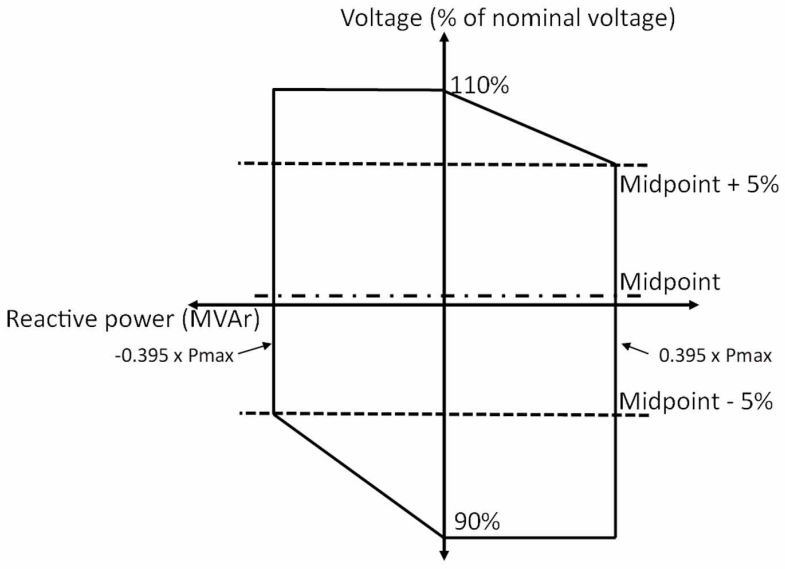
Box 4: Reducing voltage range for full reactive power capability

The Commission's draft rule would make the following changes to the automatic access standard under clause S5.2.5.1:

- Limit the full reactive power capability requirement (corresponding to 0.359 times maximum active power) to a 10% voltage band centred on a mid-point voltage nominated by the NSP (which will be within the range 95% to 105% of connection point nominal voltage).
- For voltages below the 10% full capability voltage band down to 90% require reactive injection capability at least 0.395 times maximum active power
- For voltages above the 10% full capability voltage band up to 110% require reactive absorption capability at least 0.395 times maximum active power
- For voltages from the lower limit of the 10% full capability voltage band to 90%, decrease the requirement linearly with voltage from -0.395 times maximum active power to 0 megavolt ampere reactive (MVAr)
- For voltages from the upper limit of the 10% full capability voltage band to 110%, decrease the requirement linearly with voltage from 0.395 times maximum active power to 0 megavolt ampere reactive (MVAr)

Figure 4.1 summarises the proposed automatic access standard as a diagram.

Figure 4.1: Diagram of the proposed automatic access standard for reactive power capability



Source: AEMO
Note: This diagram is proposed to be included in the draft rule as Figure S5.2.1 immediately following S5.2.5.1(a1).

Additional changes support this amendment including using re-defined active power definitions, and flexibility to reflect changes in the number of units online in the reactive power capability required.

- Clarify maximum active power (Pmax) using an amended definition of active power capability instead of rated active power.
- Provide, as a general requirement, the basis on which maximum active power and reactive power capability may be reduced with fewer than all production units in service.

The Commission's rationale for the draft rule

The Commission's draft determination is to make a draft rule that is the same as AEMO's rule change proposal. The Commission agrees with AEMO that specifying a 10% voltage band centred on a mid-point voltages specified by the NSP, within which full reactive power capability is required, would align capability with power system needs at the point of connection, in accordance with the NEO.[54]

The Commission considers an automatic access standard that requires connecting plant to invest in capability to absorb reactive power at very low voltages and inject reactive power at very high voltages does not reflect an efficient outcome where costs are aligned with power system needs. The draft rule would reduce the costs of compliance for connecting generators by removing unnecessary response capabilities to very high and low voltage conditions while maintaining response capabilities that would be beneficial to the power system.

The Commission also considers an automatic access standard, which reflects efficient outcomes, is more preferable to requiring a negotiated standard to achieve efficient levels. This is because an efficiently structured automatic access standard avoids the additional uncertainty and cost associated with negotiating a performance standard. The Commission considers requiring a negotiated performance standard to address an inherently inefficient automatic access standard is not consistent with efficient outcomes in the long-term interest of consumers, as consumers may have to bear unnecessary costs.

The Commission considers AEMO's proposal to centre the 10% band for full reactive power capability around a mid-point voltage nominated by the NSP, within the range 95% to 105% of nominal connection point voltages, provides additional flexibility to tailor plant capability to system needs. As clause S5.2.5.1 is an AEMO advisory matter, the Commission considers the NSP mid-point voltage choice should be sufficiently aligned with system needs considering the potential for changes in power system conditions over the transition.

The draft rule would promote the NEO since it would align requirements with best power system performance, streamline the connection process, and support more efficient investment and operation.

4.1.2 The draft rule would clarify and amend reactive power capability requirements considering temperature derating

Plant reactive power capability is a function of temperature. Different technologies provide differing levels of cooling with some technologies (e.g. inverter systems with water cooling) that can operate without derating across a wide range of ambient temperatures. There is however a maximum operating temperature over which a plant will not be able to operate continuously.

54 AEMO, rule change request, p 27.

Issues

Clause S5.2.5.1 expresses reactive power capability requirements as a function of active power but is silent on temperature derating. The Commission understands this silence has led to differing interpretations of this requirement and inconsistencies, and uncertainty in the interpretation of the standard.

This uncertainty is particularly relevant to the derating approach given derating can preference active or reactive power, or there can be a proportional reduction of both active and reactive power with temperature. The Commission also understands the standard is currently unclear what value of active power should be used to define the reactive power requirements when derating with temperature.

Consequences

An access standard which is silent on temperature derating of reactive power capability would create uncertainty in application of the standard and additional costs and time in negotiating a performance standard. This uncertainty is compounded by silence on whether derating should be proportional to active and reactive power. Having to undertake discussions to resolve the uncertainty on how to reflect temperature derating in the performance standard adds cost and time to the connection process. This is in addition to the material impact on cost of the connection.

There are significant consequences and trade-offs associated with preferencing active or reactive power when derating with temperature. Silence and uncertainty on the derating approach has potential reliability, security, and efficiency implications. A requirement to prioritise reactive power over active power could impact supply reliability on hot days. On the other hand, if active power is maintained at the expense of reactive power, the power system may experience reductions in voltage control capability, which may result in network constraints on hot days or a need for increased capital expenditure on network reactive plant in some network locations.

The Commission's draft rule

Box 5: Clarifying and amending reactive power capability requirements considering temperature derating

The Commission's draft determination and draft rule is to provide clarity on temperature derated active and reactive power requirements by explicitly including temperature derating in both the automatic and negotiated elements of clause S5.2.5.1. The draft rule:

- Adds a definition for temperature derating where plant capacity is materially affected by ambient temperature.
- Provides for the automatic access standard to be achieved with no temperature derating below 50 degrees Celsius.
- Allows for a negotiated access standard to include temperature derating. Unless the NSP agrees otherwise, this must represent a proportional derating of active and reactive power at the equipment level, projected to the connection point.
- Require the performance standard to document the maximum operating temperature, and any derating for a negotiated access standard.

The Commission's rationale for the draft rule

The Commission's draft determination and draft rule is to make AEMO's proposed change to include temperature derating of reactive power capability within clause S5.2.5.1.

The Commission considers clarity on temperature derating of reactive power capability would minimise time, uncertainty and cost associated with negotiating performance standards, thereby enhancing the efficient of the connection process. Further the Commission considers the draft rule balances:

- prescription — in its requirement for a proportional derating of active and reactive power, with
- flexibility — should the NSP consider a preference for active or reactive power derating is best aligned with power system conditions.

The clarity provided by explicitly recognising temperature derating as part of a negotiated access standard, with a preference for proportional active and reactive power derating but allowing flexibility in appropriate circumstances would balance the challenge of maintaining voltage control and reliability on hot days under supply scarcity conditions.

The Commission agrees with AEMO that an automatic access standard with no temperature derating below 50 degrees Celsius reflects the best available plant performance that would make the power system easier to operate and reduce the need for other investments in reactive power capability.[55] This is a practical approach that is preferable to requiring all temperature derating to be addressed via the negotiation process. This would promote the NEO since it would align requirements with best power system performance, streamline the connection process, and support more efficient investment and operation.

4.1.3 The draft determination would clarify requirements for the compensation of reactive power when units are out of service

Generators, integrated resource providers (IRPs), and other schedule 5.2 facilities have auxiliary systems that produce or absorb reactive power. When the facility is connected to the power system but not generating the reactive power produced or absorbed by auxiliary systems have implications for network voltages.

Issues

Under existing arrangements, reactive power requirements when a facility is not in service is determined under clause S5.3.5. That standard is designed for loads and specifies reactive power requirements in terms of minimum lagging power factor and excludes leading power factors.

Existing arrangements are suitable for thermal generator auxiliary systems which generally have lagging power factors given the amount of machine loads associated with crushers etc. This approach is however not fit for inverter connected plant which generally has leading power factors given the reactive influence of large lightly loaded internal reticulation systems when the plant is not generating and capacitive filtering systems to address harmonic content produced by inverter switching.

Consequences

Inappropriate standards which are not fit for purpose increase the cost and uncertainty associated with the connection process.

55 AEMO, rule change request, pp 28-29.

The Commission's draft rule

Box 6: Clarifying requirements for the compensation of reactive power when units are out of service

The Commission's draft determination and draft rule is for an automatic access and minimum access standard requirement that would replace the existing requirement for a performance standard for auxiliary plant under clause S5.3.5 with a new automatic and minimum access standard for units that are electrically connected but not otherwise in service. The draft rule would include:

- An automatic access standard requirement for no impact on voltage compared with the plant being fully disconnected.
- A minimum access standard requirement that any voltage impact is limited to 1% unless a higher percentage is agreed with the NSP.
- Guidance that the assessment of voltage impact is to be assessed in steady state conditions and for the highest system impedance value nominated by the NSP under clause S5.2.5.13. This is based on the equivalent impedance for the minimum three phase fault level declared at the electrically closest system strength node, in combination with the network outage that would cause the greatest reduction in the three-phase fault level at the connection point.

Additional general requirements in clause S5.2.5.1:

- Require the performance standards to record the level or range of reactive power to meet the compensation requirement (in MVAr) and any associated operational arrangements.
- If the operational arrangements require reactive power compensation from one or more production units:
  - A performance standard must be established for stability of the control system for settling time for a voltage step in that control mode (if a secondary control mode), and
  - The performance standard established under clauses S5.2.5.2, S5.2.5.9, S5.2.5.10, S5.2.5.15, S5.2.6.1, and S5.2.6.2 would apply, as would clause S5.2.5.8 in respect of protection requirements.

The Commission's rationale for the draft rule

The Commission's draft determination and draft rule is to include voltage impact limits and reactive power compensation arrangements within clause S5.2.5.1 that apply when the plant is connected but not generating.

The Commission considers the draft rule would provide a clear outcome-based requirement which would address the shortcomings of existing arrangements for inverter connected plant. Flexibility is provided in the minimum access standard for connection applicants and NSPs to negotiate alternate requirements to account for the specific circumstances of the connection should there by sufficient rationale why a voltage impact above 1% is acceptable.

The requirement is supported by the changes to general requirements that provide additional information on the approach to establishing voltage impact. Linking the impact assessment to the electrically closest system strength node would provide a transparent and consistent reference point.

The Commission considers the draft rule would clarify arrangements in a way that updates arrangements, making them fit for purpose for inverter-connected plant. This would promote the

NEO since it would streamline the connection process, and support efficient connection applications and associated investment needs in the NEM.

4.2 Simplifying standards for small connections

4.2.1 The draft rule would simplify standards for small connections

Issues

Applying access standards to all plant in the power system, irrespective of size, would be inefficient. This is because the power system impact of smaller plant does not always merit more onerous access standards being applied.

However, the impact of smaller plant can be cumulative and can depend on the number and size of plant connected in a local area of the network and whether their performance adversely affects other network users or the network itself.[56] AEMO can assist NSPs in helping determine the individual and cumulative impacts of smaller plant on the power system through its advisory role in the connections process.[57]

Consequences

Currently, some existing access standards have different size thresholds for different technologies (for example, 5 MW for bidirectional units and 30 MW for generating units — see clause S5.2.5.8(a1)). Power system impacts depend generally on plant size rather than technology types, and so the Commission considers that these types of distinctions between plant types should be amended.

However, there may be some requirements that are unnecessarily onerous for smaller plant. As such, there are opportunities to relax these requirements where they may reduce costs for connection applicants without compromising on power system security.

The Commission's draft rule

Box 7: Simplifying standards for small connections

The draft rule would specify size thresholds for certain access standards where a small connection is unlikely to have an adverse effect on the power system:

- In the automatic and minimum access standards for clause S5.2.5.7 (Partial load rejection for synchronous generation), exempt production systems that are less than 30 MW on the mainland and less than 7 MW in Tasmania from these access standards
- In the minimum access standard for clause S5.2.5.8 (Protection from power system disturbances), apply consistent technology-neutral thresholds for emergency over-frequency response requirements, being 30 MW and 7 MW on the mainland and in Tasmania, respectively.
- In the minimum access standard for clause S5.2.5.13 (Voltage and reactive power control), restrict the application of the following minimum access standard requirements to systems above 30 MW and 7 MW on the mainland and in Tasmania, respectively:
  - Testing facilities sufficient to establish dynamic operational characteristics of control systems (see clause S5.2.5.13(d)(2) in the draft rule)

56 AEMO review of technical requirements for connection (NER clause 5.2.6A), Final Report, p 34

57 See Chapter 10 for the NER for definition of 'AEMO advisory matter', and the proposed changes to that definition in the draft rule.

- Excitation control system characteristics (see clause S5.2.5.13(d)(4) in the draft rule)

Note: A different threshold in Tasmania is due to the proposed threshold being defined as the lesser of 30 MW and 5% of the largest credible contingency event as defined in the Frequency Operating Standard. In Tasmania, 5% of the largest credible contingency currently is 7 MW.

The Commission's rationale for the draft rule

The draft rule would simplify the connection requirements for small connections where they are unlikely to have a material adverse impact on the power system. Since the number of small connections are likely to grow throughout the energy transition, the draft rule would promote the NEO by streamlining the connection process and supporting efficient investment.

4.3 Clause S5.2.5.2 — Quality of electricity generated

Clause S5.2.5.2 sets out the access standards for plant to minimise harmonic distortion when connected to the power system. Harmonics can degrade the performance of other plant and facilities throughout the network, and generally reduces power system stability and performance.

4.3.1 The draft rule would delete a reference to a superseded Australian Standard

Issues

The clause refers to a superseded Australian Standard (AS1359.101), which is an older version of the international standard already specified in the clause (IEC 60034-1).

The Commission's draft rule

Box 8: Deleting a reference to a superseded Australian Standard

In clause S5.2.5.2(a), the draft rule would remove the reference to AS1359.101 as a plant standard for harmonic voltage distortion.

The Commission's rationale for the draft rule

The Commission's draft rule would remove this reference as referring to a superseded standard provides no value and could create confusion during the connections process. In this regard, the draft rule would promote the NEO by streamlining the connection process.

4.4 Clause S5.2.5.4 — Response to voltage disturbances

This clause sets out the access standards that determine how plant should respond to overvoltages or undervoltages. These voltage disturbances can be caused by a wide variety of faults, contingencies, switching surges or lightning. This clause is important for requiring plant to be able to remain in continuous uninterrupted operation for some amount of time (depending on the magnitude of the voltage disturbance) to minimise the risk of cascading outages that can be caused by plant tripping.

4.4.1 The draft rule would allow the point of application for overvoltage requirements to be negotiated for medium and low voltage connections

Issues

The current automatic access standard for clause S5.2.5.4 is based on European ENTSO-E overvoltage requirements.[58] However, the European requirements are for plant connected to a 400 kV system, meaning that the current automatic access standard may not be appropriate for medium or low voltage connections.

Consequences

Plant connected at medium or low voltage connection points are often not able to meet the automatic access standard because they are often connected to the network directly, with no automatic tap-changing transformer in between. This may make it very difficult for these plant to be able to remain in continuous uninterrupted operation for the long durations stated in the automatic access standard.

The Commission's draft rule

Box 9: Allowing the point of application to be at the nearest HV location for medium and low voltage connections for a negotiated access standard

The draft rule would:

- in the negotiated access standard in clause S5.2.5.4(c1), allow the point of application to be the electrically closest location with a nominal voltage of 66kV or above, upon agreement between the NSP and AEMO.
- delete clause S5.2.5.4(c) which limits negotiation based on plant size.

The Commission's rationale for the draft rule

The Commission considers that distribution-connected plant should not be subject to significantly more onerous requirements than transmission-connected plant, unless different requirements are warranted due to technical characteristics of where they are connecting in the system, especially as the number of distribution connections are likely to increase in the future.

Recognising that applying the overvoltage requirements at the connection point may be too onerous for medium or low voltage connections, the Commission considers that adding flexibility in the negotiated access standard to move the point of application to the nearest location at or above 66kV is appropriate. This would allow these connection applicants without a tap-changing transformer to propose to move the point of application where they identify that meeting the automatic access standard would be too costly or impractical.

The proposed change also allows NSPs or AEMO to reject negotiated access standard proposals where the nearest 66kV location is electrically very distant, which may sometimes have the effect of reducing the overvoltage requirements to near-zero. This is because tap-changing transformers in a distribution network could overly shield the connection applicant's plant from any overvoltages it may otherwise experience at its connection point. If a fault occurs near the connection point, then tap-changing transformers may not shield sufficiently shield the plant, potentially causing it to trip.

