EnergyCo

Rationale for final NSW REZ Access Standards

Accompanying document to the final NSW REZ Access Standards intended to apply to Central West Orana REZ

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Acknowledgement of Country

The Energy Corporation of NSW acknowledges that it stands on Aboriginal land. We acknowledge the Traditional Custodians of the land and we show our respect for Elders past, present and emerging through thoughtful and collaborative approaches to our work, seeking to demonstrate our ongoing commitment to providing places in which Aboriginal people are included socially, culturally and economically.

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Sub-title: Accompanying document to the NSW REZ Access Standards intended to apply to Central West Orana REZ

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Acknowledgements

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Contents

Shortened forms and definitions

Term	Definition
access rights network	Specified network infrastructure forming part of a REZ as defined in an access scheme declaration.
access scheme	A scheme that authorises or prohibits access to, and use of specified network infrastructure in a REZ by a REZ network operator and operators of generation and storage infrastructure[1].
AAS	An automatic access standard as defined in the NER
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator Limited
CWO	Central-West Orana
connection point	As defined in the NER
system strength rule change	AEMC's rule change 'efficient management of system strength on the power system'
EII Act	*Electricity Infrastructure Investment Act (NSW) 2020*
EnergyCo	The Energy Corporation of NSW
FCAS	Frequency control ancillary services
Generators	Generation and storage proponents wishing to connect to the access rights network
GPS	Generator Performance Standards
IBR	Inverter based resources
MAS	A minimum access standard as defined in the NER
NAS	A negotiated access standard as defined in the NER

[1] Section 24(2) of the EII Act

NEM	National Electricity Market
NER	National Electricity Rules
NSP	Network Service Provider as defined in the NER
OLTC	on-line tap changer
OEM	Original equipment manufacturer
POD	Power oscillation damping
REZ	Renewable Energy Zone
REZ Access Standards	Specific GPS and IBR standards that are intended to apply in the Central-West Orana REZ in NSW that proponents will be required to meet as a condition of the CWO REZ access rights tender and must propose in their application to connect to the CWO REZ access rights network.
RoCoF	Rate of change of frequency
SCR	Short circuit ratio

Context

Purpose of this document

This document accompanies the final 'NSW REZ Access Standards intended to apply to Central West Orana REZ' published June 2022 and available on the EnergyCo website[2].

The purpose of this document is to provide:

- **Rationale** for the final REZ Access Standards, and particularly explanations for changes made to the draft REZ Access Standards published for consultation by EnergyCo, in collaboration with AEMO and Transgrid in April 2022.
- **Clarification** in relation to the intent of certain technical requirements in the REZ Access Standards, in response to feedback received during the industry consultation process.

Where this document provides clarification in relation to the assessment approach to be applied in relation to any technical requirement in the REZ Access Standards AEMO confirms that the assessment approach in this document prevails to the extent of any inconsistency existing AEMO Guidelines regarding the assessment approach for access standards.

This document covers the following technical requirements in the REZ Access Standards which differ from the technical requirements specified as AAS in the relevant clauses of the NER:

- S5.2.5.1 Reactive power capability
- S5.2.5.4 Generating system response to voltage disturbances
- S5.2.5.5 Generating system response to disturbances following contingency events
- S5.2.5.8 Protection of generating systems from power system disturbances[3]
- S5.2.5.10 Protection to trip plant for unstable operation
- S5.2.5.11 Frequency control
- S5.2.5.13 Voltage and reactive power control

This document also covers the following technical requirement which will be introduced in the NER by the system strength rule change and which form part of the REZ Access Standards:

- S5.2.5.15 Short circuit ratio
- S5.2.5.16 Voltage phase angle shift

[2] Final REZ Access Standards available on EnergyCo website: https://www.energyco.nsw.gov.au/get-involved/resources

[3] Note that clause S5.2.5.8 of the NER only has a minimum access standard level. This clause reference relates to the removal of the increased RoCoF obligation in S5.2.5.3

About the REZ Access Standards and development process

EnergyCo has collaborated with Transgrid and AEMO to develop the REZ Access Standards.

