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Wednesday, 23 August 2023

Australian Energy Market Operator

By email: contact.connections@aemo.com.au

Dear Ms York,

AEMO review of technical requirements for connections

Transgrid welcomes the opportunity to respond to the Australian Energy Market Operator's (**AEMO**) Draft Recommendations Update Report (Part 1) under its review of technical requirements for connections.

As the jurisdictional planner, operator and manager of the transmission network in NSW and the ACT, Transgrid supports reforms that will enable both energy and system security services to be provided to consumers at the lowest possible cost. To achieve this and remain consistent with the National Electricity Objective (**NEO**), we believe that any proposed technical amendments must be analysed thoroughly, to ensure there are no unintended consequences on the power system.

The decline in coal generation and surging renewable energy generation are reshaping our power system, changing the way it must be built, managed, and operated. Transgrid's 2023 Transmission Annual Planning Report (**TAPR**), which we will release next week, demonstrates the urgency of transitioning to a renewable energy future while ensuring energy reliability, system security and operability. A thorough connections process is essential to ensure connections to the system can be progressed as quickly and as seamlessly as possible.

Transgrid supports a review of the technical requirements for connections. We appreciate AEMO's intent to provide clarity via amendments, that ensure the standards are fit for purpose with the changing generation mix. However, given the extensive scope of the review, we strongly believe that AEMO should consider further consultations on the proposed amendments. In particular:

- The Draft Recommendations Update Report (Part 1) introduces new content that requires more time (than provided) to consider and analyse.
- The time provided for stakeholder feedback on the review does not align with the extensive nature of the review.

We have identified several areas in the proposed technical amendments, which require further consideration and consultation. Attachment 1 to this letter provides detailed comments on the individual items outlined in AEMO's Update report Stakeholder feedback template.

We appreciate the opportunity to comment on AEMO's Draft Recommendations Update Report, however we believe that further industry consultation and engagement is needed, before considering a fast-tracked rule process to the Australian Energy Market Commission. This will ensure the proposed changes are fit for purpose, and that system reliability, security and operability can be maintained throughout the energy transition.

Transgrid is committed to working collaboratively with AEMO, NSPs and broader industry stakeholders throughout the transition to a clean energy future. We would welcome the opportunity to participate in a working group, or other stakeholder forum led by AEMO, to further discuss and work through the proposed changes in an effective and cooperative way.

If you would like to discuss this submission, please feel free to contact Malithi Gunawardana at Malithi.Gunawardana@transgrid.com.au.

Yours faithfully

Kasia Kulbacka

General Manager of Network Planning

Attachment 1

Update report Stakeholder feedback template:

AEMO Review of technical requirements for connection

Stakeholders making a submission on the recommendations set out in the AEMO draft report may use the below template to provide feedback. Please consider the confidentiality disclaimer at the end of this document.

Stakeholder: Transgrid

Schedule 5.2 Conditions for Connection of Generators

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
NER S5.2.1 – Outline of requirements	
Application of Schedule 5.2 based on plant type instead of registration category and extension to synchronous condensers	• Transgrid supports the draft recommendation regarding Schedule 5.2 being applied to synchronous condensers connected by a participant other than a Generator or Integrated Resource Provider (e.g., by an NSP). Transgrid does however note that the requirements regarding negotiation of performance standards for the connection of a synchronous condenser by the NSP (As detailed in the Draft NER amendments provided in Appendix A2 to the Draft Recommendations Update Report) are not sufficiently clear. While the addition of S5.2.1(b1) sets out how the process differs for a Schedule 5.2 Participant who is an NSP, NER 5.3 will still apply (as stated in the modified table under NER 5.1.2). NER 5.3 is ambiguous when applied to an NSP connecting a synchronous condenser as it is defined with reference to the main parties being: – The Connection Applicant (the NSP connecting a synchronous condenser does not meet this definition); – The NSP (who is stated as being the recipient of a connection application, which will not be the case in this situation); and, – AEMO In Transgrid's opinion, further NER updates will be required to clearly define the process for negotiation of performance standards for the connection of a synchronous condenser by an NSP. • Transgrid also notes that in the revised recommendation, where specific technical requirements differ for synchronous condensers in each clause of Schedule 5.2 is adequate for the connection of a standalone synchronous condenser. However, it is not clear how this should be applied to a synchronous generator that is also capable of operating as a synchronous condenser (A number of existing hydro generating units in NSW have this capability). There may be situations where the performance relative to a technical requirement applicable to both modes is less than the Automatic Access Standard in one mode but not the other. This would require either: – A negotiated access standard set by the lowest performing mode, resulting in an unnecessarily low standard in the other mode. – Separate performance standards for generating and synchronous condenser modes.