58 AEMO, rule change request, p 32. The ENTSO-E requirement is available here — see Article 16, clause 2.

The Commission notes that connections applicants could also continue to propose a negotiated access standard that is applied at the connection point, as long as it is no less onerous than the minimum access standard as described in clause 5.2.5.4(b). Therefore, the Commission considers that this amendment would strike the right balance between negotiation flexibility and AEMO/NSP discretion to move the point of application.

The draft rule would also delete clause S5.2.5.4(c) in the negotiated access standard, which unreasonably restricted negotiation based on plant size. The Commission considers it important that all connection applicants are able to propose negotiated access standards subject to consistent requirements.

The draft rule would promote the NEO as it would streamline the connection process, and support efficient investment and operation.

4.4.2 The draft rule would bound requirements for over-voltages above 130% and introduce obligations to minimise recurring switching surges

AEMO's proposal for amending the requirements for overvoltages above 130% can be divided into three primary sub-issues, and are numbered accordingly in each sub-section below.

Issues

1. The automatic access standard in clause S5.2.5.4(a)(1) currently requires that plant must be capable of remaining in continuous uninterrupted operation for a transient overvoltage of over 130% for at least 20 milliseconds. However, the wording of 'over 130%' can be interpreted as an unbounded obligation, with plant required to remain in continuous uninterrupted operation for any arbitrarily high overvoltage.
2. In its review, AEMO also identified that there is no requirement in the NER for NSPs and connected parties to manage their facilities in a way that minimises switching surges (that is, transient slow front overvoltages).[59] Repeated switching surges can increase the likelihood of plant tripping and can deteriorate or damage plant over time.
3. The voltages in clause S5.2.5.4 are not explicitly defined as root-mean-square voltages, and may be interpreted differently.

Consequences

1. If participants interpret 'over 130%' to mean that for a plant to achieve the automatic access standard, it must be able to remain in continuous uninterrupted operation for 20 milliseconds for any arbitrarily high overvoltage, then this is an unachievable standard that cannot be met. This creates uncertainty and does not promote connection applicants to realise power system benefits through their plant investments.
2. The requirements in clause S5.2.5.4 are related to the system standards for power frequency voltage described in clause S5.1a.4. However, clause S5.1a.4 is silent on overvoltages of more than 130%, meaning there is no explicit obligation on an NSP to minimise these overvoltages from occurring.
3. Misinterpretation of whether a voltage should be a root-mean-square voltage or a peak-to-peak voltage can create confusion and delay in the connections process.

59 AEMO review of technical requirements for connection (NER clause 5.2.5.6A), Appendix A1 to Draft Recommendations Update Report, pp 22-23; Final report, p 37.

The Commission's draft rule

Box 10: Bounding requirements for over-voltages above 130% and introducing obligations to minimise recurring switching surges

The draft rule would clarify that the automatic access standard should not be interpreted as an unbounded obligation on connection applicants, and introduces a new obligation on parties to minimise switching surges:

- In the automatic access standard in clause S5.2.5.4(a)(1), replace 'over 130%' with 'at least marginally exceeding 130%', and clarify the boundaries of the voltage ranges specified in S5.2.5.4(a)(2)-(8) to minimise potential misinterpretation.
- Add obligations on both NSPs and Schedule 5.2 Participants (in clauses S5.1.4A and S5.2.3(b)(4A), respectively) to minimise the risk of recurring switching surges through the design and operation of their network or plant:
  - In the automatic access standard in clause S5.2.5.8, add a requirement that voltage-related protection systems must not disconnect plant within 20 milliseconds.
  - In the general requirements in clause S5.2.5.8(b5), require protection settings to be set so that the plant's capability to remain in operation for abnormal power system conditions for which the plant is not required to disconnect is maximised (while maintaining safe and stable operation with good electricity industry practice).
- In clause 5.7.2(a), add a provision for registered participants to request an assessment (for example, to carry out simulation studies) of the other party's equipment.
- In clause S5.2.5.4(a0)(3), clarify that references to voltages are root-mean-square voltages.

The Commission's rationale for the draft rule

1. The Commission agrees with AEMO that connection applicants should not face an unbounded obligation to meet the automatic access standard. In the final determination for the 2018 *Generator technical performance standards* rule change, when comparing the overvoltage requirements to other international standards, the Commission stated that "AEMO's proposed over-voltage requirements in the proposed automatic access standard were comparable, and in many cases less arduous, than standards in other jurisdictions."[60] The only jurisdiction compared that had a requirement over 130% was Hydro Quebec in Canada. Its overvoltage requirements are that plant must not trip for overvoltages in the range of 130%-140% in 100 milliseconds.[61] As Hydro Quebec's obligation is clearly bounded, the Commission's intent was for clause S5.2.5.4(a)(1) to describe a plant able to remain in continuous uninterrupted operation for 20 milliseconds for an overvoltage of over 130%, but not for any arbitrarily high overvoltage. We consider the draft rule's wording change to **'at least marginally exceeding 130%'** better describes this intent, and minimises the risk of misinterpretation.[62]
2. While the Commission understands repeated switching surges may be rare, we consider that an obligation for NSPs and schedule 5.2 plant to ensure that they do not cause recurring switching surges is important. If an applicant wishes to connect a plant with capability meeting or exceeding the automatic access standard, it should reasonably expect that it is not

60 AEMC, Generator technical performance standards, final determination, p 203.

61 AEMC, Generator technical performance standards, draft determination, p 211.

62 The draft rule also clarifies the voltage ranges specified at S5.2.5.4(a)(2) — (8) by including 'up to and including' or 'down to and including'. This would better clarify the overvoltage requirements at the boundaries of each voltage range.

exposed to recurring slow front overvoltages caused by poor engineering practices from the NSP or other network users. Furthermore, the Commission considers that extending the right of parties to request an assessment (that is, a simulation study instead of a physical test) of another party's equipment ensures that the cause of any recurring surges can be discovered and addressed efficiently. This would promote power system resilience by minimising the risk of material degradation of plant or network equipment, in accordance with the NEO.

3. Clarifying that voltages are meant to be interpreted as RMS voltages in this clause would promote certainty for market participants and would reduce the potential for confusion and disputes.

The draft rule would promote the NEO as it would align the requirements with best power system performance, streamline the connection process, and support efficient investment and operation.

4.4.3 The draft rule would clarify the meaning of 'continuous uninterrupted operation' for moderate voltage disturbance requirements

Issues

AEMO has noted that the meaning of 'continuous uninterrupted operation' in the context of clause S5.2.5.4 has been interpreted in various different ways.[63]

Consequences

Different interpretations of continuous uninterrupted operation in clause S5.2.5.4 can create uncertainty for connecting parties as to the level of capability they should aim to achieve. Clarifying the meaning of continuous uninterrupted operation is especially important for inverter-based plant, where reactive power capability is directly dependent on the network voltage, and where temporary active power reductions can occur due to weather conditions.

The Commission's draft rule

Box 11: Clarifying the meaning of 'continuous uninterrupted operation' for disturbances within 90-110% of nominal voltage

The draft rule would add clauses S5.2.5.4(e1), (e2) and (e3) which qualify what 'continuous uninterrupted operation' means for voltage disturbances within 90-110% of nominal voltage:

- For voltage variations of up to 10%, reactive capability (as per performance standard established under clause S5.2.5.1) must be maintained and active power must not reduce. Tap-changing transformers, plant switching and overload capability is permitted. Transient responses, frequency deviations, phase angles changes, energy source availability and any other factors the NSP and AEMO consider reasonable are to be disregarded.
- For voltage variations greater than 10%, reasonable temporary reductions in active power output and reactive power capability, corrected by tap-changing transformer responses, are permitted.

The Commission's rationale for the draft rule

The draft rule would ensure that different interpretations of the meaning of continuous uninterrupted operation does not lead to connection being subject to inconsistent requirements,

63 AEMO review of technical requirements for connection (NER clause 5.2.5.6A), final report, p 39.

with potentially significant cost implications depending on interpretation. Minimising confusion and ambiguity within the rules will lead to greater consistency and certainty, and may be expected to reduce costs for connection applicants seeking to connect inverter-based plant. This would promote the NEO as it would streamline the connection process, and support efficient investment and operation.

4.5 Clause S5.2.5.5 — Disturbance ride-through capability

Clause S5.2.5.5 describes the requirements for plant to remain in continuous uninterrupted operation for multiple successive faults (known as multiple fault ride through), provided each fault or sequence of faults meets a specified set of conditions. In particular, this clause describes the requirements for:

- Response to contingency events and network faults, including multiple disturbances, for generating systems.
- Reactive current injection and absorption during faults, and active power recovery following faults.
- Responses following recovery from faults, in conjunction with the continuous uninterrupted operation definition.

This clause seeks to improve system security by requiring plant to ride through multiple faults and provide beneficial responses without tripping, which could further exacerbate the impact of such faults, unless required or permitted under the performance standards.

4.5.1 The draft rule would define the end of a disturbance for multiple fault ride through

Issues

While clause S5.2.5.5 specifies that the minimum clearance between the end of one disturbance and the commencement of the next disturbance may be zero milliseconds for the automatic access standard and 200 milliseconds for the minimum access standard, it does not define the end of a disturbance.

Consequences

This gives rise to the potential for different interpretations of when a disturbance can be taken to end, increasing uncertainty and creating unnecessarily onerous obligations. For example, it is possible to interpret the automatic access standard to require ride through of 15 faults consecutively with no voltage recovery between them. The probability of this occurring is very low and requiring plant capability to do so would be inefficient, as noted by AEMO in its review and rule change request.

The Commission's draft rule

Box 12: Defining the end of a disturbance for multiple fault ride through

The draft rule would:

- Add a new provision at S5.2.5.5(b)(3) specifying that a disturbance is taken to end when the voltage at the connection point recovers to within 90% to 110 % of nominal voltage and remains within that range for at least 20 milliseconds.

- Align paragraphs (d)(5) and (l)(3) of clause S5.2.5.5 so they both refer to the 'time difference between the end' of a disturbance, and remove different uses of the word 'clearance'.

The Commission's rationale for the draft rule

The Commission considers that the draft rule would clarify the nature of faults that need to be tested for multiple fault ride through by specifying a voltage recovery criterion and reduce the likelihood of misinterpretation of the clause. This would promote the NEO as it would streamline the connection process, and support efficient investment and operation.

The Commission also notes that most stakeholder submissions in AEMO's review supported defining the end of a disturbance.[64]

4.5.2 The draft rule would refine compliance requirements for multiple fault ride-through

Issues

The minimum access standard for multiple fault ride through is for a plant remain in continuous uninterrupted operation for up to 6 disturbances that are over 200 milliseconds apart within a 5-minute window, subject to a set of qualifications about the nature of the disturbances (individually and as a sequence).

Consequences

AEMO's rule change request identified that the existing minimum access standard presents an impediment to some connections because:[65]

- Simulation models cannot capture all possible disturbance combinations under different power system conditions that might cause a plant to trip.
- Assessments can generally only establish non-compliance, as opposed to proving compliance for all possible disturbance combinations.

This has resulted in connection applicants having to undertake extensive simulation studies, which are time-consuming, expensive, and still inconclusive. The requirement to meet multiple fault ride through conditions under all circumstances also disincentivises the disclosure of conditions that would cause a plant to trip for potential combinations of disturbances within the envelope described by the minimum access standard.

The Commission's draft rule

Box 13: Refining compliance requirements for multiple fault ride through

The draft rule would:

- Add a new clause S5.2.5.5(r2) allowing a negotiated access standard to include, where agreed by the NSP and AEMO, a specified plant limitation for which the plant is not required to remain in continuous uninterrupted operation for a specified combination of power system disturbances or associated conditions. The required response of the plant for such

64 AEMO review of technical requirements for connection (NER clause 5.2.6A), Appendix 2 to Final Report, p 37.
65 AEMO, rule change request, p 36.

combinations of power system disturbances or associated conditions must also be specified, to be as close to continuous uninterrupted operation as reasonably practicable.

- In clause 5.2.5.5(l), amend the qualifying conditions for the minimum sequence of 6 faults within 5 minutes to exclude technology related specific limitations disclosed to the NSP and AEMO in accordance with the new clause S5.2.5.5(r2).

The Commission's rationale for the draft rule

The Commission agrees with AEMO's view that incentivising disclosure of limitations by allowing carving out specific limitations, while otherwise maintaining the requirement to ride through 6 disturbances within 5 minutes, would benefit all parties:[66]

- For Connection Applicants, it would put reasonable limits on simulations and allow plant performance to be specified in the performance standards together with known limitations.
- For NSPs and AEMO, it would improve visibility of conditions under which a plant could trip, allowing them to be accounted for operational and planning purposes.

The draft rule would, therefore, allow disclosure of combinations of power system disturbances for which a plant cannot remain in continuous uninterrupted operation. This would facilitate dialogue between connection applicants, NSPs and AEMO regarding such disclosed limitations, enabling more efficient and collaborative management of the risk by either accepting it, if the risk is sufficiently low, or identifying mechanisms to mitigate it. For example, risk from a trip condition associated with unbalanced faults occurring at specific time intervals, which could arise for a plant mechanical resonance condition, might be mitigated by changing an auto-reclosure time on nearby circuits, as suggested by AEMO.[67] This amendment was well-supported by stakeholders in AEMO's consultation.[68]

The draft rule would promote the NEO as it would align the requirements with best power system performance, improve power system resilience, streamline the connection process, and support efficient investment and operation.

4.5.3 The draft rule would relax the continuous uninterrupted operation requirement for fault level below minimum for which the plant is tuned

Issues

Most technical access standards are assessed considering fault levels expected for system normal and single outage conditions, for a range of generation dispatch conditions. Access standards for multiple fault ride through are different in that they consider non-credible combinations of conditions. AEMO's review and rule change request identified the following issues with the current standards pertaining to fault levels for multiple fault ride through:[69]

- Multiple fault ride through requirements do not consider that multiple faults could reduce the fault level at the connection point below the level for which a plant was tuned, although they exclude material reductions of power transfer capability from the conditions for which a plant must remain in continuous uninterrupted operation.

66 AEMO, rule change request, pp 36-37.
67 AEMO, rule change request, p 36.
68 AEMO review of technical requirements for connection (NER clause 5.2.6A), Appendix 2 to Final Report, pp 38-43.
69 AEMO, rule change request, p 37.

- It is unclear for what minimum fault levels are plant required to be tuned.
- The fault levels for which plant have been tuned are not recorded.

Consequences

Control system tuning affects the dynamic performance of a plant, including the damping of its controls during disturbances. Requiring a plant to remain in continuous uninterrupted operation for fault levels below which it has been tuned puts unnecessary obligations on plant performance. Ambiguity in minimum fault levels can result in a tuning range that sub-optimally utilises available plant performance range. Lack of transparency in plant tuning hinders future assessment of whether tuning is still adequate considering changes in the power system over time (including retirement of synchronous plant).

The Commission's draft rule

Box 14: Fault levels and tuning affecting multiple fault ride through capability

The draft rule would:

- In clauses S5.2.5.5(d) and (l), exclude from the continuous uninterrupted operation requirement conditions where the three phase fault level at the connection point falls below the minimum for which the plant was required to be tuned, as specified by the NSP.
- Require the NSP to specify the minimum for tuning as the higher of:
  - the three-phase fault level derived from the short circuit ratio recorded for clause S5.2.5.15, and
  - the minimum fault level at the electrically closest system strength node combined with the single network element outage that would most reduce the fault level at the connection point.
- In the information to be provided from a Schedule 5.2 Participant under clause S5.2.4, include a requirement for information to reflect control system turning consistent with the three phase fault levels in clause S5.2.5.5, which must be recorded in the releasable user guide (RUG).

The Commission's rationale for the draft rule

The Commission's draft rule would:

- Aid the selection of appropriate disturbance / fault scenarios by removing any obligation for a plant to remain in continuous uninterrupted operation below the minimum fault levels for which it has been tuned
- Remove ambiguity by requiring the minimum fault level for tuning to be set by reference to objectively ascertained parameters.
- Facilitate review and retuning of control systems in future, if necessary, by recording plant tuning levels in an accessible document, such as the RUG.

The draft rule would promote the NEO as it would streamline the connection process, and support efficient investment and operation.

4.5.4 The draft rule would delete reference to a metallic conducting path

Issues

Clause S5.2.5.5(a) states:

> In this clause S5.2.5.5 a fault includes a fault of the relevant type having a metallic conducting path

This does not add any additional clarity to the description of faults in the clause.

Consequences

Power system faults can generally have paths that are combinations of metallic and non-metallic conducting paths (for example an arcing fault through a transmission line and ionised air to ground). There is no apparent reason why a metallic conducting path might otherwise be excluded from clause S5.2.5.5, but the statement could create room for debate about the application of the requirements to non-metallic conducting paths.

The Commission's draft rule

Box 15: Deleting reference to a metallic conducting path

The draft rule would delete the specific reference to a fault including a fault of the relevant type having a metallic conducting path in clause S5.2.5.5(a).

The Commission's rationale for the draft rule

The Commission's draft rule deletes clause S5.2.5.5(a) to remove ambiguity about continuous uninterrupted operation requirements for faults with non-metallic conducting paths. AEMO's review found a lack of consensus about the original meaning or intent of clause S5.2.5.5(a), indicating that there is potential for confusion.[70] While some stakeholders commented that clause S5.2.5.5(a) is intended to exclude high impedance faults from continuous uninterrupted operation requirements and should not be deleted[71], the Commission agrees with AEMO's view that a high impedance fault on the power system is unlikely to impact fault ride through requirements for a generating system.[72] In this regard, the Commission considers that deleting clause S5.2.5.5(a) would not alter the practical application of the clause S5.2.5.5 fault ride through requirements. Removing ambiguity would streamline the connection process, which would promote the NEO.