Proponents are required to meet these standards as a condition of the access rights tender and to propose the REZ Access Standards in their application to connect to the CWO REZ access rights network. The REZ Access Standards are intended to be treated in the same way as AAS under the NER for the purpose of connections to the CWO REZ access rights network[4]. It is intended that the REZ Access Standards are set at a level that can be met by reasonable quality equipment that is currently available in the market.

The REZ Access Standards have been developed to streamline the connection process for Generators. Key considerations during development included:

- a statistical review of historically negotiated performance standards in NSW
    - clauses where an AAS (automatic access standard) is typically met
    - clauses where a NAS (negotiated access standard) has been proposed and agreed as well as the resonating behind deviations from the AAS
- review at a global level of the technical risks associated with setting REZ Access Standards at a level below the AAS
- review of performance characteristics and limitations in different asynchronous generating system technology types
- the impacts of the generating system design on performance outcomes.

For the development of REZ IBR standards the following approach was followed:

- bring forward the implementation of new access standards for IBR to provide a risk mitigation measure in the connection of asynchronous generating systems. IBRs connecting under standard NER processes will be required to meet IBR standards from March 2023
- review the access standards introduced by the system strength rule change
- review system strength capabilities and limitations of different grid following IBR plant based on site-specific OEM models of existing/committed generating systems
- consider power system events that could test the limits of the IBR plant capability
- review technical considerations where deviating from the new access standards introduced by the system strength rule change may be warranted.

For further detail about the REZ Access Standards and their application to NSW REZs, please refer to the April 2022 Consultation Package[5].

[4] Modifications to the NER will be made by Regulation. The modifications will not be CWO REZ specific but will be drafted such that the relevant connecting plant must propose the REZ Access Standards that are applicable to the relevant REZ and access rights allocation that they are participating in.

[5] Consultation Package available at: https://www.energy.nsw.gov.au/sites/default/files/2022-04/nsw-rez-access-standards-intended-to-apply-to-central-west-orana-rez-consultation-package-220203.pdf

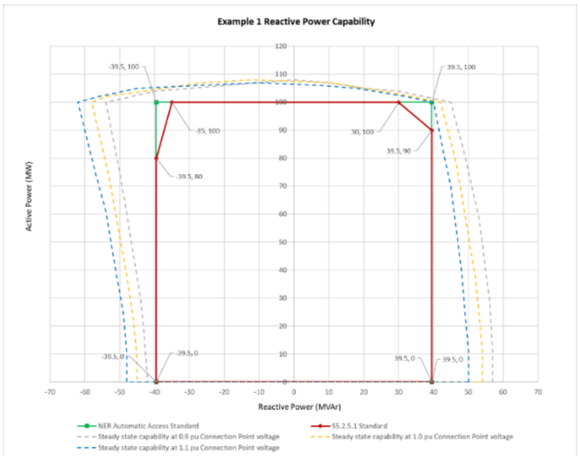
Rationale for final REZ Access Standards

S5.2.5.1 – Reactive power capability

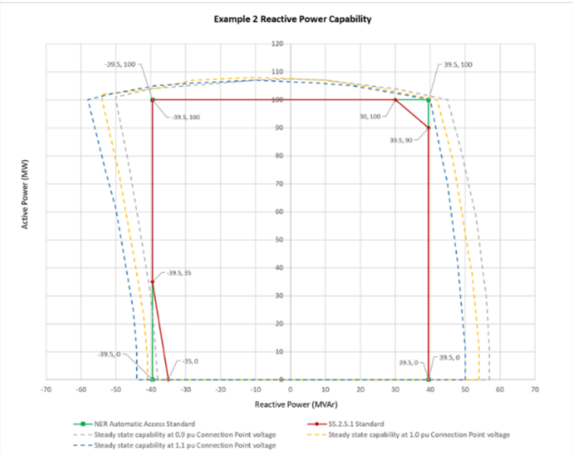
Summary of key changes to draft REZ Access Standards	Changes to Reactive Power Capability.