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
NER S5.2.5.1 – Reactive power capability	
Voltage range for full reactive power requirement	• As previously outlined, Transgrid prefers that the existing AAS requirements remain in effect and that the negotiating framework is reinforced with the proposed amendments considering the voltage-dependent requirement for reactive power. While acknowledging the additional financial implications in meeting the current AAS for some projects, there are some projects which can meet the full reactive power capability without requiring additional equipment and associated financial implications. With the proposed amendments to the AAS, projects may unnecessarily limit their reactive power capability that can be provided at no cost to the proponent. • It is unclear to Transgrid if the mid-point voltage referred to in S5.2.5.1 is the same as the target voltage (or any other term) mentioned in S5.2.5.13. • The amendments proposed in S5.2.5.13(2B)(iv)(A) requires that plants have limiting devices to achieve S5.2.5.1, which could be interpreted as voltage dependant reactive power limits. Therefore, Transgrid believes that the proposed amendments may incentivise the implementation of voltage dependant reactive power limits at PPC level. This could lead to unnecessary limiting of reactive power control in the NEM, which could lead to the need for more FACTS devices to be procured by the Networks to provide reactive power support that would otherwise be provided by generators at no additional cost, which is inconsistent with the NEO. • The proposed draft NER amendments replace the term *rated active power* in the current Rules with the term *active power capability*; in Transgrid's view this term does not fully consider the impact of reduced number of "in-service generating units". The definition of the *rated active power* in the current rules refers to "in-service generating units", which is not referenced in the new definition of *active power capability*. Therefore, it is unclear what the reactive power requirement for a generating system or an integrated resource system is when there are reduced number of generating units are in-service. This would lead to a lack of clarity as to the expected performance of non-scheduled and semi-scheduled plants when generating units are switched out of service. Transgrid has also included additional feedback on this item under the "Definition changes" section below.
Treatment of reactive power capability considering temperature derating	• Transgrid generally agrees with the changes proposed, however does not agree with the changes made to definitions for maximum active power. Transgrid's feedback on the proposed new definitions are summarised in the "Definition changes" section below.
Compensation of reactive power when units are out of service	• Transgrid believes that with the proposed voltage impact threshold of [0.5%], plants would be permitted to operate in a wider reactive power range (and inject a substantial level of reactive power) compared to what is currently allowed under the S5.2.5.1 and S5.3.5. Widening this range could have detrimental impact on the network, requiring more investment in network level reactive power compensation devices; which does not align with the NEO. If there are multiple generating systems around the same area, the cumulative impact could be significant, especially in areas with similar renewable energy sources (e.g., areas with high solar penetration). Due to this reason, instead of specifying a fixed voltage threshold in the rules, Transgrid prefers allowing each NSP to specify a voltage threshold appropriate to their network and site-specific conditions of the connection point, as suggested by other stakeholders. • Although Transgrid does not support the requirement added in the amendments to limit the impact of the voltage to a fixed threshold of [0.5%], if fixed threshold option is pursed, Transgrid believes it's more appropriate to use the maximum system impedance in calculating the steady-state voltage impact instead of the typical system impedance proposed in the proposed amendments. Transgrid also suggests AEMO to provide further clarifications and supporting data to demonstrate how the proposed [0.5%] voltage impact threshold was determined (including empirical data if available).

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
	• Under the draft NER amendments of S5.2.5.1 (g), the term auxiliary load is marked in italic text. However, this term is not defined under the Chapter 10 - Glossary. If this only refers to the auxiliary load component, it is unclear in the Rules how the reactive power drawn/supplied by the harmonic filters, collector network or other reactive plant are to be managed, when the production units are not in-service or not generating. In Transgrid's experience, the key reason why some production units are required to remain in operation to provide reactive power compensation while not generating active power is due to harmonic filters and collector networks (e.g. solar farms at night when the filters and collector networks are still connected to the grid, some inverters may have to operate in Q at night mode to compensate this reactive power draw). There is also the option to consider switching out of harmonic filters and other reactive plant within the generating system when the production units are not in-service or not generating to minimise the adverse impacts on the network. • Transgrid's original proposal highlighted that there are two aspects of zero output that could be considered – one in which the production units are not in service, and the other in which the production units are in service but not producing. AEMO's position was that the second aspect should be managed through the main part of NER S5.2.5.1 (with a negotiated access standard if necessary). However, as highlighted in the original submission, Transgrid still suggests including some guidance in the Rules around the requirements on operation of Q-on-demand type modes to streamline the requirements across NEM, considering the fact that it is very common, particularly in solar and wind projects.
S5.2.5.7, S5.2.5.8, S5.2.5.13	
Simplifying small connections	S5.2.5.7 • Transgrid does not consider there to be any issue with the current rule, even for small connections. S5.2.5.8 • Transgrid does not have any concerns with the proposed amendments for small connections for S5.2.5.8. S5.2.5.13 • Transgrid does not have any concerns with the proposed amendments for small connections for S5.2.5.13. AEMO advisory matters for small connections • Transgrid agrees with Energy Queensland that AEMO doesn't need to completely remove themselves from advisory matters for small connections and input from AEMO helps provide a certain level of consistency across jurisdictions. Input in an advisory capacity still adds value to the connection process and doesn't necessitate significant due diligence on the behalf of AEMO.
NER S5.2.5.2 – Quality of electricity generated	
Reference to plant standard	• Transgrid supports retaining the draft recommendation to remove reference to the superseded standard.
NER S5.2.5.4 – Generating system response to voltage disturbances	
Overvoltage requirements for medium voltage and lower connections	• Transgrid supports making the point of application of over voltages the nearest HV transmission location for connections below 66 kV and not through a transformer with OLTC. Transgrid notes that this is consistent to the approach proposed for the NSW REZ Access Standards for this clause.
Requirements for overvoltages above 130%	**General feedback** • In Transgrid's view, the draft recommendation has not been adequately considered and further consultation is required. Concepts pertaining to two very different categories of overvoltage are being conflated. The two different categories of overvoltage are:

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
	– Temporary overvoltage (TOV), which is defined in IEC 60071-1 as a "power-frequency overvoltage of relatively long duration"; and, – Transient overvoltage, which is defined in IEC 60071-1 as "short-duration overvoltage of few milliseconds or less, oscillatory or non-oscillatory, usually highly damped". Note also that the term transient overvoltage has been introduced into S5.2.5.5 as part of the draft NER wording in this review. S5.2.5.5 does not deal with transient overvoltage of the nature defined above. Further consideration needs to be given to consistent use of terminology. • Proposed changes to S5.1.4 and 5.7.2 are non-trivial and require further review and consultation. Given its introduction late in the consultation, Transgrid request that sufficient time be given to review the proposal in detail. Transgrid note that this appears to be outside of the general scope for a review of "technical requirements for connection" under 5.2.6A of the NER. **Temporary overvoltage** • The overvoltage limits defined in S5.2.5.4 should be for temporary power frequency overvoltage only. • Transgrid supports inclusion of the words "at least" in defining the upper limit for temporary overvoltage up to 130% rms voltage for one cycle. This aligns S5.2.5.4 with the power frequency voltage requirements defined in the system standards (S5.1a.4). **Transient overvoltage** • While it would be beneficial to capture the ability of generators to ride through sub-cycle transient overvoltage in the GPS, this should be limited to obtaining information from OEMs on ability to ride through these events, including any transient overvoltage protection and associated inverter blocking behaviour. This would need to be in addition to the highest temporary power frequency over voltage for one cycle, not replace it. • As mentioned above, Transgrid believe that there has not been adequate consultation regarding the draft recommendation around transient overvoltage. Issues that have not been adequately addressed include: – AEMO did not make a recommendation in the draft report (3 March 2023) and instead sought input from stakeholders citing "complexities of the issue". As such, the current recommendation in the updated draft report (26 July 2023) has not been subject to the same level of consultation as the recommendations for other clauses. – AEMO has not provided sufficient basis for parts of the draft recommendation including: ○ The peak transient overvoltage limit has been set by multiplying the existing temporary overvoltage limit of 130% by $\sqrt{2}$. This gives the peak value of the power frequency temporary overvoltage, which is in no way related to transient overvoltage, as the two have very separate definitions (see above and IEC 60071-1). ○ The assertion that switching surges are of most concern has not been substantiated. ○ The use of IEC 60071-1 to define ride through requirements for generators. IEC 60071-1 is related to the voltage withstand of insulation and does not translate naturally to this application. Insulation is required to withstand conditions that generators should not be expected to ride though. – Assessment of the transient overvoltage using PSCAD: ○ For accurate results that include the whole of the generation system, including surge arrestors and transformers, the setup of PSCAD models will need consideration of Balance of Plant details more commonly applicable to insulation coordination type studies. This exceeds current modelling requirements.

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
	○ Simulations to demonstrate compliance will involve applying representative transient overvoltage waveforms at the point of application (e.g. the connection point) and modelling surge transference down to the production unit level. While transformer models have been proposed in the literature for this type of assessment, they are complex and rely on input information pertaining to the physical construction of the transformer (e.g. detailed knowledge of the core and winding geometry). This information is not readily available, and modelling of this nature is not practical for generator connections. – As per draft NER amendment proposed in Appendix A2, S5.1.4 (a1) includes new obligations on NSPs regarding network design to ensure switching of network elements does not cause connected plant to experience slow front (transient) overvoltage above a certain level. Issues with this requirement include: ○ It has been included under "S5.1.4 Magnitude of power frequency voltage". The title of S5.1.4 clearly states that the clause is applicable to power frequency voltage. It is not appropriate to include transient overvoltage requirements under S5.1.4. ○ The wording of S5.1.4 (a1) sets the requirement for "voltages above those described in clause S5.1a.4 of the system standards". S5.1a.4 of the system standards is valid only for power frequency voltages and does not define voltage limits for transient overvoltage. ○ The requirement relies on the switching surge (a traveling wave) and the resulting transient overvoltage at the connected plant being directly related. This is not the case, the transient overvoltage at the connected plant is highly dependent on the design of the connected plant, most notably surge arrester specification and placement at the connected plant. • Transgrid designs network elements in accordance with the relevant international standards (including the IEC 60071 series of standards for insulation coordination). Connected plant must also be designed to IEC 60071 to meet the requirements of S5.2.3. In Transgrid's opinion, this issue is adequately handled by the existing rules and relevant international standards. Nothing further needs to be included in the NER regarding transient overvoltage.
Clarification of continuous uninterrupted operation (CUO) in the range 90% to 110% of normal voltage	• Transgrid supports the revised recommendation on the CUO that require plant to maintain reactive power capability, and active power output (with the exception of active power reduction due to transient response, losses, energy source availability and any other reasonable factors) for voltage variations of ±10% in the range of 90% to 110% nominal voltage. • Transgrid is in favour of removal of the ramp time requirement and the associated assessment methodology requirement in the Rules. • While Transgrid support the revised recommendation for voltage variations greater than 10% within the range 90% to 110% of nominal voltage, that allows the tap-changer response to occur, the term 'temporary' should be better qualified.
NER S5.2.5.5 – Generating system response to disturbances following contingency events	
Definition of end of a disturbance for multiple fault ride through	• In general, Transgrid supports AEMO's intent in providing clarity on "end of a disturbance". • In regard to AEMO's assertion that multiple faults occurring at the same time or with 0 ms delay being a technically possible but highly unlikely event, Transgrid notes that a series of 15 disturbances occurring within a five-minute period (as currently assessed under the AAS) is a low-probability event in itself. Nevertheless, given the material impact of such an event to system security, it has been recognised that it is important to understand and record the plant capability to ride-through a multiple disturbance event. Therefore, in the same vein for the AAS requirement, at least two consecutive 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)–within the 15-disturbance sequence should be included. • Transgrid also notes that, the post fault voltage recovery behaviour in some instances may be heavily impacted by the generator response. For example, post-fault voltage dips spikes or oscillatory behaviour may be caused or exacerbated due to poorly tuned controllers causing the