4.6 Clause S5.2.5.5A — Responses to disturbances following contingency events

The draft rule would move parts of clause S5.2.5.5 (the disturbance response and recovery requirements) into a new clause S5.2.5.5A to improve the clarity of the rules drafting.[73]

Following a fault or voltage disturbance, the response of all plant connected to the power system is critical to avoid plant tripping, voltage decline, load disconnections and power system

70 AEMO, rule change request, pp 44-45; AEMO review of technical requirements for connection (NER clause 5.2.5.6A), Appendix A1 to Draft Recommendations Update Report, p 41; Appendix 2 to final report, p 52.

71 Ibid.

72 Ibid.

73 The disturbance response and recovery requirements are different for synchronous and asynchronous plant, whereas the fault ride-through requirements are the same for all technologies. Separating these out makes these clauses easier to follow.

instability. This clause would set out the access standards for the volume, timing and characteristics of reactive current injection to ensure optimal power system resilience.

4.6.1 The draft rule would amend the requirements for active power recovery after a fault

Generators and integrated resource providers are required to provide a rapid reactive current response to stabilise voltages during a fault. For inverter-based technology, when a fault causes a voltage below 90% of the nominal connection point voltage the plant is required to inject reactive current, which is typically at the expense of active current and power. Active power must rapidly recover when the fault clears to minimise the effect on frequency and the continued supply to consumers.

Issues

Existing automatic access standard arrangements under clause S5.2.5.5 require active power recovery to at least 95% of the level that existed just prior to the fault within 100 milliseconds of a fault's clearance. This requirement may not be achievable or desirable under certain circumstances post-fault. Active power recovery time frames depend on network conditions and the recovery of voltage following a fault, which can be affected by a range of external factors that are not within the connecting party's control. The rate of active power recovery may also be affected by power system frequency conditions and the provision of primary frequency response and other frequency control services. A strict requirement to recover active power within 100 milliseconds is therefore unlikely to appropriately reflect generator response to actual power system conditions.

The 2023 *Efficient reactive current access standards for inverter-based resources* rule change changed the minimum access standard for active power recovery requirements to address some of these issues.[74] This change linked active power recovery to voltage recovery to link the requirement to recover active power to voltage conditions at the connection point. The automatic access and minimum access standards are therefore now expressed differently which may affect the efficiency of the performance standard negotiating process.

Consequences

Automatic access standards that are unachievable under some circumstances undermine effective assessment of ongoing compliance with technical obligations. This undermines clear achievable obligations that provide investor confidence. Automatic access standards that are not consistently expressed may lead to ambiguity in negotiated access standard negotiations, which increases uncertainty and cost-affecting investment and the maintenance of NEM reliability.

The Commission's draft rule

Box 16: Amending the requirements for active power recovery after a fault

The Commission's draft rule links the requirement to recover active power post fault to connection point voltage recovery and explicitly accounts for frequency response and the provision of primary frequency response. The draft rule:

- Links the active power recovery requirement to a new definition of the end of a disturbance in the same way as the for multiple fault ride through requirements.

74 AEMC, Efficient reactive current access standards for inverter-based resources, Rule determination, 20 April 2023.

- Instead of referring to active power recovering, the draft rule enhances clarity by referring to reaching 95% of pre-disturbance active power within a specified time.
- automatic access standard for both synchronous and asynchronous production units, and the minimum access standard for synchronous units, include a separate active power response requirement for a frequency disturbance. This requirement refers to an active power level consistent with the clause S5.2.5.11 performance standard, and the operation of the plant in accordance with clause 4.4.2(c1) for primary frequency response.
- Include a reference to primary frequency response in the minimum access standard for asynchronous units.
- Allow for inertial response and phase jump response in the minimum access standard.

The Commission's rationale for the draft rule

The draft rule would link the requirement to recover active power fault to connection point voltage recovery, and explicitly account for frequency response and the provision of primary frequency response. The Commission considers, as did AEMO[75], that a strict requirement in the automatic access standard that does not reflect actual power system conditions and requirements is inappropriate. The Commission particularly notes the absence of frequency related response qualifiers, and a lack of clarity on the end of the voltage disturbance, in this regard.

The draft rule would qualify and clarify active power recovery in a manner that better reflects actual power system conditions consistent with enhancing ongoing compliance with performance standards. The Commission also considers aligning the expression of the automatic access standard and minimum access standard requirements as in the draft rule would facilitate efficient negotiation and enhance investor certainty and confidence. This would promote the NEO as it would streamline the connection process, and support efficient investment and operation.

4.6.2 The draft rule would amend rise time, settling time and commencement time requirements for reactive current injection

A rapid reactive current response to a fault is necessary to support voltages, maintain power system stability, and provide fault current for protection system operation when a voltage disturbance occurs that sees connection point voltages depart from the normal operating voltage band of 90% to 110% of normal voltage. If voltage disturbances are not arrested by the rapid injection or absorption of reactive current, system security and the capacity of nearby generators and loads to remain connected to the power system may be compromised.

Issues

Unlike synchronous plant, which have an electromagnetically inherent response to voltage disturbances, inverter connected asynchronous plant require control system and plant capability design that provides a fast but stable reactive current response during a fault.

Clause S5.2.5.5 currently specifies an acceptably fast yet stable response for asynchronous plant by requiring a response rise time and settling time that is also adequately damped. While these requirements describe control system responses to ideal step change inputs which are established and well understood, they do not reflect actual fault voltage profiles which may not be a step or step like.

75 AEMO, rule change request, pp 37-38.

AEMO considers settling time, which describes the time taken for a step response to settle close enough to its target value, is a criterion that is only applicable to certain, simple faults with step characteristics that are rarely seen in practice.[76]For more complex voltage faults, which commonly occur in actual power system operation, the settling time requirement may not be a meaningful assessment of reactive current response adequacy. The assessment band for the settling time definition also depends on the magnitude of the response. For a shallow fault, the small voltage change can give rise to an error band that is too small for a meaningful assessment of settling time.[77]

AEMO further considers the requirement for an adequately damped response may not best reflect a desirable or achievable response in some circumstances.[78] Even when a simulated fault is step-like, if the fault is unbalanced, the measured voltage including positive and negative sequence elements may also not be 'adequately damped', although the response is entirely satisfactory. An adequately damped response may also not be achievable given power system conditions when the post fault voltage profile itself is not 'adequately damped' according to the definition of that term.

The minimum access standard requirements for reactive current injection were amended by the 2023 *Efficient reactive current access standards for inverter-based resources* rule change to address some of these issues in the minimum access standard.[79] The minimum and automatic access standards are now expressed differently with implications for clarity and the negotiating efficiency.

Consequences

A standard that is framed around requirements that do not reflect actual power system conditions does not support clear ongoing compliance with technical standards. A lack of clarity on ongoing compliance would not support security and reliability in the NEM consistent with the long-term interest of consumers.

The Commission's draft rule

Box 17: Amending rise time, settling time and commencement time requirements for reactive current injection

The Commission's draft rule would:

- Omit the settling time requirement in the automatic access standard at clause S5.2.5.5A(g)(2).
- Add a commencement time of 10 milliseconds to the automatic access standard at clause S5.2.5.5A(g)(2) and clarify that this is for a response opposing the voltage deviation.
- Replace the requirement for an adequately damped response with one that is adequately controlled. A new definition of adequately controlled is proposed below and at clause S5.2.5.5A(b)(1).
- Qualify that the automatic access standard and minimum access standard rise time requirement is to be assessed for step-like voltages.

Under the draft rule, adequately controlled would be defined as follows:

76 AEMO, rule change request, pp 39-40; AEMO review of technical requirements for connection (NER clause 5.2.6A), Draft Report, pp 58-60.
77 Ibid.
78 Ibid.
79 AEMC, Efficient reactive current access standards for inverter-based resources, Rule determination, 20 April 2023.

- the response of the schedule 5.2 plant to transient over-voltage or transient under-voltage achieves the agreed level of reactive current injection or absorption within the duration of the relevant disturbance, considering:
  - the expected positive and negative sequence reactive current response
  - the expected active current response
  - stable control when operating at and transitioning into and out of limits
- and does not cause or exacerbate:
  - over-voltages, beyond the more restrictive of the system standards and levels and durations agreed under clause S5.2.5.4
  - under-voltages, below levels and durations agreed under clause S5.2.5.4
  - voltage transients or oscillations that could adversely affect the ability of other schedule 5.2 plant to remain in operation during the disturbance.

The Commission's rationale for the draft rule

The Commission's draft rule makes AEMO's proposed changes for reactive current injection. The Commission considers these changes would better reflect performance under actual power system conditions and enhance clarity and negotiating efficiency by aligning the expression of the automatic access standard with the minimum access standard following the changes made in the 2023 *Efficient reactive current access standards for inverter-based resources* rule change.[80]

In making its determination, the Commission identified a tension between specifying requirements using idealised step response rise and settling time tests and specifying requirements that reflect actual power system conditions. While the Commission appreciates that existing automatic access standard obligations specify performance requirements utilising well-established and comparable idealised tests, the Commission agrees with AEMO that performance standards should support assessments of ongoing compliance applicable to real power system conditions.[81]

For this reason, the Commission's draft rule would qualify the requirement for rise time as being in respect of a step like response, remove the settling time requirement, and replace the requirement for an adequately damped with an adequately controlled response would better align performance requirements with actual power system conditions better supporting assessments of ongoing compliance and provide more effective guidance to all parties in the connection process.

The draft rule would impose an automatic access standard response commencement time of 10ms which would provide for a fast response while removing the settling time requirement would allow for a more stable response. Adding commencement time to the automatic access standard would also make it consistent with the minimum access standard, with a more onerous requirement to reflect higher performance.

The draft rule would promote the NEO as it would remove impediments to connecting grid forming inverters, which would better align the requirements with best power system performance and streamline the connection process.

80 AEMC, Efficient reactive current access standards for inverter-based resources, Rule determination, 20 April 2023.

81 AEMO review of technical requirements for connection (NER clause 5.2.6A), pp 46-49.

4.6.3 The draft determination would amend arrangements for the commencement of reactive current injection and provides clarity on reactive current injection location

Reactive current injection during fault conditions requires a response that senses the voltage disturbance and rapidly responds once the connection point voltage leaves the range 90% to 110% of normal voltage. This requirement is intended for reactive current injection to start as close to nominal voltage as possible to manage voltage excursions quickly.

Issues

At present, the automatic access standard for asynchronous generating systems under clause S5.2.5.5(g)(1) requires the reactive current response for an undervoltage to commence in an under-voltage range 85% to 90%, and an overvoltage range of 110% to 115%, of normal voltage. However, this requirement implicitly assumes that the plant has a low voltage ride through threshold, whereby voltage control passes from power plant controller to the production unit for reactive current injection during a fault.

In practice, not all asynchronous systems operate in this way. Some have response based on the magnitude of the voltage change rather than a specified voltage threshold. Grid forming inverters respond instantaneously to oppose a change in voltage. AEMO considers the technology specific form of the existing clause, in that it specified triggering voltage thresholds, is inappropriate for low system strength conditions and for plant with controllers that provide voltage control response at the unit level rather than the plant controller level.[82]

AEMO also identified other issues including that the 5% automatic access standard response range is not workable for most generating systems or integrated resource systems that have a step-up transformer with on-load tap-changer between the production units and the connection point.[83] A 5% range is also often not practically achievable for a medium or large system with reactive power range consistent with the automatic access standard of clause S5.2.5.1. It is typically only achievable for systems connected directly to the power system without an intervening step-up transformer.

AEMO's rule change request also identified a lack of clarity in existing arrangements on where the location for measurement of reactive current injection level as a function of voltage.[84] While flexibility to adjust the measurement location was present in existing arrangements, there is a low level of understanding and appreciation of this flexibility as currently expressed.

Consequences

An automatic access standard which is inappropriate or unachievable for certain technologies including grid forming technologies doesn't align requirements with best power system performance, streamline the connection process, and removes impediments for connection of grid forming inverters.

The Commission's draft rule

82 AEMO, rule change request, pp 41-42.
83 Ibid.
84 Ibid.

Box 18: Amending arrangements for the commencement of reactive current injection and clarifying reactive current injection location

The draft rule would:

- For the automatic access standard for asynchronous production units, require reactive current response to an:
  - Under-voltage event to commence when or before voltage reaches 85% of nominal voltage at the connection point
  - Over-voltage event when or before voltage reaches 115% of nominal voltage at the connection point
- Clarify in the general requirements that reactive current rise time and commencement time can be measured at a location other than the connection point, where agreed with the NSP and AEMO.
- Require in the general requirements (and not under the minimum access standard) that all elements of reactive current response must be recorded, including:
  - the location for measurement of reactive current injection level as a function of voltage.
  - the location of measurement of commencement time and rise time; and
  - the response initiating conditions, including the location at which it is measured, noting that rise time and commencement time might be measured at a different location.

The Commission's rationale for the draft rule

The Commission's draft rule makes AEMO's proposed changes on commencement of reactive current injection and clarity on reactive current injection location.

The Commission agrees with AEMO that its proposed rule change to amend the voltage conditions at which a reactive current response commences would arrest the change in voltage following disturbance more quickly and closer to the pre-disturbance value.[85] This would provide a better outcome for the power system than under existing arrangements. The draft determination therefore would better reflect actual technology capabilities, align with best power system performance, streamline the connection process, and remove impediments to the connection of grid forming inverters.

The draft rule would change the automatic access standard from a response range to a requirement to commence above 85% and below 115% of normal voltage. This is to accommodate grid forming inverters and because there is no benefit in specifying an upper limit on the commencement of reactive injection. The Commission particularly considers enhancing arrangements supporting grid forming inverter connection to be important given the role of these inverters for future power system security, in accordance with the NEO.

The Commission also considers the changes that align automatic access standard requirements with minimum access standard changes made in the recent *Efficient reactive current access standards for inverter-based resources* rule change supports effective negotiation.[86]

85 Ibid.

86 AEMC, Efficient reactive current access standards for inverter-based resources, Rule determination, 20 April 2023.

Clarifying the ability to measure reactive current commencement at locations other than the connection point would provide additional flexibility allowing performance standards that best reflect power system conditions and the connecting plant.

The draft rule would promote the NEO by removing impediments to connecting grid forming inverters, which would better align the requirements with best power system performance and streamline the connection process.

4.6.4 The draft rule would clarify the response requirements for balanced and unbalanced faults, and recognise negative sequence current responses

Issues

The current automatic access standard for asynchronous systems in clause S5.2.5.5(f) requires them to have facilities capable of at least 4% of reactive current injection or 6% of reactive current absorption for each 1% decrease or increase of voltage at the connection point, respectively. This requirement is generally interpreted to be for positive sequence injection or absorption.

Consequences

Most faults on the power system are unbalanced faults, rather than balanced faults.[87] For unbalanced faults, positive sequence current injection or absorption only is not necessarily the optimal response, and could lead to overvoltages on unfaulted phases.[88] Instead, negative sequence current responses may sometimes be preferred and be more closely aligned with best power system outcomes.

However, the current rules do not explicitly promote the use of negative sequence currents for unbalanced faults, nor describe the desired power system outcome that positive or negative sequence current responses should aim to achieve.

The Commission's draft rule

Box 19: Defining a control objective for both balanced and unbalanced faults, and recognise that negative sequence current contributions may contribute to better system outcomes

The draft rule would:

- Define a **control objective** in clause S5.2.5.5A(b)(2) for balanced & unbalanced faults and transient overvoltages to minimise the deviation of voltage on each phase from pre-disturbance values, while maintaining stable control.
- In the automatic access standard in clause S5.2.5.5A(f):
  - Require that asynchronous production units must have facilities capable of at least 4% and 6% of reactive current injection or absorption, respectively, for each 1% decrease or increase of positive sequence voltage at the connection point (applying to both balanced and unbalanced voltage disturbances).

87 A balanced fault is one that affects all three phases equally (such as a three-phase to ground fault), whereas an unbalanced fault affects each phase differently (such as a phase-to-phase or phase-to-ground fault).

88 Excessive reactive current injection may also lead to temporary overvoltages on all three phases, cause inverters to exit low voltage ride through (LVRT) mode before the fault is cleared, or cause the withdrawal of active power. See AEMC Efficient reactive current access standards for inverter-based resources, final determination, pp 62-64.

- Require that asynchronous production units must have facilities capable of supplying or absorbing negative sequence current (or equivalent contributions) to oppose unbalanced voltages during a disturbance.

- Specify in both the automatic and minimum access standard (in clause S5.2.5.5A(n)) that the required responses must be consistent with achieving the **control objective**.
- In clause S5.2.5.5A(t), require that the performance standards must record the response to balanced & unbalanced faults and transient overvoltages, including details of the facilities, the positive and/or negative sequence reactive current response (or some other method agreed with AEMO and the NSP), and details of control priority.
- In clause S5.2.5.5A(s)(2), clarify that the reactive current contribution and voltage deviation may be measured and assessed at a location other than at the connection point where agreed by AEMO and the NSP, and that the response must be set at levels consistent with the access standard at the connection point.

The Commission's rationale for the draft rule

Given the wide range of capabilities of inverter-based plant and facilities, the draft rule defines a control objective to guide how parties should tune their plant, minimising the risk that plant settings and responses lead to sub-optimal power system outcomes, consistent with AEMO's proposal. By explicitly including negative sequence responses into the access standard, the draft rule would also better align the requirements with best power system performance and would better recognise the capability of inverter-based plant, which would promote the NEO.

In addition, the Commission considers that performance standards should record the details of plant response and control priority during unbalanced faults, given that the majority of faults on the power system are unbalanced faults.

4.7 Clause S5.2.5.7 — Partial load rejection

This clause describes the requirements for plant to remain in continuous uninterrupted operation in case of a sudden power system load reduction (occurring in less than 10 seconds). This clause contributes to system security by preventing a potential cascade of plant tripping events and resulting power outages as a consequence of sudden load reduction of up to 30% for the automatic access standard and up to 5% for the minimum access standard.