Material wording updates since draft REZ Access Standards

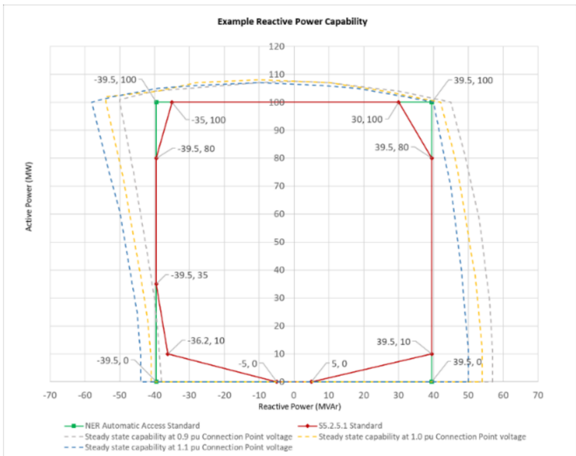
Draft Reactive Power Capability:



or



Final Reactive Power Capability:



Changes to capacitive reactive power requirement:

- [(1) (a) (ii)] the amount equal to the product of rated active power of the generating system and 0.395 when generating between 10% and 80% of the rated active power of the generating system.
- [(1) (a) (iii)] the amount equal to the product of rated active power of the generating system and 0.05 when not generating active power.
- [(1) (a) (iv)] the amount defined by lines between the capabilities specified at:
  - 80% of the rated active power and the rated active power of the generating system; and
  - 10% of the rated active power and when the generating system is not generating active power.

Changes to inductive reactive power requirement:

- [(1) (b) (ii)] the amount equal to the product of rated active power of the generating system and 0.395 when generating between 35% and 80% of the rated active power of the generating system.
- [(1) (b) (iii)] the amount equal to the product of rated active power of the generating system and 0.362 when generating at 10% of the rated active power of the generating system;
- [(1) (b) (iv)] the amount equal to the product of rated active power of the generating system and 0.05 when not generating active power; and
- [(1) (b) (v)] the amount defined by lines between the capabilities specified at:
  - 80% of the rated active power and the rated active power of the generating system;
  - 35% of the rated active power and 10% of the rated active power; and
  - 10% of the rated active power and when the generating system is not generating active power.

Rationale for final REZ Access Standard

- Clause S5.2.5.1 is typically a negotiated access standard.
- It is noted that many large generating systems (particularly large wind farms with extensive reticulation systems) have difficulty in meeting the AAS requirement, without additional reactive plant or oversizing the plant.
- Based on survey of agreed GPS:
  - — it is recognised that 40–50% of generating systems have reduced capacitive reactive power capability (with respect to the AAS requirement) at higher levels of active power (top right corner)
  - — on the inductive side, a reduced reactive power capability on the top left corner (at rated active power) or on the bottom left corner (low active power level) is also seen across 10–20% of generator connections.
- Based on the response received from the industry stakeholders during the REZ Access Standard consultation process, it is recognised that certain types of generating systems have a minimum operating active power level, below which the reactive power capability of the generating system may be reduced due to limitations associated with the generating units.

- The final REZ Access Standard requirement for reactive power capability has been set at a level that a well-designed generating system can reasonably achieve with consideration given to network requirements, optimised generating system design and economic efficiency of the REZ.
- It is anticipated that any impact due to the reduction of the reactive power capability from the REZ generating systems could be addressed by plant providing centralised system strength for the CWO REZ.
- Technical requirements to capture temperature de-rating and reactive power at night (Q at night) capability/wind free capability are included in the REZ Access Standards in accordance with current Transmission Network Service Provider's practices.

Clarification: Reactive capability requirement below minimum operating active power level

It is understood that generating units may have a minimum operating active power level for which stable operation is guaranteed. The REZ Access Standards do not require the generating units to operate or generate below its minimum operating level advised by the OEM. However, the generating system, when connected, must at least meet the reactive power capability requirements in clause S5.2.5.1 (1) (a) (iii) and (1) (b) (iv) when not generating active power.