NER Schedule 5.2 issue	Schedule 5.2 (Generators) – feedback on revised recommendations and relevant draft NER amendments
	voltage to move beyond the specified 90%-110% range (i.e., prolonging the disturbance or causing subsequent disturbances), even though the original disturbance has been cleared. Transgrid's understanding is that if a disturbance is prolonged or exacerbated due to poorly tuned plant response, that will be considered as a non-compliance to the CUO requirement.
Form of multiple fault ride through clause	• Transgrid is in favour of AEMO's recommendation on disclosure of MFRT limitations, supported by evidence (preferably supported by laboratory tests or HIL tests). • Transgrid supports AEMO's intent in allowing NSPs to nominate alternative/additional combinations for MFRT if deemed necessary due to connecting location. However, Transgrid believes that AEMO should consider defining a common suite of tests that would exercise the models for MFRT requirement as proposed in Option 5 of the Draft Recommendation. While this suite of tests must not be considered as an exhaustive list, it will provide the OEMs and the developers a set of testing conditions that the plant should be designed to ride-through. This can be supplemented with additional combination of MFRT test scenarios if deemed necessary by the connecting NSP, due to the connecting location. • In circumstances where NSP and/or AEMO reasonably believe there is an inadequately disclosed limitation–that may be uncovered by specific multiple contingency conditions–both AEMO and NSP should have the flexibility to request for these additional studies to be considered. However, Transgrid notes that it is not clear on what is required to be provided as 'reasonable grounds' for the additional studies. If there are in fact inadequately disclosed limitations, those limitations will be only known by the relevant OEM. If the limitations are incorporated to the modelling (in most instances this is not the case), they may be uncovered by specific multiple contingency events. NSP's should have flexibility to request for additional combinations for MFRT at the Connection Application stage if deemed necessary.
Number of faults with 200 ms between them	• Transgrid supports AEMO's revised recommendation to retain the MAS requirement, while allowing specific limitations to be carved out provided that the number of disturbances remains at six.
Reduction of fault level below minimum level for which the plant has been tuned	• Transgrid suggests recording the lowest fault level (lower than the lower bound of the fault level range for which the plant has been tuned to achieve GPS compliance) the plant can operate stably and remain connected (even if GPS compliance across others performance standards are not achievable at this fault level).
Active power recovery after a fault	• Transgrid support amend the MAS to include reference to clause 4.4.2(c1) for primary frequency response where S5.2.5.11 has been referenced in regard to a frequency disturbance response in the AAS. • The ambiguity of the term 'return' is not addressed nor removed by the new "end of disturbance" definition. The definition of "end of disturbance" affects the start time of the active power recovery measurement (as mentioned above) but does not provide any clarity on the end time of the active power recovery measurement, hence the potential misinterpretation of 'return' remains. In Transgrid's experience, proponents have misinterpreted the end of active power recovery measurement to be when active power 'settles'to 95%, not when it first reaches 95% of pre-disturbance value. Hence Transgrid suggested include definition of "recovery" to be the "first instance at which the active power reaches 95% of the pre-fault level" for instead of the ambiguous term "return". This is especially important to remove ambiguity of the performance requirements if the active power has overshoot/undershoot/oscillations while the voltage is stabilising in the 90% - 110% range.