4.7.1 The draft rule would limit the application of clause S5.2.5.7 to synchronous generation only

Issues

Under clause S5.2.5.7, the requirement to remain in continuous uninterrupted operation following a load reduction event is currently subject to the loading level remaining above the minimum generation required for continuous stable operation. This clause currently applies to all types of generation as well as integrated resource systems, which could include generating units, loads and bi-directional units.

Consequences

Clause S5.2.5.7 was originally drafted for synchronous generation, considering that some synchronous machines may have difficulty in maintaining their plant prime mover in stable operation for a load rejection event. This clause was extended to all types of generation in 2018,

and more recently was modified under the *Integrating energy storage systems into the NEM* rule change to cover integrated resource systems.[89] However, AEMO's assessment has found no benefit from extending this requirement to plant other than synchronous generators.[90] Bidirectional units are unlikely to have a minimum generation level for continuous stable operation since such units can transition smoothly between generating and consuming power. Similarly, minimum generation doesn't apply to synchronous condensers since they do not generate any active power. Moreover, both these types of plant must meet other schedule 5.2 access standards for voltage and frequency disturbances and contingencies.

The Commission's draft rule

Box 20: Limiting application of S5.2.5.7 to synchronous generators only

The draft rule would:

- Apply clause S5.2.5.7 only to synchronous generation.
- Amend the title of clause S5.2.5.7 to "Partial load rejection for synchronous generation"

The Commission's rationale for the draft rule

Load rejection is most likely to affect synchronous generation only. Hence, the Commission agrees with AEMO's view that limiting the application of clause S5.2.5.7 to synchronous generation would reduce unnecessary duplication of requirements and reduce the time and resources needed for compliance assessments.[91] This would help streamline the connection process, which would promote the NEO.

We understand that AEMO discussed this proposed change with NSPs prior to the rule change request being lodged and received no in-principle objections. Stakeholder responses in AEMO's review also generally supported this proposed change.[92]

The Commission's formulation in the draft rule allows for Tasmania to have a lower threshold, based on materiality in relation to the maximum credible contingency event size as specified in the frequency operating standard, while preserving a general threshold of 30 MW for other regions.

4.7.2 The draft rule would clarify the meaning of continuous uninterrupted operation for clause S5.2.5.7

Issues

The automatic access standard requires that a relevant plant must be capable of continuous uninterrupted operation during and following a power system load reduction of 30% from its pre-disturbance level or equivalent impact from separation of part of the power system in less than 10 seconds.

89 AEMC, Integrating energy storage systems into the NEM, Rule determination, 2 December 2021.
90 AEMO, rule change request, p 46.
91 AEMO, rule change request, pp 46-47.
92 AEMO review of technical requirements for connection (NER clause 5.2.6A), Appendix 2 to Final Report, pp 54-55.

Consequences

AEMO's review and subsequently its rule change request identified two issues with this clause as currently drafted:[93]

- There is ambiguity in the interpretation of "capable of" in this context, specifically whether such capability must be always enabled or not.
- The definition of continuous uninterrupted operation only allows substantial reductions in active power and reactive power after fault clearance when allowed by specified performance standards, which currently exclude clause S5.2.5.7. However, the definition doesn't explicitly allow reduction in active power and reactive power during a disturbance to provide frequency or inertial response to load reduction, even though it does allow contributing active and reactive current as required.

The Commission's draft rule

Box 21: Clarifying meaning of continuous uninterrupted operation for partial load reduction

The draft rule would:

- Amend clause S5.2.5.7 to:
  - Replace the term "be capable of" with "remain in".
  - Permit varying active power and reactive power to the extent required to oppose a voltage variation or frequency variation
- Amend the definition of continuous uninterrupted operation in Chapter 10 to:
  - Allow contributing active power and reactive power during a disturbance
  - Refer to "required or permitted by performance standards" without referring to specific clauses in order to be more general and consistent

The Commission's rationale for the draft rule

These amendments under the draft rule would:

- Clarify that the automatic access standard for clause S5.2.5.7 requires a plant "to remain" in continuous uninterrupted operation during and following a power system load reduction of 30%, not just "be capable of" doing so. As load reduction events cannot be anticipated in advance, a plant must maintain settings that will always provide the necessary response.
- Ensure that beneficial responses to oppose voltage or frequency variation are permitted

Removing ambiguity would help streamline the connection process, and permitting beneficial responses would help align with best power system performance, which would promote the NEO.

4.8 Clause S5.2.5.8 — Protection from power system disturbances

Clause S5.2.5.8 describes the requirements for plant to automatically reduce output power or disconnect in response to an over-frequency event. A reduction in output acts to lower the frequency of the system and thereby contributes to system security. The NEM still has several generating systems not currently providing primary frequency response, for which a response under clause S5.2.5.8 is valuable, as a contribution to managing a power system over-frequency

93 AEMO, rule change request, p 47.

event. This clause also serves to protect generating systems from power system disturbances by requiring them to disconnect under certain conditions.

4.8.1 The draft rule would strengthen and streamline emergency over-frequency response requirements

Issues

The minimum access standard for clause S5.2.5.8(a)(2) currently describes three options for a generating system of 30 MW or more and an integrated resource system with bidirectional units of 5 MW or more to rapidly reduce active power in an over-frequency event.

Consequences

AEMO's review and subsequent rule change identified the following consequences associated with these three options:

- Clause S5.2.5.8(a)(2)(ii) requires the reduction in output to be completed within 3 seconds of the frequency reaching the upper limit of the *extreme frequency excursion tolerance limits*. But at this level plant are permitted to trip (considering clauses S5.2.5.3 and S5.2.5.8(a)(1)), so the response might be too late to be useful.
- Clause S5.2.5.8(a)(2)(i)(A) requires a response that reduces the plant's output by at least half, within 3 seconds of the frequency exceeding a threshold, but some plant (e.g. some hydro generating units) cannot physically achieve a reduction in output at the required rate safely. The same limitation might also arise with clause S5.2.5.8(a)(2)(ii), which describes a response proportional to the frequency deviation.
- Clause S5.2.5.8(a)(2)(i)(B) provides a third option to disconnect the plant, which is not desirable as it could reduce the power system inertia, leading to an increase in the rate of change of frequency.

AEMO's review and subsequent rule change also identified the following limitations with the application criteria of this clause:[94]

- There are different size criteria for the application of this requirement based on whether or not a system includes bidirectional units. This distinction appears to have been based on registration thresholds, but for this technical requirement there is no reason to differentiate based on technology.
- The requirements only apply to transmission-connected plant, but do not apply to distribution-connected plant, even when larger than 30 MW. There is no technical reason to exclude a plant based on its connection to transmission or distribution.

The definition of 'disconnect' doesn't allow plant to disconnect other than at the connection point.

- The NER defines 'disconnect' as: 'The operation of switching equipment or other action so as to prevent the flow of electricity at a connection point.' The definition does not specify the location of switching, but does specify the outcome — that is, 'so as to prevent flow of electricity at a connection point'. In some circumstances, there may be some ambiguity in the definition as to whether it requires preventing all flow of electricity (including reactive power) through the connection point.

94 AEMO, rule change request, pp 48-49.

The Commission's draft rule

Box 22: Strengthening and streamlining emergency over-frequency response

The draft rule would in clause S5.2.5.8:

- For over-frequency response requirements, create an automatic access standard requiring frequency droop response, where droop has the meaning given in clause S5.2.5.11(a), and a minimum access standard allowing disconnection.
- For the automatic access standard:
  - Require the necessary active power reduction to have been completed by 3 seconds after frequency reaches a level 0.5 Hz below the upper limit of the extreme frequency excursion tolerance band, provided the rate of change of frequency does not exceed the maximum established for the plant under clause S5.2.5.3.
  - Make the 50% reduction requirements subject to the plant remaining above a minimum generation level for continuous, stable operation, where applicable.
  - Require any voltage-related protection systems to not disconnect the relevant system or any of its operating production units within 20 milliseconds of an over-voltage disturbance at the connection point.
- Provide that a negotiated access standard can only be accepted to the extent that physical plant limitations prevent compliance with the automatic access standard, and to that extent a negotiated access standard may include:
  - Droop response that is smaller or slower than the automatic access standard (as reasonable).
  - Rapid active power reduction, by fast ramping in preference to disconnection, at an agreed frequency trigger level and time lag.
- Amend the application criteria to:
  - Apply the same size threshold irrespective of the type of plant, being 30 MW (or 30 MVA) or if smaller, 5% of any applicable maximum credible contingency size in the frequency operating standard for the relevant region. The latter allows a lower threshold for Tasmania (currently) while preserving a general threshold of 30 MW for other regions.
  - Remove the reference to transmission-connected, for the automatic and minimum access standards.

The draft rule would in the glossary, amend the definition of disconnect to prevent the flow of electricity "to or from connected equipment" rather than "at a connection point".

The Commission's rationale for the draft rule

The Commission considers that these amendments would:

- provide a clearer structure consistent with other access standards, creating an automatic access standard aligned with best power system performance, with disconnection in the minimum access standard being an option only where preferable responses are not feasible
- acknowledge the need for synchronous generation to maintain a minimum continuous level of generation

- correct and clarify the frequency conditions for commencement or completion of the response, to ensure capability is sufficient to assist frequency recovery and sufficiently flexible to ensure a range of plant capabilities can provide a suitable and compliant response
- coordinate the completion of the response with a frequency less than the upper limit of the extreme frequency excursion tolerance band to better align the automatic access standard with best power system performance
- make the standard technologically and geographically neutral. The size threshold allows adaptation for Tasmania's smaller power system, where the same size plant would have a larger impact on power system frequency than on the mainland
- allow for disconnection somewhere other than at the connection point while keeping ancillary plant in service.

These would promote the NEO as they would align the requirements with best power system performance, streamline the connection process, and support efficient investment and operation.

The Commission notes that most stakeholder submissions in AEMO's review supported droop response as a preferred approach, with tripping being the least preferred as a minimum access standard.[95] The Commission also acknowledges that while Caterpillar suggested specifying a specific droop setting in the automatic access standards because of plant limitations, it considers that such plant can seek to negotiate this in an appropriate access standard.[96] The Commission considers that there would be no benefit in specifying either a maximum ramp rate or a specific droop setting, as all technologies are covered by these requirements, and different technologies and plant have different capabilities.

4.8.2 The draft rule would require plant protection settings to be set to maximise capability to ride through disturbances

Issues

It is common for plant protection settings to be fixed just outside the required access standard conditions for continuous uninterrupted operation for frequency, rate of change of frequency and voltage.

Consequences

This fails to utilise plant capability that is available at no incremental cost, in circumstances where a plant is capable of safely remaining in operation for a materially wider operating range.

The Commission's draft rule

Box 23: Utilising maximum available capability to ride through disturbances

The draft rule, in the general requirements for clause S5.2.5.8, would require that:

- Except as otherwise required by AEMO or the NSP, a schedule 5.2 plant's protection settings must be set to maximise its capability to remain in operation for abnormal power system conditions for which the plant is not required to disconnect under any performance standard, while maintaining safe and stable operation of the plant within safety margins consistent with good electricity industry practice.

95 AEMO review of technical requirements for connection (NER clause 5.2.6A), Appendix 2 to Final Report, pp 56-58.
96 Ibid., p 56.

- Vector shift protection or similar protective functions must not operate for phase shifts less than 20 degrees (moved here from clause S5.2.5.16).

The Commission's rationale for the draft rule

Under abnormal conditions, it would generally be more beneficial for power system resilience for a plant to remain connected for as long as it can continue to operate stably and safely. Hence, the Commission considers that this amendment would facilitate improved power system resilience at no incremental cost, which would promote the NEO.

The Commission notes that some stakeholders in AEMO's review commented that better alternatives to vector shift protection for the detection of islanding exist, such as topology-based schemes.[97] The Commission clarifies that this amendment does not exclude or require any specific islanding detection scheme to be in place. It only prohibits the operation of vector shift protection or similar protective functions for phase shifts less than 20 degrees, for plant using such protective functions.

4.8.3 The draft rule would move the vector shift requirement from clause S5.2.5.16 to clause S5.2.5.8

Issues

The current minimum technical requirements for vector shift protection relays has its own clause in schedule 5.2. It is odd and inconsistent with the rest of schedule 5.2 for such a specific requirement to have its own clause.

The Commission's draft rule

Box 24: Moving the minimum requirement for vector shift protection or similar functions to clause S5.2.5.8

The draft rule would delete clause S5.2.5.16 and move these requirements to the general requirements of clause S5.2.5.8 — Protection from power system disturbances at clause S5.2.5.8(b6).

The Commission's rationale for the draft rule

The Commission considers that the vector shift protection requirement would be better placed in clause S5.2.5.8 which relates to the requirements for protection systems generally because it would be more aligned there. This is a minor amendment to streamline and clarify the application of the rules, which would help streamline the connection process, in accordance with the NEO.

4.9 Clause S5.2.5.10 — Detection and response to unstable operation

Clause S5.2.5.10 describes the requirements for plant to not cause any instability at the connection point. This clause serves to prevent any unstable operation from having an adverse impact on power system security.

97 AEMO review of technical requirements for connection (NER clause 5.2.6A), Appendix 2 to Final Report, p 56.

4.9.1 The draft rule would add new requirements for instability detection and response

Issues

The automatic access standard requires generating systems and integrated resource systems to have a protection system that trips the plant for unstable operation. This is intended to protect the network from active power, reactive power and voltage instabilities caused or amplified by a generating system or integrated resource system. However, currently there is no requirement for a plant to have the capability to detect instability at the connection point and determine its contribution to the instability.

Consequences

Several NEM states have seen multiple oscillatory events in recent years with different levels of oscillation severity and frequency.[98] These events needed to be individually investigated by NSPs and AEMO to identify (as far as possible) which generating systems and integrated resource systems were contributing to the instability.[99] Some events required manual disconnection of the plant contributing to the instability because there was no automatic system to eliminate the instability or disconnect the plant. This approach is not sustainable for a power system with a large and steadily increasing number of asynchronous plant. However, there are potential problems with disconnecting a plant based solely on detection of oscillations or instability at the connection point, which may occur regardless of plant participation. In fact, a plant might be damping the oscillations, so disconnection based on the presence of an oscillation at the connection point alone might disconnect the wrong plant, which could exacerbate the oscillations or cause a supply deficit.

Moreover, there has been uncertainty in the interpretation and application of the automatic access standard and minimum access standard, causing delays and potentially sub-optimal outcomes in multiple connection projects for asynchronous plant in the past. For example, some concerns are:

- What types of instabilities should be covered under clause S5.2.5.10?
- Should plant be required to disconnect without considering their contribution to instabilities?
- Should plant be required to have the capability to detect their contribution to instabilities?
- Is prompt disconnection the best solution for a modern grid with high penetration of asynchronous generation?

The Commission's draft rule

Box 25: Adding new requirements for instability detection and response

The draft rule would amend the automatic access standard for asynchronous production units to require:

- Facilities capable of detecting instability in voltage, reactive power and active power and automatically disconnecting the plant for unstable behaviour with configurable triggers and settings.
- Automatic and prompt execution of a configurable hierarchy of response actions on detection of instability, as agreed with the NSP and AEMO.

98 AEMO, rule change request, p 50.

99 Ibid.

- Any action that involves plant tripping to account for available automated information on the plant's contribution to the instability.

The draft rule would amend the minimum access standard to apply minimum requirements to schedule 5.2 plant that can change the voltage at its connection point by more than 1%, for system normal or planned outage conditions (considering its reactive power range under clause S5.2.5.1), as follows:

- Capability to detect instability of voltage, reactive power and, where relevant, active power.
- For asynchronous production units, a process agreed with the NSP and AEMO to manage oscillations promptly on detection.
- For synchronous production units or synchronous condensers, a protection to disconnect for sustained pole slipping, if the NSP or AEMO requires.

The draft rule would for the automatic access standard, all production systems 100 MW or more and synchronous condenser systems 100 MVA or more must have access to a phasor measurement unit to send data to the NSP and AEMO, and capability to receive information about contribution to oscillations from an AEMO facility where available.

Under the draft rule, for the minimum access standard, the same requirements would apply only where required by the NSP or AEMO.

The Commission's rationale for the draft rule

The Commission considers that the draft rule would:

- recognise that a range of responses may be preferable to tripping
- provide flexibility to use available capability for connected plant to promptly respond to instability when detected, in a manner that is likely to be proportionate and efficient, considering power system needs and plant capabilities
- allow for detection, monitoring and response of the plant's own contribution to instability as those capabilities mature
- allow for both a local and a future centralised system to identify plant contributing to the instability, for visibility and control of response, with size thresholds balancing risk and efficiency.

While the Commission acknowledges that stakeholders were not fully aligned on some of these changes in AEMO's review[100], the draft rule adopts AEMO's proposed changes since attribution of instability to a plant and execution of a pre-agreed hierarchy of actions would further the NEO by reducing power system security risk.[101] The Commission notes that the automatic access standard requires a plant to have facilities to detect instability and disconnect it for unstable operation, but does not mandate shutting down the plant for any detected instability. The hierarchy of actions required under the automatic access standard must be agreed with AEMO and the NSP. The Commission considers that scrutiny of the proposed triggers, conditions and actions would avoid the potential for increased risk to power system security that might arise from simply tripping a plant that detects an oscillation at its connection point. These changes would promote the NEO as they would align the requirements with best power system performance, improve power system resilience, streamline the connection process, and support efficient investment and operation.

100 AEMO review of technical requirements for connection (NER clause 5.2.6A), Appendix 2 to Final Report, pp 58-63.
101 AEMO, rule change request, pp 50-52.