S5.2.5.3 – Generating system response to frequency disturbances

Summary of key changes to draft REZ Access Standards	Change to withstand and achieve stable operation for RoCoF from 6 Hz/sec to 4 Hz/sec. (Note related change to S5.2.5.8)

Material wording updates since draft REZ Access Standards

Change from:

> *"Unless the rate of change of frequency is outside the range of ±6 Hz/s for more than 0.25 s..."*

To:

> *"Unless the rate of change of frequency is outside the range of ±4 Hz/s for more than 0.25 s..."*

Note: Final REZ Access Standard requirement for clause S5.2.5.3 is consistent with the NER AAS requirement. Related change made to clause S5.2.5.8 to include a "must not trip" obligation of 6 Hz/s for up to 0.25 seconds.

Rationale for final REZ Access Standard

- While it is still expected that the larger RoCoF could occur, the critical component to system security is to remain connected, therefore the 6 Hz/s has been retained as a "must not trip" criteria in S5.2.5.8.

S5.2.5.5 – Generating system response to disturbances following contingency events

Summary of key changes to draft REZ Access Standards	Various changes to subclause (2) multiple disturbances and (3) asynchronous generating systems.

Material wording updates since draft REZ Access Standards

Note: comments made in square brackets [ ] are drafting notes for Generators to respond to when completing the REZ Access Standards as proposed generator performance standards in their application to connect under the NER. These are highlighted yellow in the final REZ Access Standards published on the EnergyCo website.

Changes for Multiple disturbances:

- [(2) (x)] [delete if plant can tolerate cumulative 1,800 milliseconds faults within a 30 second period, or if no thermal limitations affecting ability to ride through faults] exceedance of a thermal limit on a generating unit or dynamic reactive plant within the generating system due to occurrence of [insert a number of faults not less than 4] or more faults, within any 30 second period.
- [(2) (xi)] despite (v), a doubly-fed induction generator may trip where the timing between two or more faults is [detail fault timing that would lead to a mechanical resonance condition, if any. Delete clause if no such condition is identified] which can lead to a mechanical resonance condition or mechanical overload.

Changes for asynchronous generating systems

- [(3) (i) (a)] capacitive reactive current in addition to its pre-disturbance level of at least 2% [this value is a design requirement; this value may be optimised during batch tuning of REZ generating systems] of its maximum continuous current for each 1% reduction of the connection point voltage, up to its maximum continuous current, commencing at a voltage greater than 80% of connection point normal voltage;
- [(3) (i) (b)] inductive reactive current in addition to its pre-disturbance level of at least 2% [this value is a design requirement] of its maximum continuous current for each 1% increase of the connection point voltage, up to [sufficient current, please specify if possible] to maintain its rated apparent power, commencing at a voltage less than 120% of connection point normal voltage; and,
- [(3) (i) (c)] the reactive current response measured at the generating unit terminal, or if the reactive current response is provided by an ancillary dynamic reactive plant, at the terminal of that plant, will:
    - commence within 20 milliseconds of the initiating condition.
    - have an initiating condition that is: [insert the initiating condition: voltage excursion commencement, exceeding the voltage change threshold or traversing voltage threshold level. Delete whichever is not applicable and retain the condition relevant to the technology]; and,
    - have a settling time as soon as practicable and be adequately damped.

- [(3) (ii)] From [insert ms] [active power recovery time of less than 300 ms to be specified, this value may be amended if batch tuning of REZ generating systems affects the recovery time] of the voltage recovering to within 90% to 110% of Normal Voltage on the connection point on all three phases after the clearance of the fault, active power of at least 95% of the level existing just prior to the fault.

Rationale for final REZ Access Standard

- Historically, S5.2.5.5 has been a negotiated access standard, primarily due to:
  - failure to meet reactive current injection/absorption criteria for AAS
  - failure to meet active power recovery time criteria specified in the AAS.
- It is recognised that applying the requirements for AAS for reactive current injection and absorption at the connection point and the active power recovery time of 100 milliseconds (ms) as the REZ Access Standard may be too onerous for some technologies.
- It is also unlikely optimal performance of the access rights network will be achieved by applying the most aggressive control responses across every generating system connected to that network.