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
Rise time and settling time for reactive current injection	• Transgrid acknowledges that the settling time is not a comprehensive measure as to the adequacy and stability of the reactive current response for complex disturbances. However, the settling time requirement provides good generalised and quantifiable assessment criteria for stability when applied to step-like voltage disturbances. Transgrid prefers to retain the performance criterion for settling time in the AAS with similar amendments as proposed by AEMO for the definition of rise time (with specific test conditions). Transgrid also notes that with the removal of the settling time requirement from the MAS, the rules are more flexible to negotiating this performance. • Transgrid supports the inclusion of the commencement time of no greater than 10ms in the AAS; however, it's noted that there is ambiguity regarding the response initiating condition in the proposed AAS. The current MAS under S5.2.5.5 (O)(2A) allows for the response initiating conditions to be agreed with the NSP and AEMO. Further comments on this are included under 'Commencement of reactive current injection' section. • Transgrid supports the inclusion of "adequately controlled" definition in the NER. However, Transgrid notes that proposed amendment S5.2.5.5 (a00) refers to plant response for transient over-voltage and transient under-voltage in defining "adequately controlled" response. As noted in our response under clause S5.2.5.4, transient overvoltage is defined in IEC 60071-1 as "short-duration overvoltage of few milliseconds or less, oscillatory or non-oscillatory, usually highly damped". The requirement under clause S5.2.5.5 is for the plants to provide an adequately controlled stable response for power frequency overvoltage or undervoltage disturbances that are typically cleared within 80ms to few seconds and is not limited to transient events. Further consideration needs to be given to consistent use of terminology, considering defined terms in relevant IEC standards.
Commencement of reactive current injection	• Transgrid supports the modified wording that specifies that reactive current response needs to commence above or below a specified voltage level at the connection point. However, with the proposed amendments under the AAS, there is some ambiguity in regard to the location at which the reactive current commencement and rise time is to be measured. Noting that S5.2.5.5 (g)(2) specifies the reactive current response requirements for a step-like voltage profile at the connection point, is the expectation that the reactive current commencement time and rise time is to be measured at the Connection Point for the AAS? Suggest providing further clarity on the location at which the reactive current commencement and rise time is to be measured for the AAS. • Transgrid notes that S5.2.5.5 (o1) MAS provides the ability for the reactive current commencement conditions to be agreed with NSP and AEMO and record in the performance standards. However, there is no such equivalent requirement under the AAS to explicitly record the reactive current commencement conditions such as response initiating condition or the location. Transgrid suggests adding an equivalent of subclause (o1) to the AAS part of S5.2.5.5, to remove ambiguity on commencement conditions and require the commencement conditions to be recorded in the performance standards.
Clarity on reactive current injection volume and location and consideration of unbalanced voltages	• Transgrid supports retaining in the AAS 4% and 6% levels for injection and absorption, however, suggests that this requirement should apply for each 1% voltage deviation of positive sequence voltage for both balanced and unbalanced faults and overvoltage disturbances. • Transgrid welcomes the S5.2.5.5 (u)(3) amendment requiring the response to unbalanced faults and overvoltage disturbances to be recorded in the GPS. However, we note that there is no quantifiable assessment criterion for unbalanced faults proposed in the amended AAS (since S5.2.5.5(f)(1)(i) and (ii) are limited to balanced faults). While the proposed amendment under S5.2.5.5(f)(1)(iii) to minimise the deviation of voltage on each phase provides the broader intent and guidance for the required positive and the negative sequence reactive current response, it is ambiguous and open to interpretation. In Transgrid's experience, lack of clarity on unbalanced fault response requirements has resulted in prolonged plant tuning and negotiations. Therefore, it is crucial that clear technical requirements are set in the AAS. Transgrid suggest applying clause S5.2.5.5(f)(1)(i) and (ii) requirement to both unbalanced and balanced faults (based on each 1% voltage deviation of