In response to some stakeholders' concerns about using unproven technologies for instability detection and attribution, the Commission understands from AEMO that there are several commercially available devices, including protection relays and monitors capable of instability detection. There were also concerns that automatic disconnection could exacerbate instabilities, especially given that unproven technologies might erroneously attribute instabilities to a plant that might not be causing them. The Commission notes that while reliable detection of contribution to instability is not straightforward, there can be a higher level of confidence in some circumstances. For example, loss of communication between a plant controller and inverters has been observed to cause instability in some cases, so shutting down the inverters via a communication fail-safe procedure is a typical requirement. A detectable abnormal condition on the plant (such as communication failure), in conjunction with detected instability could indicate a higher likelihood of causal relationship between the two, which could justify disconnection of the plant, or justify its more rapid shutdown than would otherwise occur.

4.10 Clause S5.2.5.13 — Voltage and reactive power control

While clause S5.2.5.1 describes the reactive power capability that is required from plant, and clause S5.2.5.4 describes the continuous uninterrupted operation requirements for plant following a voltage disturbance, clause S5.2.5.13 describes the required performance of a plant's control system. The control system governs how plant adjusts its reactive power output to support network voltages and power system stability. Improperly tuned control systems can inadvertently cause greater instabilities in response to a fault, which may also depend upon network conditions or the behaviour of nearby plant.

4.10.1 The draft rule would remove impediments to unit-level voltage control

Issues

The current setpoint-related rise time and settling time requirements of clause S5.2.5.13 is not well suited for connection applicants who wish to use voltage control strategies at a unit level.

Consequences

Typically, a power plant controller controls the voltage of the entire plant by sending global commands to each unit in the plant. However, this type of control can be less stable than unit-level control in low system strength conditions and is less resilient to communication failures between the power plant controller and the individual units. Moreover, grid-forming inverters often utilise and benefit from unit-level voltage control.

When using unit-level voltage control, compliance with the current setpoint-related rise time and settling time requirements in clause S5.2.5.13 is often difficult, and may not provide a clear power system benefit. This can unnecessarily delay the connections process, especially for many grid-forming inverter-based plant.

The Commission's draft rule

Box 26: Remove impediments to implementing unit-level voltage control

The draft rule would:

- In the general requirements at clause S5.2.5.13(n), specify that limits on the rate of change of setpoint (rate limits) may be applied to schedule 5.2 plant for normal operating conditions. If used, the performance standard must record details of the rate limits applied.
- By the inclusion of Table S5.2.1, the use of ramp limits can be applied to setpoint changes when plant is operating in voltage, reactive power and power factor modes.

The Commission's rationale for the draft rule

With grid-forming technology expected to be more common throughout the energy transition, the Commission considers that clarifying the voltage control requirements would remove any unnecessary impediments to grid-forming technologies. This is essential to support efficient investment in new connections that would support the stability of the power system, in accordance with the NEO.

4.10.2 The draft rule would prioritise stability over the speed of a plant's response across a range of system impedances

Issues

The requirements in clause S5.2.5.13 for voltage control use maximum rise times and settling times as a measure of stability. However, fast rise or settling times do not always imply stable responses, especially when the range of system impedances experienced in a network can be very large and volatile. Due to synchronous generator retirement and increasing amounts of inverter-based resources connecting to the system, networks are expected have less system strength on average, with the levels of system strength (and consequently, system impedances) being more closely correlated to generator dispatch profiles.

Consequences

If plant controls are set only with low system impedance conditions in mind, the response may not be appropriate for high system impedance conditions, and is more likely to be unstable. For example,

- At low system impedances (high system strength conditions), responses are generally slower, but more stable.
- At high system impedances (low system strength conditions), responses are generally faster, but less stable.

AEMO considers that stability should generally be prioritised over the speed of a response, but this is also not explicitly considered in the negotiated access standard within clause S5.2.5.13.[102] This could potentially lead to plant meeting the automatic access standard, but still exhibiting unstable behaviour under certain system conditions, risking power system security.

The Commission's draft rule

102 AEMO, rule change request, pp 53-54.

Box 27: Prioritising stability over speed of responses across a range of typical to highest system impedances

The draft rule would:

- In the automatic access standard at Table S5.2.1:
  - For asynchronous units only, require a rise time of less than 3 seconds for a voltage disturbance between 2% and 5%, not into a limiter, for the typical and maximum system impedances as nominated by the relevant NSP
  - For all schedule 5.2 plant, require settling times of less than 5 seconds (not into a limit) and less than 7.5 seconds (into a limit) for a voltage change between 2% and 5% or 5% voltage setpoint change, for typical and maximum system impedances
  - The 7.5 second settling times also apply to steps out of a limit.
- In the minimum access standard at Table S5.2.2:
  - Permit a longer settling time than the current requirement of 7.5 seconds if agreed by the NSP
- In the negotiated access standard at clause S5.2.5.13(f), prioritise stability of response under high impedance conditions if the automatic access standard cannot be met.
- In the general requirements at clause S5.2.5.13(m), require NSPs to nominate the typical and maximum system impedance values (and record these in the Releasable User Guide) that would be used for assessment and compliance with this access standard, where:
  - The typical system impedance* is a value that the NSP considers representative of a typical network configuration and typical levels of schedule 5.2 plant in service
  - The maximum system impedance must be consistent with the impedance that would be experienced at the electrically closest system strength node at close to nominal voltage, in combination with the network outage that would cause the greatest reduction in the three-phase fault level at the connection point.

Note: *Refer to section 5.9.2 of AEMO's rule change request for an explanation of typical system impedance.

The Commission's rationale for the draft rule

As the current rules were written at a time when the system only experienced a narrow range of system impedances, the Commission considers it sensible to adjust the requirements of clause S5.2.5.13 to reflect the reality of the current power system. This would enable connection applicants to better align their plant performance with optimal power system outcomes, which would promote the NEO. The draft rule's explicit prioritisation of stability in the negotiated access standard would also provide flexibility for connection applicants to negotiate their voltage control capability where the automatic access standard is not practical, while still promoting optimal plant performance for the system. This would help improve power system resilience, in accordance with the NEO.

Although the Commission acknowledges that NSPs may need to perform some extra work to determine appropriate levels of system impedances for typical and maximum impedance, we consider that this is sufficiently justified by the power system benefits associated with tuning plant against the range of impedances it would expect to experience when operating.[103]

103 Transgrid and Powerlink opposed AEMO's proposal to use typical system impedance for assessment and compliance with clause S5.2.5.13 — see AEMO review of technical requirements, Appendix 2 to Final Report, pp 64-71.

4.10.3 The draft rule would add materiality thresholds on settling time error bands

Issues

Clause S5.2.5.13 requires calculation of settling time for each of voltage, reactive power and active power for steps of voltage, reactive power and power factors for operation in those modes. As currently defined in the NER, settling time calculation is based on the output quantity reaching within a 10% error band.

Consequences

For a small transient change, the error band becomes very small and the settling time calculation becomes meaningless. This can give rise to issues with compliance assessment since:

- active power excursions, in particular, tend to be quite small for the step changes contemplated in clause S5.2.5.13
- voltage and reactive power, particularly in the compliance testing scenario where noise and measurement errors are present, may face challenges with settling time calculation when error bands are in the order expected for noise.

The Commission's draft rule

Box 28: Adding materiality thresholds on settling time error bands

The draft rule would in the general requirements for clause S5.2.5.13, provide that a settling time requirement for that clause is taken to be met if, for a voltage step in any mode or for a voltage setpoint step, the magnitude of error does not exceed the greater of the value calculated using the definition of settling time and:

- For active power, the higher of ±0.5 MW or ±2% of the maximum active power (Pmax) recorded in the performance standard for clause S5.2.5.1
- For reactive power, the higher of ±0.5 MVAr or ±2% of the reactive power capability recorded in the performance standard for clause S5.2.5.1
- For voltage, ±0.5% of nominal voltage

The Commission's rationale for the draft rule

The Commission considers that the draft rule would:

- allow scaling of the error band relative to the size of the plant ensuring that settling time calculation returns a meaningful value
- reduce unnecessary effort during the connection process in dealing with non-compliance associated with the existing poor definition and lack of materiality consideration.

This would promote the NEO by helping to streamline the connection process.

4.10.4 The draft rule would amend and clarify requirements for multiple modes of operation and treatment of voltage settling time for reactive power and power factor modes

Reactive power capability can be used in several ways to support the power system and facilitate power flows. Production units generally use their reactive power capability to control voltages at the connection point by injecting reactive power to increase voltages and absorbing reactive

power to reduce voltages. In addition to voltage control, production units can maintain a ratio between active power and reactive power, being the power factor,[104] or directly controlling the amount of reactive power to a target. Operation in power factor and reactive control modes are less common than for voltage control.

Issues

The existing automatic access standard of clause S5.2.5.13 requires a generator and integrated resource provider to operate in multiple reactive power control modes, switch between modes, and be able to do so through remote control in response to a command from AEMO. Requiring operation in three modes requires all the activities of connection and compliance to be repeated for each mode. This is a non-trivial cost over the life of the plant if only one mode is ever likely to be used. Requiring full connection assessment and compliance with each mode may be overly onerous without justifiable power system benefits.

The compliance arrangements specified in clause S5.2.5.13, applying to each mode of operation, are specified for voltage control but not power factor or reactive control modes. In reactive power and power factor modes voltage is not controlled, so it is not appropriate to assess compliance against voltage settling time for these modes. Also, the speed and stability requirements for power factor and reactive power modes were too specific and would benefit from additional flexibility.

Consequences

Automatic access standards that require compliance and assessment of reactive power connection modes that are seldom if ever used slow the connection process and impose unjustifiable costs on connecting applicants. This doesn't support an efficient connection process or support efficient investment and operation.

The Commission's draft rule

Box 29: Amending and clarifying requirements for multiple modes of operation and treatment of voltage settling time for reactive power and power factor modes

The Commission's draft rule on multiple modes of operation and the treatment of voltage setline time for reactive power and power factors modes is to make the following changes to the automatic access standard of clause S5.2.5.13:

- Require voltage control mode to be the primary operating mode unless the NSP requires a different primary mode, in which case voltage control must be the secondary mode.
- Plant must operate in primary mode in normal operation. Secondary mode is for testing, abnormal power system conditions or abnormal plant operating conditions.
- Where voltage is the secondary mode, omit the rise time requirement,
- For secondary modes, only require assessment for typical system impedance because probability of high impedance operating conditions while operating in this mode is very low, and to test compliance there would need to be performance requirements for typical impedance conditions.

In the automatic access standard and minimum access standard the draft rule would:

104 Note: Power factor is defined as the ratio of active power to apparent power, which is fundamentally related to reactive power.

- Remove the requirement to assess voltage settling time for power factor and reactive power modes
- Remove the requirement to assess active power settling time for the reactive power mode.

The Commission's rationale for the draft rule

The Commission has made a draft rule consistent with AEMO's proposal in relation to multiple modes of operation and treatment of voltage settling time for reactive power and power factor modes. The Commission considers these changes would take an appropriate risk-based approach to testing and compliance, allowing connections to be streamlined but not compromising power system performance. We understand that existing arrangements are onerous and impose costs on connecting parties that are not justified by power system benefits.

The requirement for multiple modes of reactive power control would provide AEMO and the NSP with the flexibility to manage abnormal power system conditions including changes in power flows following separation events. These are highly abnormal circumstances which would only be used in a minority of facilities in certain parts of the NEM. These changes would calibrate costs and obligations to the power system benefits and clarify the applicability of clause S5.2.5.13 requirements for secondary control modes.

The Commission considers these changes would promote the NEO as they would align the requirements with best power system performance, streamline the connection process, and support efficient investment and operation.

4.10.5 The draft rule would recognise system strength services provided by system strength service providers

Issues

A plant that has an adverse impact on system strength may elect to pay the relevant system strength service provider (SSSP) to provide these services.

Consequences

The system strength services provided by the SSSP is not currently considered in clause S5.2.5.13. This would mean that where a schedule 5.2 participant has paid the system strength charge, the requirements on the schedule 5.2 plant would be overly onerous as it does not consider the system strength (and associated voltage and reactive power control) provided by the SSSP.

The Commission's draft rule

Box 30: Ensure that assessments for clause S5.2.5.13 should consider the system strength services to be provided by a SSSP

The draft rule would, in the general requirements at clause S5.2.5.13(o), include a requirement that where a connection applicant has elected to pay the system strength charge for its plant, the assessment for the access standard should take into account the services that would be provided by the relevant SSSP.

The Commission's rationale for the draft rule

The Commission considers that participants who pay the system strength charge should not face equivalent requirements compared to if they choose to self-remediate their system strength impact. This amendment would help to deliver the benefits of the system strength framework by ensuring that connection applicants who have elected to pay the system strength charge are delivered the value provided to them by the SSSP. Accordingly, these connection applicants should face less onerous requirements in clause S5.2.5.13. This would promote the NEO as it would align the requirements with best power system performance, streamline the connection process, and support efficient investment and operation.

4.11 Definitions of continuous uninterrupted operation, rise time and settling time

Chapter 10 of the NER defines the terms "continuous uninterrupted operation", "rise time" and "settling time", which are used throughout schedules 5.2, 5.3 and 5.3a. These definitions serve to provide clarity on the meaning and application of these terms in the respective clauses.

4.11.1 The draft rule would amend the definition of continuous uninterrupted operation to recognise frequency response mode, inertial response and active power response to angle jump

Issues

The definition of continuous uninterrupted operation is used in clauses S5.2.5.3, S5.2.5.4, S5.2.5.5 and S5.2.5.7, which relate to ride through requirements for frequency disturbances, voltage disturbances, contingency events and partial load rejection, respectively. The definition is also used in clause S5.2.5.8, in reference to those other clauses. Although the definition applies to multiple types of disturbances, it fails to adequately account for the types of responses that can occur under these disturbances.

Consequences

Such responses may be beneficial for some disturbances and permissible for others given those benefits. In particular, the definition of continuous uninterrupted operation does not currently anticipate active power response opposing phase angle jumps and primary frequency response including inertial response opposing frequency changes.[105] The absence of any allowance for such responses may disincentivise their provision, despite being beneficial to power system operation.

The Commission's draft rule

Box 31: Amending the definition of continuous uninterrupted operation to recognise beneficial responses

The draft rule would modify the definition of continuous uninterrupted operation and relevant access standard clauses to permit inherent or programmed responses opposing voltage phase angle jumps and frequency changes, including inertial response during disturbances.

105 Refer to AEMO's review of technical requirements for connection, draft report pp. 91-92, for additional technical discussion on these responses.

The Commission's rationale for the draft rule

The draft rule would:

- ensure that beneficial responses are not inadvertently prevented
- remove impediments and speed up connection process for grid-forming inverters, since inertial response is programmed in grid-forming inverters rather than inherent.

This would promote the NEO as it would align the requirements with best power system performance, streamline the connection process, and improve power system resilience.

4.11.2 The draft rule would amend the definition of rise time to explicitly disregard longer-term dynamics and external influences

Issues

Rise time is currently defined in Chapter 10 of the NER as:

> In relation to a *control system*, the time taken for an output quantity to rise from 10% to 90% of the maximum change induced in that quantity by a step change of an input quantity.

Consequences

AEMO's review and subsequently the rule change request identified two adverse consequences of the current definition:

- The definition provides a longer time for a response with a higher overshoot (i.e. maximum change). It is more usual to describe the rise time in terms of 10% - 90% of the mean sustained change.
- The definition is used in clauses S5.2.5.5 and S5.2.5.13. In clause S5.2.5.5, reactive current injection, especially for longer faults, may be affected by longer-term dynamics of other controls (such as pitch controllers on wind farms) or external influences, which can interfere with the calculation of these quantities. This issue of longer-term dynamics has also been observed for grid-forming inverters. Similarly, in clause S5.2.5.13, the effect of longer-term dynamics should be disregarded for rise time calculation, or misleading results can be obtained.

The Commission's draft rule

Box 32: Amending the definition of rise time

The draft rule would amend the definition of rise time in Chapter 10 to:

- Refer to the "mean sustained change" rather than the "maximum change" induced
- Disregard longer-term dynamics and influences external to the generating system, following the step change.

The Commission's rationale for the draft rule

The draft rule would help streamline the connection process by focusing the definition on what needs to be measured to align with best system performance, which is the fast initial response, and de-emphasise the effect of longer-term dynamics. Hence, the Commission considers the draft rule would promote the NEO.

4.11.3 The draft rule would simplify the definition of settling time

Issues

Settling time is currently defined in Chapter 10 of the NER in two parts based on the ratio of the maximum deviation to the sustained change.

> In relation to a *control system*, the time measured from initiation of a step change in an input quantity to the time when the magnitude of error between the output quantity and its final settling value remains less than 10% of:
>
> (a) if the sustained change in the quantity is less than half of the maximum change in that output quantity, the maximum change induced in that output quantity; or
>
> (b) the sustained change induced in that output quantity

Consequences

The assessment band for settling time depends on the magnitude of the change. This is intended to allow settling time to be calculated when the sustained change is very small, as well as when it is large. However, when both maximum and sustained changes are small (e.g. in case of a shallow fault), the error band can be too small for a meaningful assessment of settling time.

The Commission's draft rule

Box 33: Amending the definition of settling time

The draft rule would delete paragraph (a) from the definition of settling time in Chapter 10, in conjunction with materiality thresholds described for P, Q and V in the context of settling time under clause S5.2.5.13.

The Commission's rationale for the draft rule

The Commission considers that a simplified definition would reduce confusion about whether paragraph (a) or (b) of the current definition applies to error calculation. The draft rule also makes AEMO's proposed change to explicitly manage the error bands for small changes by amending clause S5.2.5.13 in conjunction with removing settling time from clause S5.2.5.5A.[106] This would promote the NEO as it would align the requirements with best power system performance and streamline the connection process.