Multiple fault ride through

- Considering feedback from the consultation, relaxations to the multiple fault ride through (MFRT) requirements have been made for multiple-fault conditions that cause mechanical resonance or plant thermal limitations
- If either relaxation is included in the GPS, the Generator will be expected to provide evidence to support the need for the relaxation as a requirement for registration

Reactive current response magnitude

In response to consultation feedback, the final REZ Access Standards have been simplified to refer to the volume of reactive current response only at the connection point.

- The generating system must have the capability to respond at an appropriate level at its connection point in order to support the network voltage during a disturbance.
- The REZ Access Standard for reactive current response magnitude has been set to require the generating system to have facilities sufficient to meet the MAS level (2%/%) at the connection point. During the batch tuning process, a different setting for reactive current injection may be set to optimise the performance of the REZ and the broader power system.

Commencement of reactive current response

- Considering difficulties applying the NER access standards for reactive current rise time and settling time, the REZ Access Standards have instead included a commencement time requirement. The measurement of this parameter is at the terminals of the plant providing the reactive current response. This altered requirement reflects an expectation of a fast response to a large power system disturbance. Investigations of actual plant responses indicate that well-tuned generating systems should meet the requirement to commence a response within 20 ms.

Active power recovery

- It is understood that a rapid recovery of active power may not be possible or desirable in some instances due to local power system conditions. Conversely, if a large number of plants in a geographical area recover slowly following a fault event, the slow recovery can cause an energy deficit that translates into additional frequency ancillary service requirements within the NEM.
- Following consideration of responses from the REZ Access Standards consultation and the appropriate level that can be reasonably achieved by a well-designed generating system, the active power recovery time has been increased to 300 ms in the final REZ Access Standard.
- To achieve the best performance from the CWO REZ access rights network and connected generating systems, coordination of plant tuning may be required. This tuning process can be undertaken for all generating systems connecting to the CWO REZ access rights network in a batched assessment and may impact the performance level required for active power recovery.

Clarification: Multiple disturbances for S5.2.5.5 Clause (2) of the REZ Access Standards

For the purpose of assessing multiple disturbances, in a series of up to 15 disturbances within any five minute period, consider:

- two faults, where the second fault commences immediately after the clearance of the previous fault (i.e., minimum clearance between the two faults is zero milliseconds); and,
- for other faults within the sequence, the end of a disturbance is the time at which the voltage at the connection point returns to above 90% of normal voltage.

Clarification: Requirement for generating system to commence reactive current response

The AAS for S5.2.5.5 (g)(1) requires the generating system to commence the reactive current response in the range of 85-90% voltage for under-voltage disturbances. The NER incorporates the understanding that the voltage level is referenced at the connection point, however the generating units respond to the under-voltage disturbance as experienced at their terminals. This results in different voltage ranges depending on the pre-fault operating condition, e.g. the tap position, active and reactive power flow. To compensate for this, an initiation voltage range is specified for the generating systems commencement to the disturbance.

The REZ Access Standards require the generating system to commence its reactive current injection response for voltages above 80% at the connection point. Similarly, reactive current absorption should commence for voltages at the connection point below 120%.

This range aligns with the minimum access standard of the NER and allows for generating unit response that commences on initiation of a disturbance (for example in grid forming inverters) as well as response that is triggered by voltage at the terminals exceeding a threshold voltage. Generators should tune the appropriate reactive current response to commence above 80% voltage and below 120% at the connection point. This should be confirmed over entire operating range of the generating system.

S5.2.5.8 – Protection of generating systems from power system disturbances

Summary of key changes to draft REZ Access Standards	Addition of "must not trip" obligation of ±6 Hz/s for up to 0.25 seconds. (Relates to changes made to S5.2.5.3)

Material wording updates since draft REZ Access Standards

Additional subclause:

- [(e) (i)] The conditions for which the generating unit or generating system must not trip are: [specify the conditions to facilitate AEMO and NSP maintaining power system security].
    - For a rate of change of frequency of ±6 Hz/s for up to 0.25 seconds.