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
	positive sequence voltage) supplemented by proposed S5.2.5.5(f)(1)(iii) requirement to minimise voltage deviation on each phase. This should allow for the balancing of the voltages by providing appropriate level/s of positive and negative sequence current. • Inconsistency noted in the Draft NER amendments for S5.2.5.5(f) and S5.2.5.5(n) (i.e., between the AAS and the MAS for reactive current response). The AAS refers to positive sequence voltage deviations, while the MAS refers to voltage. • The Draft NER amendment for S5.2.5.5(o)(ii) specifies an overvoltage threshold of 115% of nominal voltage for the MAS which is the same as the overvoltage threshold specified under S5.2.5.5(g)(ii) for AAS. Given that AEMO has not specified this MAS amendment in the recommendation report, it is assumed to be a typographical error.
Metallic conducting path	• Transgrid supports the deletion of this subclause.
Reclassified contingency events	• Transgrid agrees with the amendment rule in S5.2.5.5 (t1) to expand the term credible contingency by reference to specify credible contingency events selected by the NSP for the purpose of NER S5.1.2.1.
NER S5.2.5.7 – Partial load rejection	
Application of minimum generation to energy storage systems	• Transgrid notes the amendment to minimum generation "the minimum sent out generation for continuous stable operation of a production system including each of its operating production units". The term "sent out generation" is defined in the NER as "In relation to a generating unit, the amount of electricity supplied to the transmission network or distribution network at its connection point". As AEMO asserted in the Approach paper, bi-directional units are not likely to have minimum generation for continuous stable operation; therefore, the proposed amendment in S5.2.5.7 (a0) should also apply to bi-directional systems.
Clarification of meaning of CUO for NER S5.2.5.7	• Transgrid supports the addition of paragraph (h) "A relevant system is permitted to vary its active power and reactive power to the extent required to oppose a voltage variation or frequency variation" as it makes the performance requirement clearer. • Transgrid notes that AEMO has not incorporated the revised recommendation to replace the term "be capable of" with "remain in" in Appendix A2 Draft NER amendments for clause S5.2.5.7 (c) and (d).
NER S5.2.5.8 – Protection of generating systems from power system disturbances	
Emergency over-frequency response	• Transgrid supports the prioritisation of response being: 1) continuous frequency droop control, 2) fast ramping, 3) disconnection, as well as changes to the wording on protection settings. • The Negotiated clause states that "A reduction in active power output should generally be achieved by fast ramping in preference to disconnection of production units." This does not make it clear that that "frequency droop" response is preferred over "fast ramping". Transgrid recommend including "frequency droop" in (b4) of the Negotiated standard to make this clear.
NER S5.2.5.10 – Protection to trip plant for unstable operation	
Requirements for stability protection on asynchronous generating systems	• Transgrid supports AEMO's proposed revised recommendations on clause S5.2.5.10 and, providing flexibility in the access standards for actions other than tripping to address the issue, and to allow triggers, thresholds and actions to be agreed with the relevant NSP and AEMO. In regard to the proposed NER amendments, Transgrid has following comments:

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
	– Transgrid believes that the proposed NER amendment under S5.2.5.10 (a)(2)(i) 'have the capability to detect instability in voltage, reactive power or active power at the connection point' is a deviation from the draft recommendation which states 'Must have system that can detect an instability in voltage, reactive power and active power. The latter is a mandatory requirement to be implemented, while the former is ambiguous on the implementation requirement. Transgrid suggests that the AAS requirement be clear in the rules and for removing any doubt, replacing 'have the capability to detect' with 'must have systems that can detect'. – Transgrid suggests including a clear definition of "instability" or a clear reference to types of instability that is defined under the Power System Stability Guideline. – Transgrid suggests adding 'as per agreed configuration' at the end of (2) (iii)(A) to address any future disputes on 'contribution'. The agreed configuration is expected to be considered in the design phase based on R1 data. – Transgrid notes that further clarity is required on what actions to be taken by the plant on receipt of the information from AEMO as per AAS (a)(3)(ii) and MAS (b)(2)(ii). Additionally, it would need more clarity on what 'form nominated by AEMO' in AAS (a)(3)(ii) and MAS (b)(2)(ii) would be. – Amended rules refer to pole slipping condition of synchronous condenser. Considering synchronous condensers do not a have prime mover, can AEMO clarify the conditions that pole slipping becomes relevant to syncon technology. – Transgrid recommend General Requirement (f) to include "remote enablement and disablement signals" in addition to the remote tripping signal.
NER S5.2.5.13 – Voltage and reactive power control	
Voltage control at unit level and slow setpoint change	• Transgrid supports the inclusion of limits on the rate of change of setpoints, though it is recommended that the draft wording is updated to make it clearer that the setpoint rate-limiter can be bypassed/disabled during testing and compliance assessments. • Transgrid acknowledges AEMO's legal advice that the current drafting does not preclude unit level voltage control.
Realignment of performance requirements to optimise power system performance over expected fault level (system impedance) range – Voltage control	• **It is unclear from AEMO's proposal that introducing the concept of apparent system impedance will provide any benefit over the established method of using three-phase fault levels:** – Both methods result in the tuning/assessment of the plant using a network equivalent series impedance connected to a voltage source. The only difference in outcome appears to be that the resultant impedance calculated to represent the system would be different. It is difficult to see how the use of the apparent system impedance is going to add value to this process. – AEMO notes that "AEMO is not convinced that fault level would give a suitable measure here that IBR plant tends to have limited fault level contribution, but capable of injecting reactive power up AAS level around target voltage level". Transgrid acknowledges the transient response of IBR plant and their contribution to the "voltage stiffness", but it is unclear how this is going to be adequately captured through the use of a static series impedance in a SMIB model. This comment implies that the calculated fault level is resulting in a lower level of "voltage stiffness" to which a plant is being tuned for. Transgrid believes this is a more robust approach, as the plant would be tuned to consider lower fault levels (higher system impedance conditions). – The proposal by AEMO is also likely to result in a significant amount of additional work for NSPs to calculate apparent system impedance quantities for proponents (in addition to the fault level quantities that are currently supplied). Transgrid doesn't believe sufficient supporting evidence has been provided by AEMO to demonstrate the benefit of using this method or adequate consultation has been carried out on this matter.