106 Refer to section 4.10.3 and section 4.6.2 for these amendments.

5 The draft rule would amend the access standards for HVDC links

This section outlines the Commission's draft NER amendments (primarily in schedule 5.3a) to advance the NEO by improving the access standards for HVDC links[107], based on the recommendations in AEMO's review and rule change request.[108,109]

5.1 Clause S5.3a.8 — Reactive power capability

Reactive power is necessary to control voltages and enable power to flow from generation to load. Reactive power capability is a provided by generators and integrated resource providers to control voltages at their connection points. HVDC connections also contribute reactive power capability. The Commission's draft rule aligns access standards for HVDC connections with the capability bought by modern HVDC converter plant.

5.1.1 The draft rule would align the reactive power capability of HVDC links with schedule 5.2 plant

Issues

At present, the reactive power requirements for HVDC links in clause S5.3a.8 are specified through power factor ranges. The power factor is the ratio of real power to apparent power, which describes how much reactive power is being absorbed or supplied.[110] In contrast, the reactive power requirements in schedule 5.2 are specified in terms of its capability to inject or absorb reactive power depending on the voltages at its connection point.

However, modern HVDC links have the same capability of generating systems or integrated resource systems to provide reactive power, which can be provided at low incremental cost with important benefits for managing the voltage profiles in the AC power system. It is therefore important to fully and accurately capture the reactive power capability of HVDC links under the access standards in the same way as schedule 5.2 plant.

Consequences

Existing arrangements are not consistent with HVDC links efficiently delivering capabilities to support the power system. As the power system transitions, reactive capability will become more important given the variability of power flows in a future power system with higher proportions of inverter-based plant. Hence, existing arrangements are inefficient as more expensive reactive capability will be required from other sources.

The Commission's draft rule

Box 34: Aligning HVDC reactive power capability with schedule 5.2 plant

- Amend clause S5.3a.8 to apply the equivalent reactive power capability requirements in the automatic and minimum access standards for clause S5.2.5.1 to HVDC links, by reference.

107 Currently limited to MNSP facilities in schedule 5.3a, but would be amended to extend to all HVDC links as described in chapter 3.

108 Refer to section 6 of AEMO's rule change request document Overview of rule change proposals to improve NEM access standards available from the AEMC website.

109 Detailed stakeholder feedback and AEMO's analysis can be found at AEMO review of technical requirements for connection (NER clause 5.2.6A).

110 For example, a power factor of 1 means that there is no reactive power being supplied or absorbed, while a power factor of 0.9 means that approximately 0.436 VAr of reactive power is being supplied or absorbed for every 1 VA of apparent power.

- Apply equivalent provisions for negotiated access standard and general requirements as under clause S5.2.5.1.

The Commission's rationale for the draft rule

The Commission's draft determination and draft rule reflects AEMO's rule change request to align reactive power capability requirements for HVDC links with those for schedule 5.2 plant. The Commission considers this change is efficient as it unlocks the inherent capabilities of modern HVDC voltage source converters and would avoid the requirement to invest in more expensive reactive power capability from other sources to support voltages in the network. This would promote the NEO as it would align requirements with best power system performance, improve power system resilience and support efficient investment and operation.

5.2 Clauses S5.3a.13 & S5.3a.14 — Response to disturbances in the power system

Clause S5.3a.13 describes the continuous uninterrupted operation requirements for HVDC links in response to disturbances in the power system, which serve to maintain system security. Clause S5.3a.14 defines the abnormal power systems conditions under which HVDC links are permitted to automatically disconnect in order to protect themselves. These clauses are important since the continuous uninterrupted operation of HVDC links is critical to prevent islanding and support adequacy of supply, system strength and inertia in the NEM.

5.2.1 The draft rule aligns voltage disturbance requirements for HVDC links with schedule 5.2 plant

Issues

Currently, the voltage ride through requirement for HVDC links is to maintain continuous uninterrupted operation for the range of voltage conditions permitted in the system standards (at clause S5.1a.4).[111] However, the requirements for schedule 5.2 plant to remain in continuous uninterrupted operation at clause S5.2.5.4 cover a wider range of voltage conditions permitted in the system standards. They are also significantly more rigorous to provide better power system resilience for many non-credible contingency events.

Consequences

Despite modern HVDC links having similar voltage disturbance capability to inverter-based plant, the requirements between clauses S5.2.5.4 and S5.3a.13 are not consistent. Moreover, if large HVDC systems do not have the same capability as schedule 5.2 plant, then the likelihood that it trips in response to a voltage disturbance is increased, potentially creating a cascading outage that risks power system security.[112]

The Commission's draft rule

111 Clause S5.3a.13(a).

112 As noted by AEMO in its rule change request at p 63, Basslink (until recently) was the largest credible contingency event in Victoria. If an HVDC like Basslink trips, plant on both ends of the link are also more likely to trip, significantly impacting the power system.

Box 35: Aligning voltage disturbance requirements for HVDC links with schedule 5.2 plant

- Amend clause S5.3a.13 to apply the equivalent voltage disturbance power capability requirements in the automatic and minimum access standards for clause S5.2.5.4 to HVDC links.
- Apply the general requirements of clause S5.2.5.4 into the general requirements of clauses S5.3a.13.

The Commission's rationale for the draft rule

The Commission considers that the power system would significantly benefit from aligning the voltage ride through requirements for HVDC links to the requirements in clause S5.2.5.4. As modern HVDC links have similar capabilities to inverter based plant, having similar access standards for HVDC links would improve power system resilience to a wider range of voltage disturbances at low incremental cost, which would promote the NEO.

Moreover, by adopting an automatic access standard and minimum access standard for this requirement, a connection applicant for an HVDC link has the added flexibility of negotiating a suitable performance standard in circumstances where meeting the automatic access standard is too onerous. This would deliver power system benefits from HVDC links in a more cost-effective manner than the status quo because there is currently no negotiation range available to HVDC connection applicants in cases where meeting the fixed standard in existing clause S5.3a.13 may be too costly or impractical. This would also promote the NEO by supporting more efficient investment and operation.

5.2.2 The draft rule would align frequency disturbance ride through requirements for HVDC links with schedule 5.2 plant

Issues

Currently the frequency ride through requirement for HVDC links is to maintain continuous uninterrupted operation for power system frequency within the frequency operating standards.[113] The equivalent frequency ride through requirements for generating and integrated resource systems in clause S5.2.5.3 are generally consistent with this but are expressed in greater detail, including automatic and minimum access standards.

Consequences

Modern HVDC links have similar frequency disturbance ride through capability as inverter-based generation and integrated resource systems. In addition, the importance for power system security of an HVDC link maintaining continuous uninterrupted operation for a frequency disturbance is similar to that of a generating system or integrated resource system of a similar size. Therefore, given the capability of the respective technology and the impact on the power system security are similar, the frequency disturbance ride through requirements for HVDC links should be aligned with those in schedule 5.2.

The Commission's draft rule

113 ClauseS5.3a.13(a)(1).

Box 36: Aligning frequency disturbance ride through requirements for HVDC links with schedule 5.2 plant

The draft rule would:

- Amend clause S5.3a.13 to apply the equivalent frequency disturbance ride through requirements in the automatic and minimum access standards for clause S5.2.5.3 (including rate of change of frequency) to HVDC links, by reference.
- Include a general requirement allowing flexibility for operational arrangements designed to minimise the power system impacts of tripping of the HVDC link where this is necessary.

The Commission's rationale for the draft rule

The Commission considers that aligning the requirements for HVDC links with those for generating systems and integrated resource systems would allow the frequency disturbance ride-through capability of the voltage source converters used in HVDC links to be made available to the power system. This would improve system security by increasing the resilience of HVDC systems during frequency disturbances, in accordance with the NEO. The incremental cost of the additional resilience is expected to be relatively small given that all future HVDC systems are expected to use voltage source converters, and therefore the Commission considers that the benefits associated with this change would outweigh the costs. This would promote the NEO by supporting more efficient investment and operation.

5.2.3 The draft rule would align fault ride through, response and recovery requirements for HVDC links with schedule 5.2 plant

Issues

Clause S5.3a.13 defines the required performance for HVDC links regarding disturbances in the power system, which does not include requirements for fault ride through capability. Clause S5.3a.14 explicitly allows disconnection of a market network service facility to protect it from disturbances, but only for conditions under which it is not required to continuously operate or withstand under another provision of the NER. However, there is no requirement for HVDC links to respond (by supplying or absorbing reactive current) and recover following a disturbance.

Consequences

Power system security depends on the ability of the network, load and generation plant to operate continuously following faults that are somewhat likely to occur, including multiple faults associated with non-credible contingencies. A lack of clearly defined fault ride through, response and recovery requirements for HVDC links similar to schedule 5.2 plant currently presents a risk to system security.

The Commission's draft rule

Box 37: Aligning fault ride through, response and recovery requirements for HVDC links with schedule 5.2 plant

The draft rule would:

- Replace clause S5.3a.14 with automatic and minimum access standards aligning disturbance ride through, response and recovery requirements with the equivalent automatic and minimum access standards for clauses S5.2.5.5 and S5.2.5.5A, by reference.
- Apply equivalent provisions for negotiated access standard and general requirements as under clauses S5.2.5.5 and S5.2.5.5A, respectively.

The Commission's rationale for the draft rule

The Commission considers that modern HVDC links have similar fault ride through and response capability as inverter-based generation and integrated resource systems, with the benefits for power system security of maintaining continuous uninterrupted operation for faults being similar to that for a generating system or integrated resource system of a similar size. Moreover, voltage source converters used in modern HVDC systems operate using the same principles as the inverters in solar, wind and battery energy storage systems. Therefore, given that the capabilities of the respective technologies and their impacts on power system security are similar and these capabilities can be provided at low incremental cost, the fault ride through, response and recovery requirements for HVDC links (including for multiple faults) should be aligned with those in schedule 5.2. This would promote the NEO as it would align requirements with best power system performance, improve power system resilience and support efficient investment and operation.

5.3 Clause S5.3a.4 — Monitoring and control requirements

Clause S5.3a.4 describes the remote monitoring and control requirements for HVDC links including the required communications equipment. This clause is essential to provide real time HVDC link data required by AEMO to discharge its market and power system security functions as set out in Chapters 3 and 4 of the Rules, respectively.

5.3.1 The draft rule would align remote monitoring and control requirements for HVDC links with schedule 5.2 plant

Issues

Schedule 5.3a currently has no requirements for remote monitoring and protection against instability for HVDC links.

Consequences

HVDC links can participate in power system instabilities in a manner similar to inverter-based generation systems and integrated resource system. This presents a risk to system security in the absence of any remote monitoring and control requirements for instabilities.

The Commission's draft rule

Box 38: Aligning remote monitoring and control requirements for HVDC links with schedule 5.2 plant

The draft rule would:

- Amend clause S5.3a.4.1 to add automatic and minimum access standards requirements equivalent to the data communication aspects of clause S5.2.5.10 for asynchronous plant,

including access to a phasor measurement unit and the receipt of information or trip signals, as applicable. For HVDC links, no minimum size threshold is proposed for these requirements.

- Add a new clause S5.3a.4.2 to align with the remaining requirements for detection and protection against inverter instability in clause S5.2.5.10 for asynchronous plant. Automatic disconnection capability would not be a fixed requirement except for the automatic access standard.

The Commission's rationale for the draft rule

The Commission considers that to improve the ability to monitor, control and analyse instabilities in the power system, remote monitoring and protection requirements for HVDC links should be generally aligned with those in clause S5.2.5.10 for asynchronous plant. This amendment would provide a coordinated approach to inverter based resource instability that can be applied to all plant likely to participate in a controller instability. This would promote the NEO as it would align requirements with best power system performance and improve power system resilience.

The Commission also considers that while disconnection could be one of the responses to instability, disconnecting an HVDC interconnector is likely to have significant impacts on the operation and security of the power system. Hence, capability to automatically disconnect on instability detection would not be an automatic access standard requirement, in accordance with the NEO, unless agreed with the NSP and AEMO, in order to make sure that the operation and security of the power system is considered by these parties that have responsibility for this.

Note that the amended rule refers to 'connection point or pole (as applicable)' under clauses S5.3a.4.1(a)(1) and S5.3a.4.1(b)(1). This is important to clarify so that it can cater to a bi-pole HVDC link where both poles connect behind the same connection point. In this case, we understand that it is possible for one pole to become unstable and the other to provide damping, with separate monitoring requirements therefore desirable in order to have more accurate visibility and better control.

5.4 New standards

The current requirements in schedule 5.3a are silent on the voltage and active power control capabilities of HVDC links. However, the impact of these links on the power system can be significant and can present themselves as large contingencies during the operation of the NEM. Despite this, the current access standards in schedule 5.3a are not as detailed or comprehensive as they are in schedule 5.2, even though the power system impact could be similar (and in some cases greater) than schedule 5.2 plant. Creating new access standards for HVDC links that are aligned with the standards in schedule 5.2 would support power system security through efficient investment in the capabilities of new HVDC links.

5.4.1 The draft rule would align voltage control and reactive power control requirements with schedule 5.2

Issues

The current access standards do not contain any voltage control standards for HVDC links. However, HVDC systems have the capability to control voltage independently at each terminal.

Consequences

Currently, the Rules are silent on the voltage control capability required from HVDC links. The power system would greatly benefit from creating new standards for HVDC links that are similar to the voltage control access standards for generating systems and integrated resource systems.

The Commission's draft rule

Box 39: Creating new access standards for voltage control for HVDC links by reference to clause S5.2.5.13

The draft rule would add a new clause S5.3a.15 to apply AC voltage control and reactive power control capabilities to HVDC links equivalent to those in clause S5.2.5.13 (but with some minor modifications suitable for HVDC links).

The Commission's rationale for the draft rule

The Commission's determination and draft rule would ensure that voltage control requirements for HVDC links would align with the equivalent requirements for schedule 5.2 plant in clause S5.2.5.13.[114] Given that HVDC links have similar voltage control and reactive power capabilities to inverter-based plant, the power system would greatly benefit from applying consistent requirements on all schedule 5.2 and schedule 5.3 plant at a low incremental cost. Moreover, it would incentivise HVDC connection applicants to make efficient decisions through negotiation of its performance standards where meeting the automatic access standard may be too costly or impractical. This would promote the NEO as it would align requirements with best power system performance and support efficient investment and operation.

5.4.2 The draft rule would align active power control requirements with schedule 5.2

Issues

Existing requirements under schedule 5.3a does not require active power flows on HVDC links to be controlled in a manner like dispatch of scheduled production units. The absence of arrangements does not reflect the capabilities of modern HVDC links and therefore efficiently support power system needs.

The active power control capabilities of HVDC links are no different to those from other inverter-connected plant.

Consequences

Existing arrangements do not realise active power control capabilities that are inherent in modern HVDC links. These arrangements will not support efficient investment and operation as active power control capabilities will be required from higher cost sources, increasing overall costs for consumers.

The Commission's draft rule

114 The proposed amendments to S5.2.5.13 are intended to improve power system resilience in the context of networks likely to experience a broader range of network impedances — see section 4.10.

Box 40: Creating new access standards for active power control for HVDC links

The draft rule would add a new clause S5.3a.16 to apply active power control requirements for HVDC links equivalent to those in clause S5.2.5.14, including for dispatch and ramping.

The Commission's rationale for the draft rule

The Commission's determination and draft rule would ensure that active power requirements for HVDC links would align with the equivalent requirements for schedule 5.2 plant. This would support efficient operation by placing the responsibility for these requirements with the operators of connected HVDC facilities, which is appropriate because the active power control capabilities of HVDC plant are the same as inverter-based plant. As such, connection applicants are incentivised to make efficient investment decisions regarding active power and voltage control. It is important to capture this capability in the access standards for HVDC links to facilitate the achievement of the NEM's active power requirements and improve power system resilience, which would be in the long-term interests of consumers.

6 The draft rule would make other consequential NER amendments

In its rule change request AEMO also proposed several other amendments to the NER. These are either related to AEMO's proposed amendments to the schedule 5 access standards, or seek to clarify the intent of the existing rules where ambiguity may have created confusion or uncertainty.[115]

The Commission's draft rule would make such consequential amendments to Chapters 3, 4, 5, 5A, 6A, 7, 9 and 10. These amendments are made to related clauses of the NER to support the intent of the draft rule by clarifying inconsistencies, removing redundant provisions and reducing duplication. Such changes would promote the long-term interests of consumers, in accordance with the NEO, by making the draft rule more clear for stakeholders to understand and follow, minimising confusion.

6.1 The draft rule would remove references to superseded standards

Issues

The NER currently contains a number of references to standards that are either defunct or superseded. Given these standards are outdated, such references on longer provide no value to the connections process.

The Commission's draft rule

Box 41: Removing references to superseded standards

The draft rule would substitute references to AS/NZS 61000.3.6 and AS/NZS 61000.3.7 in clauses S5.1.5, S5.1.6, S5.1a.5 and S5.1a.5 with references the latest versions of relevant International Electrotechnical Commission standards, IEC/TR 61000.3.6 and IEC/TR 61000.3.7.

The Commission's rationale for the draft rule

The Commission agrees with AEMO's view that these references to superseded standards may cause confusion in the connections process. The draft rule updates the references, as it would be good regulatory practice to make them current. We have also decided to update these clauses by not including a date (as is the case currently in the Rules). This would make the clauses more robust to future changes and would avoid them becoming superseded in the future.

While an alternative approach would have been to remove these references from the Rules and instead contain references to standards in a guideline or procedure which may be easier to update, we did not consider this was appropriate. This is because the relevant clauses would not make sense without such a reference, and it is important that this information is set out in the NER.