Note: This addition replaces the requirement in clause S5.2.5.3 for stable operation for RoCoF from ±6 Hz/sec to ±4 Hz/sec, from the draft REZ Access Standards.

Rationale for final REZ Access Standard

- AEMO's final 2022 Integrated System Plan shows declining inertia levels in the mainland NEM, as thermal units retire. Inertia shortfalls can occur earlier than expected if coal fired power stations retire early or move to flexible operation.
- In NSW, with the retirement of Eraring, Bayswater, Liddell and Vales Point power stations, it is expected that higher RoCoF will be experienced following multiple generating system trip events.
- It is not clear that fast-frequency response FCAS will operate fast enough to prevent initial high RoCoF that could occur in this scenario.
- To future proof the power system, it is critical to ensure IBR have sufficient capability to remain connected in the event of high RoCoF events and avoid cascading failures.
- Based on analysis of the capability of a subset of existing asynchronous generating systems, well-tuned asynchronous generating units have capability to withstand and achieve stable operation for RoCoF of 4-6 Hz/s for 0.25 seconds.
- From a system security point of view, it is undesirable to have multiple generating systems trip during a more severe over-frequency or under-frequency event. Therefore, a requirement not to trip for a RoCoF up to ±6 Hz/s for 0.25 seconds is included.
- A requirement not to trip is less onerous than a requirement for *continuous uninterrupted operation* as defined in the NER.

S5.2.5.10 – Protection to trip plant for unstable operation

Summary of key changes to draft REZ Access Standards	Simplification of the clause for the detection and alarming scheme to be included in more relevant REZ Access Standard clauses. The thresholds of the protection schemes to be determined and agreed at detailed design.

Material wording updates since draft REZ Access Standards

Simplification of the subclause to specify the instability detection and protection system capabilities:

- [(2)] The generating system has an instability detection system for voltage, active power or reactive power oscillations, which will promptly raise and send a SCADA alarm to the Network Service Provider and AEMO control centres [Detection scheme to be determined and agreed at detailed design].
- [(3)] The generating system has a protection system that is capable of promptly disconnecting the generating system for sustained voltage oscillations based on the contribution of the generating system to the oscillation [Protection scheme to be determined and agreed at detailed design].

Rationale for final REZ Access Standard

The key challenge for an oscillating or unstable network condition is to understand which generating systems are exacerbating or damping oscillations and what the best course of action would be to address the adverse impact. It has been observed in the NEM that asynchronous generating systems can participate in voltage oscillations, due to interactions between their control systems. In a REZ there will be a high density of asynchronous generating systems, and over the life of the plant, the system strength of the mainland NEM is expected to decline further, which could exacerbate oscillations resulting from control interactions.

Instability Detection Capability

- The final REZ Access Standard simplifies the requirement for an instability detection system that can raise an alarm and communicate with the NSP and AEMO control centres.
- The changes provide the ability for the NSP, AEMO and the proponent to agree the detection thresholds and coordinate the monitoring and alarming during the detailed design stage.

Protection System Capability

- The generator's protection system must be able to promptly disconnect the generating system based only on its contribution to the voltage oscillation.
- The protection system will be capable of signalling to the protection devices (circuit breakers) or control system (ramp down, control mode changes etc) of the generating system and will be determined and agreed with the NSP and AEMO during detailed design.
- The purpose of the protection system is to improve power system security.

S5.2.5.13 – Voltage and reactive power control

Summary of key changes to draft REZ Access Standards	Additional wording to allow alternatives to a power system stabiliser (PSS) or POD device that has equivalent functionality that can be agreed with AEMO and relevant NSP.