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
	• **Transgrid disagrees with the concept of a typical apparent system impedance for the purposes of specifying a performance standard:** – The variability of nearby generation can have a significant impact on the "voltage stiffness" of the network for a given plant. The concept of what a typical network scenario would be for these surrounding generators is too vague, especially when the surrounding plant consist of different fuel sources. – The proposal in the draft wording that a plant would need to be compliant between the nominated highest and typical system impedance, is effectively the current negotiated access standard without the specification of what that typical system impedance is. For a negotiated access standard, at some point along the range of fault levels between low to high, a plant would exceed the AAS requirement of a 2 second rise time. The current rules requirement is that the negotiated rise time is specified in the performance standards, rather than retaining the 2 second requirement and carving out a fault level (or system impedance) range for which the 2 second requirement is applicable. • **Transgrid agrees with AEMO that the response of nearby plant can have a significant impact on a plant's own response to both setpoints and disturbances:** – Transgrid recommends the use of full network models such as AEMO's OPDMS snapshots and the Connections Simulation Tool, as these are much better placed to capture the interactions with surrounding plant. As noted above, it is unclear how the concept apparent system impedance is going to provide significant benefit over using the calculated fault levels. – Transgrid considers that these tools are likely underutilised by proponents for the purposes S5.2.5.13 plant/unit level voltage control tuning. • **Transgrid disagrees with the removal of the reactive power rise time requirement for a change in voltage setpoint:** – It is understood that for some plant, all else being equal, the existing AAS objective for a voltage setpoint can negatively impact the stability of the plant due to aggressive tuning. – Transgrid proposes that the reactive power rise time requirement be applicable for a change in voltage setpoint or a step change in the voltage at the specified location. That is, retain the existing requirement, but introduce the requirement for a step change in the voltage. This would then align with the requirements for settling time. – This proposal allows for the plant performance to remain readily testable during commissioning whilst also facilitating the possibility of a negotiated access standard, where a different rise time can be agreed to for setpoints and disturbances. – The above proposal also better accommodates unit level voltage control, as the plant level and unit level responses can therefore be tuned for different objectives (slower setpoint change and faster disturbance response). • **The magnitude of the voltage step should not be specified as any voltage less than 5%:** – Not including a limit on the minimum size of the disturbance is not recommended to avoid compliance testing and requirements for very small step changes in the voltage which would have a low signal to noise ratio. – The removal of the requirement for setpoint changes, as outlined above, also make this performance criterion difficult to test onsite.

NER Schedule 5.2 issue	Schedule 5.2 (Generators) – feedback on revised recommendations and relevant draft NER amendments
	• **It is unclear from AEMO's proposal whether the intention of the rules is to allow the NSP to provide updated minimum, typical and apparent system impedance advice to a proponent, after the performance standards have been agreed, to which the plant is then potentially required to retune their plant for:** – It is unclear if AEMO's intent is that the RUG can be updated with revised system impedance values for which the plant will be required to remain compliant with, or whether the reference to the RUG in the GPS refers only to that version at the time of GPS agreement. • **As noted in the previous submission, Transgrid believes that amendments to these aspects of S5.2.5.13 are much better suited as general guidelines for a negotiated access standard:** – The introduction of a new concept should be treated with caution, especially when it becomes a required performance standard and significantly deviates from the standard methodology carried out by both NSPs and proponents. – Transgrid does not consider that AEMO has provided clear and sufficient evidence to the industry that these changes to S5.2.5.13 are going to meet the objectives of the NEO or provide a material improvement to the process of tuning plant control systems. – Transgrid believes that the current rules already provide flexibility for a negotiated access standard to be agreed upon, though the rules should be updated to provide much clearer guidance for such a negotiated standard. – It is also worth mentioning that the current rules are not overly complicated as they don't carve out system conditions for when the plant is considered compliant. It is recommended that the rules be updated to provided better guidance for a negotiated access standard and better guidance as to how to appropriately tune the plant when the plant's connection point might experience a wide range of fault levels (or system impedances).
Materiality threshold on settling time error band and voltage settling time for reactive power and power factor setpoints	• Transgrid agrees with the introduction of a materiality threshold for active power settling time in response to a voltage step or voltage setpoint. • Transgrid agrees with AEMO's intent to "avoid the calculation where it is not meaningful...", yet AEMO doesn't appear to have considered that a fixed 3 MW materiality threshold can still lead to relatively small error bands being calculated for large plant, thus leading to potential calculations which are not deemed meaningful. Furthermore: – For a large plant, a 3 MW materiality threshold can result in an extremely small tolerance to which AEMO is expecting the plant to regulate active power within. For example, if a 500 MW plant exhibited a maximum change of 5 MW in response to the step, then this would require the plant to regulate active power to back within ±0.5 MW, or ±0.1% of the rated active power. This tolerance for the settling error band is not considered reasonable, cannot be readily verified through on-site testing and does not appear to serve a useful purpose as a performance standard. – If the induced change in active power is relatively small compared to the size of the plant but above the materiality threshold of 3 MW, then a plant controller's integral gain would need to be tuned relatively aggressively to regulate the active power to within such a small tolerance. Even with the added flexibility of the updated MAS for settling time, this is not deemed to be a reasonable incentive to speed up the active power controller's response time. – Such a small tolerance bands for large plant would also prohibit plant controllers from setting reasonable deadbands around the target setpoint or only allow setting dead them to be so small as to be of no value.