6.2 The draft rule would delete the definition of 'voltage' and 'normal voltage'

Issues

115 AEMO, rule change request, pp 78-79.

The existing definition of 'voltage' in Chapter 10 of the NER does not align with its engineering interpretation. The current definition of 'voltage' is:

> The electronic force or electric potential between two points that gives rise to the flow of electricity.

This definition can create confusion in the connections process if different parties have different views on what this term means.

In addition, the Rules define the term 'normal voltage', describing the voltage at a connection point which may be up to 10% higher or lower than the network's nominal voltage. NSPs may notify AEMO it wishes to change the normal voltage of a connection point, and AEMO may approve such a request.[116] The normal voltage at any connection point in the NEM has only been changed twice: once to raise the normal voltage, and again to return it to the previous level at nominal voltage.[117]

The Commission's draft rule

Box 42: Removing the definition of 'voltage' and references to 'normal voltage'

The draft rule would:

- Delete the definitions of 'voltage' and 'normal voltage' in the glossary of the NER.
- Replace references to 'normal voltage' with 'nominal voltage'.
- Un-italicise all references to *voltage*.
- Delete the definition of 'RMS phase voltage', but clarify in clauses S5.1.4 and S5.2.5.4 that voltages in these clauses refer to root-mean-square voltages.
- Delete clause 5.3.11 which describes the process for NSPs to change the 'normal voltage' of a connection point.

The Commission's rationale for the draft rule

The Commission considers that the current NER definition of voltage is not accurate because it is not consistent with standard engineering practice. Therefore, it does not provide value to parties during the connections process. The term 'voltage' could refer to a variety of different values, such as (but not limited to) the root-mean-square voltage, the peak-to-peak voltage, the average voltage or the positive sequence voltage, depending on the context.

Rather than rewriting the definition, the Commission agrees with AEMO's view that the term 'voltage' is best understood in the context of where it appears in the NER[118], and that clarifications (where necessary) could be made to distinguish which type of voltage the NER refers to.[119] This would minimise any confusion that can arise during the connections process. Therefore, the draft rule deletes the definition of voltage in Chapter 10.

Similarly, the Commission considers that deleting the definition of 'normal voltage' would minimise any potential confusion or delay that could be caused by the confusion of this term with 'nominal voltage'.[120] Changes to normal voltages can impose significant costs on connecting plant

116 Clause 5.3.11.

117 AEMC, Changes to normal voltage, Rule determination, 28 February 2013, p 8.

118 AEMO, rule change request, pp 76-77.

119 For example, the draft rule would clarify that the voltages in S5.1.4 and S5.2.5.4 are references to root-mean-square voltages.

120 The draft rule would also delete clause 5.3.11, which describes the process for NSPs to request to AEMO a change to the normal voltage of a connection point.

by requiring bespoke equipment that is rated at a non-standard voltage. Given that changes to normal voltage have only occurred twice, and there are no clear benefits from modifying a connection point's normal voltage to be different to the nominal voltage of the network, the Commission agrees with AEMO's view that the concept of 'normal voltage' is not providing any value to the power system or to parties.[121]

Therefore, we consider it would be appropriate to delete these definitions in order to minimise delay and confusion in the connections process, and to promote good regulatory practice.

6.3 The draft rule would amend definitions of rated active power and rated maximum demand

Issues

The definitions of rated active power and rated maximum demand in Chapter 10 of the NER are important for a number of access standards:

- rated active power is used for reactive power capability (clause S5.2.5.1), reactive power and voltage control (clause S5.2.5.13), and short circuit ratio (clause S5.2.5.15) access standards.
- rated maximum demand is used for clause S5.2.5.1.

AEMO considers that these existing definitions are problematic as they refer to production units operating at 'nameplate rating' when defining reactive power requirements.[122] The Commission understands that 'nameplate rating' is interpreted differently for inverter based and synchronous units. Nameplate rating is interpreted as an apparent power MVA rating, rather than an active power MW rating.

AEMO's rule change request considers a literal reading of the rated active power definition in the context of clause S5.2.5.1 implies a higher reactive power capability automatic access standard for some technologies.[123] AEMO considers that this is not consistent with the intent of the clause and could result in additional capital expenditure.[124]

For clause S5.2.5.15, AEMO considers that the use of 'rated active power' to calculate the short circuit ratio is problematic for inverter based equipment.[125] It changes the divisor of the short circuit ratio calculation for the purpose of this clause, effectively increasing the performance requirement beyond that intended by a minimum short circuit ratio of 3. This might lead to a requirement for additional mitigation measures at higher capital cost and design effort. AEMO's rule change request also identifies challenges and uncertainties for clause S5.2.5.13 (voltage and reactive power control), which may increase the negotiation time for some generating units.[126]

The Commission's draft rule

Box 43: Amending definitions of rated active power and rated maximum demand

The draft rule would:

121 AEMO, rule change request, pp 76-77.
122 AEMO, rule change request, pp 77-78.
123 AEMO, rule change request, p 77.
124 Ibid.
125 AEMO, rule change request, p 78.
126 AEMO, rule change request, p 77.

- Delete 'rated active power' definition. Replace in relevant rules with existing defined term active power capability.
- Delete 'rated maximum demand' definition. Replace in relevant rules with existing defined term maximum demand.
- Change definition of 'short circuit ratio' to address an issue with the definition of the term 'rated active power'
- Adopt the following definition of 'active power capability' for use instead of rated active power for all schedule 5.2 access standards, and used also in relation to the use of short circuit ratio in clauses 5.3.4C and 6A.23.5(j).
  - The maximum amount of active power that may be transferred to a connection point from a generating system or integrated resource system as specified or proposed to be specified in a performance standard or connection agreement.
  - For a generating system or integrated resource system that is a scheduled resource, the active power capability is equivalent to the aggregate of the maximum generation quantities specified in the bid validation data for all its production units, after accounting for auxiliary load and losses within the relevant system.

The Commission's rationale for the draft rule

The Commission's draft rule reflects AEMO's proposal. The Commission agrees with AEMO that the existing definitions are not aligned with the intent of the relevant access standards given the different interpretation of 'nameplate rating'.[127] Definitions that result in excessively high reactive power capability requirements and short circuit ratio obligations would not be consistent with efficient outcomes.

The draft rule amendments would clearly align standard requirements with active power capability, which would result in outcomes consistent with the intent of the relevant standards. The draft rule would:

- Clarify that capability should reflect the recorded active power capability in the performance standards, that is, at the connection point. (Note that bid validation data are terminal quantities, so to convert to connection point quantities, an allowance must be made for auxiliary load and losses).
- For simplicity and consistent with a common understanding of maximum output power (Pmax), confirm that the active power capability refers to the maximum sent out capacity for a generating system or integrated resource system with all units operating. Where an access standard needs to refer to the maximum capacity of operating production units, the standard itself would need to recognise the necessary adjustment.

These amendments would improve the clarity of various access standards, leading to decreased administrative costs and delay associated with the connections and negotiations process.

6.4 The draft rule would clarify and streamline several clauses of the NER

Issues

127 AEMO, rule change request, pp 77-78.

AEMO has identified various aspects of the NER that may be ambiguous, confusing or not aligned with the intent of the current rules or proposed amendments.[128] It has proposed amendments to streamline and clarify the clauses that are related to its other proposed amendments in its rule change.

The Commission's draft rule

Box 44: Clarifying and streamlining related NER clauses

The draft rule would:

- Clarify wording in clause 5.3.4A(b)(1A) to refer explicitly to the 'existing' performance standard, and align language consistent with the rest of the clause to be 'less onerous' instead of 'below' an access standard
- Add wording in clause 5.3.4A(b) to consolidate common assessment criteria for various negotiated access standards in schedule 5.2
- Amend the table in 5.3.9(d) to include proposed new clause S5.2.5.5A in the 'power converter', 'reactive compensation plant', 'excitation control system', 'voltage control system' and 'protection system' rows
- Amend S5.2.5.11(c) to swap 'and' & 'or' between subparagraphs (1) and (2) of the minimum access standard to align with the automatic access standard, as it was a typographical error
- Amend S5.2.5.7(c) and (d) to clarify that the combined loading level of the synchronous production units applies for the access standard in S5.2.5.7
- Amend the definition of 'AEMO advisory matter' to reflect the proposed new HVDC standards in schedule 5.3a, the deletion of clause S5.2.5.16 and the omission of clause S5.3.5 which already requires AEMO consultation
- Amend the definition of 'disconnect' to be broader than only the disconnection of flows at connection points
- Add a definition of 'minimum operating level' to the glossary for generating units, as it is proposed to be used in clauses S5.2.5.7, S5.2.5.8 and S5.2.5.11
- Delete the definition of 'maximum operating level' in clause S5.2.5.11 as it is refers to both 'sent out generation' and 'generation', which may be different values, nor accounts for other operating limits
- Amend S5.6(g) and the definition of 'disconnect' to make clear that the equipment of a registered participant's facility would be disconnected, not the participant itself
- Amend the definition of 'negotiated access standard' to remove reference to a connection agreement, as access standards are defined by the NER (while performance standards are included in connection agreements or is set by an NSP)
- Amend the definition of 'power transfer' to remove references to connection points, as it is currently used in broader contexts (than simply the power transfer between two connection points)
- Amend the definition of 'reactive power capability' to clarify that it is not a single maximum number or rate, nor unidirectional, not limited to production units, nor necessarily specified in a connection agreement

128 AEMO, rule change request, pp 78-79.

- Amend the definition of 'performance standard' to clarify that performance standards can be documented in a connection agreement, or by a network service provider in respect of its own relevant plant and provided to AEMO under clause 5.2.3(c1)
- Amend the definition of 'plant' to include equipment involved in or supporting the generation, consumption or conveyance of electricity
- Add a definition of 'production system' for ease of drafting, which refers to a generating system or an integrated resource system
- Delete the definition of 'RMS phase voltage' as it would be made redundant through proposed clarifications in S5.1.4 and S5.2.5.4
- Amend the definition of 'scheduled integrated resource system' to remove the words 'to the extent it is comprised of production units' to improve drafting clarity
- Amend the definition of 'synchronous condenser' to clarify that they do not generate or consumes active power, other than consumption for losses within the plant
- Add a definition of 'synchronous condenser system' that refers to a system with one or more synchronous condensers that are not part of a generating system or integrated resource system
- Make other minor formatting and grammatical changes that would fix various typographical errors

Note: See the draft rule and markup of Chapter 5 for more information on all proposed consequential and minor NER amendments.

The Commission's rationale for the draft rule

The Commission agrees with the intent of AEMO's proposed changes to streamline and clarify various clauses and definitions to clarify aspects of the NER that may be confusing or misaligned with its proposed amendments. We consider it good regulatory practice to clarify and streamline relevant clauses, wherever possible, to minimise confusion, which would contribute to lowering costs for consumers associated with the connection process.

For more detail on the Commission's rationale for specific minor amendments, refer to the relevant sections in chapter 3 or chapter 4 that the specific amendment is related to.

A Rule making process

A fast-track rule change process includes the following stages:

- a proponent submits a rule change request
- the Commission publishes a notice advising of its intention to initiate the rule change under a fast track process
- the Commission publishes a draft determination and draft rule (if relevant)
- stakeholders lodge submissions on the draft determination and engage through other channels to share their feedback
- the Commission publishes a final determination and final rule (if relevant).

You can find more information on the rule change process on the AEMC website.[129]

A.1 AEMO proposed to improve the NEM access standards

Under clause 5.2.6A, AEMO is required to conduct a review of the access standards at least once every five years. AEMO conducted its first such review in 2022-23, undertaking extensive public consultation, and identified numerous opportunities to improve the current access standards and their application. AEMO then submitted a fast track rule change request to the Commission to give effect to the final recommendations from its review. AEMO's recommendations recognise that some existing access standards are no longer fit for purpose in an increasingly inverter-based resources connected NEM. They may unintentionally disincentivise beneficial grid-forming responses, or do not fully utilise available plant performance, or do not account for increasing connections at a sub-transmission or distribution level, or refer to defunct standards.

A.2 AEMO seeks to ensure the access standards are fit for purpose to support the energy transition

The access standards contained in schedules 5.2, 5.3 and 5.3a of the NER define the permissible range of technical requirements that connection applicants need to meet before being allowed to connect to the NEM. With the energy transition underway, the NEM needs to grow and change to continue delivering secure, reliable and affordable electricity to millions of Australians whilst achieving the government's emissions reduction targets. AEMO's 2024 Integrated System Plan (ISP) projects that on the optimal development path, grid-scale variable renewable energy would triple by 2030 and increase by six-fold by 2050.[130]

To support this enormous growth and deliver the energy transition in accordance with the NEO, new NEM connections need to be approved at a much faster rate than at present, while lowering connection costs and keeping the whole system stable and reliable throughout the transition. Given this context, AEMO's proposal seeks to make the NEM access standards more fit for purpose to support the energy transition and reduce connections costs and time.

A.3 AEMO's proposed rule

AEMO's proposal sought to improve the access standards and reduce connections costs and time by:

- aligning them with best power system performance

129 See the AEMC website for more information on the rule change process: https://www.aemc.gov.au/our-work/changing-energy-rules
130 AEMO, 2024 Integrated System Plan, p 11.

- streamlining the connection process
- removing impediments for connection of grid-forming inverters
- broadening their application to synchronous condenser connections
- broadening their application to all HVDC links
- accounting for potential impacts and beneficial capabilities of HVDC links

A.4 The process to date

On 14 November 2024, the Commission published a notice advising of its intention to initiate the rule making process in respect of the rule change request.[131] The Commission decided to fast-track this rule change request. This is because it concluded that the rule change request is consistent with the relevant recommendations of AEMO's review and adequate consultation with the public was undertaken during that review on the relevant recommendation.[132]

Accordingly, the Commission did not publish a consultation paper upon initiation of the rule change process and there has been no formal consultation carried out by the Commission in this rule change process to date.

131 This notice was published under section 95 of the NEL.

132 The decision to fast-track the rule change request was made under section 96A(1)(a) of the NEL.

B Regulatory impact analysis

The Commission has undertaken regulatory impact analysis to make its draft determination.

B.1 Our regulatory impact analysis methodology

We considered a range of policy options

The Commission compared a range of viable policy options that are within our statutory powers. The Commission analysed these options: the rule proposed in the rule change request; a business-as-usual scenario where we do not make a rule; and a more preferable rule.

We identified who would be affected and assessed the benefits and costs of each policy option

The Commission's regulatory impact analysis for this rule change used qualitative methodologies. It involved identifying the stakeholders impacted and assessing the benefits and costs of policy options. The Commission drew upon the stakeholder feedback to AEMO's review process for this analysis. The depth of analysis was commensurate with the potential impacts. The Commission focused on the types of impacts within the scope of the NEO.

Table B.1 summarises the regulatory impact analysis the Commission undertook for this rule change. Based on this regulatory impact analysis, the Commission evaluated the primary potential costs and benefits of policy options against the assessment criteria. The Commission's draft determination considers the benefits of the options relative to the costs. The Commission will use stakeholder feedback to the draft determination to determine the final rule.

Table B.1: Regulatory impact analysis methodology

Assessment criteria	Primary costs (Low, medium or high)	Primary benefits (Low, medium or high)	Stakeholders affected	Methodology QT = quantitative, QL = qualitative
Safety, security and reliability	Unintended consequences of amending performance standards leading to degraded system security (L)	**More efficient investment in, and operation of power system (H)** **Decreased costs and time taken to connect (H)** Improved system security & resilience (M)	• Connection applicants • NSPs • AEMO • AER • Market participants • Consumers	• QL: Stakeholder consultation on the costs of meeting and complying current access standards • QL: Stakeholder consultation on the potential cost savings by amending specific access standards
Emissions reduction	N/A	**Faster connections for new renewable generation and storage (H)**	• Connection applicants • AEMO • NSPs • Consumers	• QL: Stakeholder feedback to ensure new performance standards do not unintentionally stifle new connections and will facilitate faster connections
Innovation and flexibility	New standards may not properly account for future technologies (L)	Removal of impediments to connecting grid-forming inverters (M)	• Connection applicants • AEMO • NSPs	• QL: Consultation with grid-forming inverter OEMs to verify that new access standards would be preferable over existing standards
Implementation considerations	Increased enforcement & compliance costs (L)	**Decreased costs of negotiating access standards (H)**	• Connection applicants • AEMO • AER • NSPs	• QL: Cost estimates from market bodies (AEMO & the AER) for updates to administrative process, connection negotiations and enforcement. • QL: Cost estimates from NSPs and connection applicants on the current negotiation process during enquiry, registration and commissioning.

C Legal requirements to make a rule

This appendix sets out the relevant legal requirements under the NEL for the Commission to make a draft rule determination.

C.1 Draft rule determination and draft rule

In accordance with section 99 of the NEL, the Commission has made this draft rule determination for a more preferable draft rule in relation to the rule proposed by AEMO.

The Commission's reasons for making this draft rule determination are set out in chapter 2.

A copy of the more preferable draft rule is attached to and published with this draft determination. Its key features are described in chapter 1. We have also published a mark-up of the amendments to the current rule to make it easier for stakeholders to navigate the changes.

C.2 Power to make the rule

The Commission is satisfied that the more preferable draft rule falls within the subject matter about which the Commission may make rules.

The more preferable draft rule falls within section 34 of the NEL as it relates to the activities of persons (including Registered participants) participating in the national electricity market or involved in the operation of the national electricity system.[133] Additionally, the more preferable draft rule falls within the matters set out in schedule 1 to the NEL as it relates to item 11, being the operation of generating systems, transmission systems, distribution systems or other facilities.

C.3 Commission's considerations

In assessing the rule change request the Commission considered:

- its powers under the NEL to make the draft rule
- the rule change request
- stakeholder input received by AEMO as part of its Access Standards Review
- the Commission's analysis as to the ways in which the draft rule will or is likely to contribute to the achievement of the NEO
- the application of the draft rule to the Northern Territory.