Material wording updates since draft REZ Access Standards

Additional wording to allow alternative solutions that can meet equivalent power system stabiliser or power oscillation damping performance specified in subclauses (i) – (vi):

- [(6)] The power system stabiliser or POD device has functionality agreed with AEMO and the relevant NSP or… [continued for subclauses (i) – (vi)]

Rationale for final REZ Access Standard

- The S5.2.5.13 performance standard has typically been negotiated, primarily due to:
  - lack of POD capability of the voltage control system
  - failure to meet the AAS requirement for reactive power rise time of 2 s.

POD requirement

- Considering the potential for oscillations due to control interactions between generating systems that are in close electrical proximity within the REZ, POD capability is recognised as an important capability to be included in the generating system design.
- The requirement for enabling and appropriate tuning of the POD can be determined during detailed assessments.
- At present, there are few committed asynchronous generating systems in NSW where requirement for a POD has been included in the GPS.
- The final REZ Access Standard provides more flexibility on the design of the POD functionality, compared with the draft REZ access standard.

Reactive power rise time

- It is recognised that the performance characteristics of a generating system's response to a step change in voltage or voltage setpoint are dependent on the fault level at the connection point and the tuning capability of the associated generation technology.
- A generating system connecting at a lower fault level tends to have a faster, but more oscillatory and less stable response, while at high fault levels the response can be slower, but well damped with no subsequent oscillatory behaviour.
- Considering the potential for control system interactions between generating systems in close electrical proximity within the REZ, it is recognised that a coordinated approach to tuning of voltage controllers should provide the optimal performance outcome for the REZ and the power system, rather than setting an onerous performance standard that may have adverse system impacts.

Active power settling time

The settling time calculation includes error bands based on either the sustained change or the maximum change of an output quantity. For voltage steps, when the resulting sustained change in active power and/or the overshoot is very small, the settling time criterion is not meaningful, as the small error bands can lead to extended settling times. However, for active power excursions above a certain threshold, the requirement for meeting settling time criteria should still apply. A general requirement for adequate damping should also still apply.

Operation in reactive power and power factor control

While operation in either reactive power mode or power factor control is useful under certain circumstances, it is expected the operation of REZ generating systems will predominantly be in voltage droop control mode. To support streamlining the connection process, it is recognised that some simplification of the compliance requirements can be made in terms of the operation modes. The REZ Access Standard omits the settling time compliance requirement for reactive power and power factor setpoint changes but retains the settling time requirement for 5% voltage disturbance.

S5.2.5.15 – Short circuit ratio

Summary of key changes to draft REZ Access Standards	SCR changed from 1.8 at the connection point to 2.2 at the connection point.

Material wording updates since draft REZ Access Standards

- [(1)] The generating system has plant capability sufficient to operate stably and remain connected at a short circuit ratio of 2.2 at the connection point, assessed in accordance with the system strength impact assessment guidelines made under NER clause 4.6.6.

Rationale for final REZ Access Standard

- The system strength rule change will introduce a new performance standard in Schedule 5.2 of the NER, requiring a connecting generating system to be capable of stable operation at a short circuit ratio (SCR) of 3 at its connection point.
- A coordinated, centralised approach to provision of system strength for the CWO REZ access rights network is proposed to achieve efficiencies in design and procurement. This will avoid the need to model the system strength impacts of each project individually and the inefficiencies that can be created by decentralised provision of system strength.
- The SCR in the REZ Access Standards is set at a level that aims to optimise the balance of centrally provided system strength remediation against increased requirements of equipment performance, with the goal of minimising the total cost of the CWO REZ, in turn minimising the overall cost to consumers.
- Based on a review of a sample IBR plant's capability and feedback from industry during the consultation process, an SCR of 2.2 has been set as an appropriate performance standard that a well-tuned IBR plant of reasonable quality should be able to meet.
- Industry stakeholders were consulted to understand the balance of commercial and technical risk when determining the SCR level. A comparison of SCR options with relative cost differences for the additional system strength remediation to be provided by the REZ Network Operator (who will construct the CWO REZ access rights network) was provided to industry stakeholders. The feedback was varied, though most of the responses suggested that the additional costs to achieve an SCR of 2.5 and above was not preferred.
- Taking into consideration that the primary concerns were related to wind generating systems – it was determined that the SCR level at 2.2 was the appropriate balance between cost and technical performance. This SCR should also provide a level of engineering margin around the technical capability and operating expectations.

S5.2.5.16 – Voltage phase angle shift

Summary of key changes to draft REZ Access Standards	Voltage phase angle changed from 40 degrees at the connection point to 30 degrees at the connection point.

Material wording updates since draft REZ Access Standards

The generating system and each of its asynchronous generating units must:

- [(1)] Not include any vector shift or similar relay or protective function that acts upon voltage phase angle which might operate for phase angle changes less than 30 degrees at the connection point.
- [(2)] Have sufficient plant capability to remain connected and operate stably for voltage phase angle changes of up to 30 degrees at the connection point.

Rationale for final REZ Access Standard

- The system strength rule change introduced the performance standard S5.2.5.16 Voltage Phase Angle Shift that applies to asynchronous generating units. This mandates a single standard of the protective function not operating for a voltage angle change of less than 20 degrees.
- Access rights will be allocated to intermittent generation, along with energy storage, to enable efficient utilisation of the REZ infrastructure. This might lead to periods with highly loaded transmission lines. Faults on the transmission network within and adjacent to the REZ could lead to large impedance and voltage angle changes. Studies indicated that this could be as high as 40 degrees, however system planning and design experience indicates that this may be able to be managed in some situations with network design mitigation measures.
- The feedback during the consultation process from OEMs indicated that 30 degrees voltage shift was achievable by most OEMs. At levels beyond this there are a reduced number of OEMs willing to confirm viable operational capability.
- There should be an opportunity in future revisions of the REZ Access Standards to review this clause with consideration of transmission network conditions at the time, to understand whether further changes to the standard are technically and economically feasible.

Appendix: Final REZ Access Standard clauses with no changes from draft

S5.2.5.4 – Generating system response to voltage disturbances

Rationale for final REZ Access Standard

- For those generating systems with a connection point at medium voltage (typically below 66 kV), a main transformer with OLTC capability may not be present in the balance of plant design. Without an OLTC the generating system is not able to regulate the voltages across the collector system during over-voltage conditions for long durations required by the clause.
- It is assumed that medium voltage connection points will be supplied from the transmission system (HV level) via a transformer with an OLTC. This OLTC would normally regulate the medium voltage level ensuring voltage levels of the connection point remain within system standards. The OLTC will therefore operate during long duration over-voltages bringing the connection point within normal voltage ranges.
- Application of very high, shorter duration over-voltages at the medium voltage level also means that, for assessment purposes, the generating system voltage controls cannot influence the medium voltage system over-voltage, which is more onerous than if the over-voltages were applied on a high voltage connection point, where the intervening transformer impedance means the generating system voltage controls can reduce the over-voltage to some extent.
- It is recognised that to meet the AAS, a transformer with OLTC is required. Without a transformer with an OLTC the AAS requirements can be achieved at a higher voltage level location, beyond the upstream network transformer. An appropriate point of application of the AAS level requirement would typically be the high voltage terminals of the relevant network transformer.
- For generating systems connecting to the transmission system (HV) level a transformer OLTC allows for the voltage of the reticulation system to be regulated for the long duration over-voltages. It is therefore expected that for generating systems connected to the transmission system the AAS is applicable.
- The under-voltage requirements 70–80% and 80–90% of normal voltage of 2 s and 10 s respectively are within the typically tap change timeframes and therefore the performance requirements irrespective of the generating system’s transformer or OLTC configuration. It is considered the under-voltage AAS requirement is appropriate for all generating system connection configurations.

S5.2.5.11 – Frequency control

Rationale for final REZ Access Standard

- Under the NER, the AAS requirement for clause S5.2.5.11(b)(2) excludes the wording ‘subject to energy source availability’, while the MAS includes the dependency of the response on energy source availability.
- It is recognised that for intermittent generating systems, the primary energy source availability may be beyond the generator’s reasonable control.