There is no relevant Ministerial Council on Energy (MCE) statement of policy principles for this rule change request.[134]

The Commission may only make a rule that has effect with respect to an adoptive jurisdiction if satisfied that the proposed rule is compatible with the proper performance of AEMO's declared network functions.[135] The more preferable draft electricity rule is compatible with AEMO's declared network functions because they would not affect those functions.

133 Section 34(1)(a)(iii) of the NEL.

134 Under s. 33 of the NEL and s. 73 of the NGL the AEMC must have regard to any relevant MCE statement of policy principles in making a rule. The MCE is referenced in the AEMC's governing legislation and is a legally enduring body comprising the Federal, State and Territory Ministers responsible for energy. On 1 July 2011, the MCE was amalgamated with the Ministerial Council on Mineral and Petroleum Resources. In December 2013, it became known as the Council of Australian Government (COAG) Energy Council. In May 2020, the Energy National Cabinet Reform Committee and the Energy Ministers' Meeting were established to replace the former COAG Energy Council.

135 Section 91(8) of the NEL.

C.4 Making electricity rules in the Northern Territory

The NER, as amended from time to time, apply in the Northern Territory, subject to modifications set out in regulations made under the Northern Territory legislation adopting the NEL.[136] Under those regulations, only certain parts of the NER have been adopted in the Northern Territory.

As the more preferable draft rule relates to parts of the NER that apply in the Northern Territory, the Commission is required to assess Northern Territory application issues, described below.

Test for scope of "national electricity system" in the NEO

Under the NT Act, the Commission must regard the reference in the NEO to the "national electricity system" as a reference to whichever of the following the Commission considers appropriate in the circumstances having regard to the nature, scope or operation of the proposed rule:[137]

1. the national electricity system
2. one or more, or all, of the local electricity systems[138]
3. all of the electricity systems referred to above.

Test for differential rule

Under the NT Act, the Commission may make a differential rule if it is satisfied that, having regard to any relevant MCE statement of policy principles, a differential rule will, or is likely to, better contribute to the achievement of the NEO than a uniform rule.[139] A differential rule is a rule that:

- varies in its term as between:
  - the national electricity systems, and
  - one or more, or all, of the local electricity systems, or
- does not have effect with respect to one or more of those systems

but is not a jurisdictional derogation, participant derogation or rule that has effect with respect to an adoptive jurisdiction for the purpose of s. 91(8) of the NEL.

A uniform rule is a rule that does not vary in its terms between the national electricity system and one or more, or all, of the local electricity systems, and has effect with respect to all of those systems.[140]

The Commission is still considering whether a uniform or differential rule would be appropriate and would welcome submissions on this. The Commission is also discussing directly with the Northern Territory Government on this issue.

Most of the amendments in the draft rule relate to rules in the NER that do not currently apply to the Northern Territory, relevantly Chapter 3, Chapter 4, numerous clauses in Chapter 5, schedules 5.1a to 5.3a, schedule 5.5, schedule 5.5.3, schedule 5.6, Chapter 6A and Chapter 7.[141] However, some of the amendments in the draft rule relate to rules currently in effect in the Northern Territory, including certain clauses in Chapter 5 and definitions in Chapter 10 of the NER. The Commission will explore whether a differential rule could be made which only includes the amendments that are appropriate to the NER as applied in the Northern Territory and which meet the policy objectives of this rule change. The Commission will continue to consult with the

136 These regulations under the NT Act are the National Electricity (Northern Territory) (National Uniform Legislation) (Modifications) Regulations 2016

137 Clause 14A of schedule 1 to the NT Act, inserting section 88(2a) into the NEL as it applies in the Northern Territory.

138 These are specified Northern Territory systems, listed in schedule 2 of the NT Act.

139 Clause 14B of schedule 1 to the NT Act, inserting section 88AA into the NEL as it applies in the Northern Territory.

140 Clause 14 of schedule 1 to the NT Act, inserting the definitions of "differential Rule" and "uniform Rule" into section 87 of the NEL as it applies in the Northern Territory.

141 See regulation 5A of the National Electricity (Northern Territory) (National Uniform Legislation) (Modifications) Regulations 2016.

Northern Territory Government and determine how these application issues should be addressed in the final rule.

C.5 Civil penalty provisions and conduct provisions

The Commission cannot create new civil penalty provisions or conduct provisions. However, it may recommend to the Energy Ministers' Meeting that new or existing provisions of the NER be classified as civil penalty provisions or conduct provisions.

The NEL sets out a three-tier penalty structure for civil penalty provisions in the NEL and the NER.[142] A Decision Matrix and Concepts Table,[143] approved by Energy Ministers, provide a decision-making framework that the Commission applies, in consultation with the AER, when assessing whether to recommend that provisions of the NER should be classified as civil penalty provisions, and if so, under which tier.

Subject to consulting with the AER, the Commission proposes to make the following civil penalty recommendations to the Energy Ministers' Meeting in relation to the final rule.

Table C.1: New civil penalty provision recommendation(s)

Clause	Description of clause	Proposed classification	Reason for proposed classification
5.2.2(e)	This new clause would consolidate existing obligations on registered participants in respect of their connection agreements (specifically, existing clauses 5.2.3(b), 5.2.3(g1), 5.2.3A(d), 5.2.4(a), 5.2.4(f), 5.2.5(a), 5.2.5(c), 5.2.5A(a) and 5.2.5A(c)). The obligations are for these registered participants to plan, design, operate and maintain their plant in order to comply with the terms and conditions in their connection agreements.	Tier 1	Compliance with the provision is necessary to ensure appropriate supply security and reliability and failure to comply with this provision could result in consumer harm. Connection agreements set out the performance standards for plant that are set in accordance with the requirements in schedule 5. It is vital that parties comply with their performance standards and any associated terms and conditions (such as system strength remediation schemes) to ensure that the security of the NEM is not compromised. In the worst circumstances, non-compliance with connection agreements can have severe adverse effects and significant costs on other network users and consumers.

142 Further information is available at https://www.aemc.gov.au/regulation/energy-rules/civil-penalty-tools

143 The Decision Matrix and Concepts Table is available at: https://web.archive.org.au/awa/20210603104757mp_/https://energyministers.gov.au/sites/prod.energycouncil/files/publications/documents/Final%20-%20Civil%20Penalties%20Decision%20Matrix%20and%20Concepts%20Table_Jan%202021.pdf

Where the draft rule amends provisions that are currently classified as civil penalty provisions, the Commission does not propose to recommend to the Energy Ministers' Meeting any changes to the classification of those provisions.

Table C.2: Amended civil penalty provision recommendations

Clause	Description of amendment	Current classification	Reason to retain tier
4.3.5(a)	The existing obligation for some Market Customers to have interruptible loads available would be amended so that the obligation is placed on the relevant Schedule 5.3 Participant instead. This is so the obligation lies with the owner or operator of the load, who may not be the Market Customer for the connection point.	Tier 1	As the intent of the amendment is to ensure the obligation sits with the relevant owner or operator, and not to change the nature of the obligation itself, no change to the civil penalty tier is recommended.
4.3.5(b)	The existing obligation is for some Market Customers to provide their interruptible load in 'manageable blocks'. The proposed amendment would place this obligation on the relevant Schedule 5.3 Participant instead.	Tier 1	As the intent of the amendment is to ensure the obligation sits with the relevant owner or operator, and not to change the nature of the obligation itself, no change to the civil penalty tier is recommended.
4.4.2(b)	The proposed amendment substitutes 'generating units' and 'bidirectional units' with 'production units'.	Tier 1	A minor change that would also encapsulate any synchronous condensers inside integrated resource systems. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
4.4.3, 4.5.2(b), 4.9.4(b), 5.7.4(a1), 5.13.1(d)	The proposed amendment unitalicises 'voltage' wherever it appears, to align with the draft rule's proposed deletion of the glossary definition of 'voltage'.	Tier 1	As these changes do not change the nature of these obligations, no change to the civil penalty tier is recommended.
5.2.2(a)	The proposed amendment would simplify the drafting of this clause for brevity and clarity.	Tier 2	As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.

Clause	Description of amendment	Current classification	Reason to retain tier
5.2.3(b)	The proposed amendment streamlines the drafting and enables common connection agreement obligations to be consolidated by 5.2.2(e)	Tier 1	The proposed amendment retains the obligation for NSPs to comply with the standards in schedule 5.1. No change to the civil penalty tier is recommended.
5.2.3(c)	The proposed amendment makes a minor grammatical correction for clarity.	Tier 2	As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.2.3(d)(11)	The proposed amendment to this clause would substitute references to specific categories of Registered Participants with Connection Applicants and Network Service Providers (where relevant). This clause obliges Network Service Providers to provide to AEMO the information required from relevant Connection Applicants and Registered Participants under schedules 5.2, 5.3 or 5.3a, rather than limiting the obligation to the two categories of Registered Participants.	Tier 2	The proposed amendment is intended to better capture that NSPs are obliged to provide all required information to AEMO from all connection applicants and/or registered participants. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.2.3(g)	The proposed amendment would add a reference to *schedule 5.3a plant* and would not limit the application of the clause to *market network services*, consistent with the intent proposed changes to schedule 5.3a in this draft rule (that is, schedule 5.3a would apply to all HVDC links, regardless of whether the HVDC link is a market network service).	Tier 1	The intent of the proposed amendment aligns with broader changes to the application of schedule 5.3a. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.3.3(b1)	The proposed amendment would remove a reference to 'normal voltage' which would be made redundant through the proposed deletion of 'normal voltage' in the draft rule.	Tier 3	As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.3.4B(a2)	The proposed amendment would replace 'generating system, integrated resource system or other connected plant' with 'plant', for brevity.	Tier 2	As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.

Clause	Description of amendment	Current classification	Reason to retain tier
5.3.4B(q)	The proposed amendment would replace a reference to 'Registered Participant' with 'party'. This aligns with the intent of the draft rule to apply the system strength mitigation requirement on schedule 5 plant that meet AEMO's definition of *large inverter-based* resource in its system strength impact assessment guidelines, who may or may not be registered participants.	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.3.6(j)	The proposed amendment would replace references to a Distribution Connected Resource Provider and a Market Network Service Provider with a link to proposed rule 5.3AA(a)(2).	Tier 3	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.3.7(g)	The proposed amendment would replace references to Registered Participants and certain categories with Connection Applicant and Schedule 5.2 Participant.	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.3.8(f)	The proposed amendment would replace a reference to a 'Registered Participant' with 'NSP or a Schedule 5 Participant'. It also expands 'incorrect' information in relation to a performance standard with 'incomplete, inaccurate or out of date' information.	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. The obligation would be extended slightly to 'incomplete, inaccurate or out of date' information, which the Commission considers is a reasonable expansion of the provision. It would ensure that AEMO has complete visibility over all performance standards to maintain system security and resilience. As the nature of the obligation is largely unchanged, no change to the civil penalty tier is recommended.

Clause	Description of amendment	Current classification	Reason to retain tier
5.3.9(b)(2)	The proposed amendment would replace references to 'generating system/unit' with 'production units or synchronous condensers'.	Tier 2	The intent of the proposed amendment aligns with the intent to broaden schedule 5.2 to synchronous condensers. As the nature of the obligation is largely unchanged, no change to the civil penalty tier is recommended.
5.3.9(h)	The proposed amendment would replace a reference to 'Generator or Integrated Resource Provider' with 'Schedule 5.2 Participant'. It would also link the requirement for the NSP and the Schedule 5.2 Participant to jointly notify AEMO of any changes to information as a result of the clause 5.3.9 process to clause 5.3.7, not limiting it to changes to a connection agreement.	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. Linking this provision to clause 5.3.7 slightly changes the obligation, but would ensure that AEMO is aware of all relevant changes made through the clause 5.3.9 process, including any changes that may not be included in a connection agreement. The Commission considers that as this provision is similar in nature to clause 5.3.8(f) and therefore recommend that a similar tier 2 classification should apply.
5.3.10(a)	The proposed amendment would replace references to 'Generator' with 'Schedule 5.2 Participant'.	Tier 1	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.3.12(b)	The proposed amendment would replace 'Network User or Market Network Service Provider' with 'Schedule 5.3 Participant or Schedule 5.3a Participant'.	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.3.12(h)	The proposed amendment aligns with other proposed changes throughout rule 5.3 to apply obligations to Schedule 5.3 and Schedule 5.3a Participants, and	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change

Clause	Description of amendment	Current classification	Reason to retain tier
	streamlines the Rules for clarity.		the nature of the obligation, no change to the civil penalty tier is recommended.
5.3.13(a)	The proposed amendment would replace 'Network User or Market Network Service Provider' with 'Schedule 5.3 Participant or Schedule 5.3a Participant'.	Tier 1	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.7.2(h)	The proposed amendment would simplify the drafting of this clause for brevity and clarity.	Tier 3	As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.7.2(i)	The proposed amendment (in conjunction with proposed changes to other paragraphs in clause 5.7.2) would allow registered participants to request an assessment of equipment owned or operated by another registered participant if it believes that the equipment may not comply with the NER or a connection agreement.	Tier 3	The proposed amendment is related to the proposed changes in S5.2.5.4 (see section 4.4.2) so that registered participants would be able to request an assessment (instead of a physical test) of equipment. The Commission considers that allowing parties to request an assessment (such as a simulation study) provides a more cost-effective and simpler option to discover the root causes of any equipment behaviours that could be causing issues for the network or network users. The civil penalty provision currently obliges the Registered Participant who conducts a test to provide a report to AEMO and/or relevant registered participants. The proposed amendment would extend this obligation to any Registered Participant who also conducts an assessment. The Commission considers that the expansion of the obligation would be minor, and therefore does not recommend changing the civil penalty tier classification for this clause.

Clause	Description of amendment	Current classification	Reason to retain tier
5.20B.6(b)	The proposed amendment would consolidate 5.20B.6(b) and (b1) together by replacing 'generating' unit with 'production unit' for brevity.	Tier 2	As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
5.20C.4(b)	The proposed amendment would consolidate 5.20C.4(b) and (b1) together by replacing 'generating' unit with 'production unit' for brevity.	Tier 2	As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
S5.2.4(a)	The proposed amendment would replace references to registration categories with 'Schedule 5.2 Participant', and 'generating system or integrated resource system' with 'schedule 5.2 plant'	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
S5.2.4(b)	The proposed amendment would rewrite the clause to refer to a 'Schedule 5.2 Participant', 'production systems', 'production units' or 'synchronous condenser systems' instead of referring to registration categories.	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
S5.3.1(a1)	The proposed amendment would replace 'Network User' with 'Schedule 5.3 Participant'.	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.
S5.3a.1(a1)	The proposed amendment would replace 'Market Network Service Provider' with 'Schedule 5.3a Participant'.	Tier 2	The intent of the proposed amendment aligns with broader changes to the application of the access standard framework. As the proposed amendment would not change the nature of the obligation, no change to the civil penalty tier is recommended.

The Commission proposes to recommend to the Energy Ministers' Meeting that the classifications for a number of provisions are removed given the relevant clauses have been deleted and therefore the current classifications are redundant.

Table C.3: Deleted civil penalty provision recommendations

Clause	Description of rule	Reason
5.2.3(g1)	A Network Service Provider must comply with any terms and conditions of a connection agreement for its market network service facilities that form part of a system strength remediation scheme.	This clause would be made redundant by proposed clause 5.2.2(e).
5.2.3A(d)	A Market Network Service Provider must comply with any terms and conditions of a connection agreement for its connected plant that form part of a system strength remediation scheme.	This clause would be made redundant by proposed clause 5.2.2(e).
5.2.4(a) This clause is not deleted but is completely replaced by a new clause that does not contain the existing obligation	A Customer must plan and design its facilities and ensure that its facilities comply with its connection agreement, all applicable performance standards, and the system standards.	This clause would be made redundant by proposed clause 5.2.2(e).
5.2.4(f)	A Customer must comply with any terms and conditions of a connection agreement for its connected plant that form part of a system strength remediation scheme.	This clause would be made redundant by proposed clause 5.2.2(e).
5.2.5(a)	A Generator must plan and design its facilities and ensure that its facilities comply with its connection agreement, all applicable performance standards, and the system standards.	This clause would be made redundant by proposed clause 5.2.2(e).

Clause	Description of rule	Reason
5.2.5(c) This clause is not deleted but is completely replaced by a new clause that does not contain the existing obligation	A Generator must comply with any terms and conditions of a connection agreement that form part of a system strength remediation scheme.	This clause would be made redundant by proposed clause 5.2.2(e).

Abbreviations and defined terms

AAS	Automatic access standard
AS/NZS	Joint Australian and New Zealand Standards
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
Commission	See AEMC
ENTSO-E	European Association for the Cooperation of Transmission System Operators (TSOs) for electricity
HVDC	High voltage direct current
IEC	International Electrotechnical Commission
IEC/TR	International Electrotechnical Commission Technical Report
IRP	Integrated Resource Provider
kV	Kilovolt
MAS	Minimum access standard
MCE	Ministerial Council on Energy
MVA	Megavolt-ampere
MVAr	Megavolt-ampere reactive
MW	Megawatt
MNSP	Market Network Service Provider
NECA	National Electricity Code Administrator
NEL	National Electricity Law
NEM	National Electricity Market
NEO	National Electricity Objective
NER	National Electricity Rules
NSP	Network Service Provider
NT Act	*National Electricity (Northern Territory) (National Uniform Legislation) Act 2015*
OEM	Original equipment manufacturer
Pmax	maximum active power
Proponent	The individual / organisation who submitted the rule change request to the Commission
RUG	Releasable User Guide
RMS	Root mean square
SSSP	System strength service provider
STATCOM	Static synchronous compensator
SVC	Static VAR compensator
VA	Volt-ampere
VAR or VAr	Volt-ampere reactive