NER Schedule 5.2 issue	Schedule 5.2 (Generators) - feedback on revised recommendations and relevant draft NER amendments
	• Transgrid recommends using the rated active power when determining the materiality threshold, potentially with an upper limit the maximum magnitude of the threshold. In addition, consideration should be given to an allowable deadband for the active power control response to a change in voltage setpoint. This would be in line with the setpoint accuracy requirement for reactive power control in S5.2.5.13, where the rules require that the plant only need to be able to regulate reactive power to within 2% of the rating (in MVA; expressed in MVAr).
Clarification of when multiple modes of operation are required	• Transgrid suggests retaining the existing rules requirement for the settling time for a step change in reactive power (or power factor) setpoint for the secondary control mode. The secondary control model should be appropriately tested during commissioning. Reference setpoint tests are important to verify that the plant has been turned appropriately for the mode. • Transgrid recommends that the rules have flexibility to allow for a different primary control mode, at the discretion of the NSP. The reason why this flexibility is important for the AAS, is because if a proponent proposes voltage control mode as the primary control and it is the AAS, then the NSP must accept that, as per the requirements of the NER.
Impact of a generating system on power system oscillation modes	• While Transgrid supports AEMO's intent in modifying the MAS to require the plant not to reduce the damping of any oscillation that is not adequately damped, combining this requirement with the current S5.2.5.13(d)(ii)(A) as per the proposed drafting in Appendix A2 makes application of this requirement ambiguous. For clarity Transgrid suggests S5.2.5.13(d)(ii) to be amended to: "(ii) operation of the schedule 5.2 plant production unit does not degrade: (A) damping of any oscillation mode not adequately damped; (B) any mode of oscillation that is within 0.3 nepers per second of being unstable, by more than 0.01 nepers per second; and (C) any other mode of oscillation to within 0.29 nepers per second of being unstable; and" • Transgrid supports the revised recommendation requiring the assessments to consider the required performance from the system strength service provider at the relevant system strength node, noting that paying system strength charge should not preclude the connecting plant from requiring to optimise plant design and control system tuning if stability issues are noted at the connecting location.
Other items	• Reference to apparent system impedance is not consistent throughout the NER amendments, some clauses refer to system impedance, while others refer to apparent system impedance. • AEMO has proposed to amend the definition of rise time, such that longer-term dynamics and external influences following the step change are disregarded. Transgrid agrees with this in principle noting that there is ambiguity in what constitutes 'longer term dynamics'. In addition, AEMO should clarify whether an 'external influence' is separate to the Schedule 5.2 plant entirely or can be a separate control system within the Schedule 5.2 plant (separate to the main control system controlling the change output quantity). For example, the unit level voltage control response might be subject to slower dynamics of the plant controller.
Definition – continuous uninterrupted operation	
Recognition of frequency response mode, inertial response and active power response to an angle jump	• Transgrid supports the amendments proposed to the CUO definition.

NER Schedule 5.2 issue	Schedule 5.2 (Generators) – feedback on revised recommendations and relevant draft NER amendments
	• However, as noted in the previous submission, Transgrid has seen issues with application of CUO requirement in paragraph (d), when considering inadvertent disconnection scenarios (classified as credible contingency events under S5.1.2.1) for assessing feasibility of transfer trip schemes under clause S5.2.5.8(d). This issue is exacerbated by the lack of clarity in the system standards under clause S5.1a.4 on the allowable reduction in voltage of supply at a connection point due to a contingency event. In Transgrid's view, there should be flexibility for the NSP to allow transient voltage variations below 90% of normal voltage for a limited period due to inadvertent disconnection of transmission plant, provided that there are no material adverse impacts to other connected plant.

Schedule 5.3a Conditions for connection of MNSPs

Issue	Schedule 5.3a (HVDC links) – feedback on revised recommendations and relevant draft NER amendments
NER S5.3a.1a Introduction to the schedule	
Alignment of schedule with plant-type rather than registration category	No comment
NER S5.3a.8 – Reactive power capability	
Reactive power	No comment
NER S5.3a.13 – Market network service response to disturbances in the power system	
Voltage disturbances	No comment
Frequency disturbances	No comment
Fault ride through requirements	No comment
NER S5.3a.4 – Monitoring and control requirements	
Remote monitoring and protection against instability	No comment

Issue	Schedule 5.3a (HVDC links) – feedback on revised recommendations and relevant draft NER amendments
New standards	
Voltage control	No comment
Active power dispatch	No comment

Multiple Schedules

Issue	Multiple schedules – feedback on revised recommendations and relevant draft NER amendments
NER Multiple clauses	
References to superseded standards	No further comments

NER structural amendments

Issue	NER structural amendments – feedback on revised recommendations and relevant draft NER amendments
NER structural amendments	
Drafting principles	Transgrid is intending to provide further feedback on the NER structural amendments.
Proposed approach	

Consequential amendments

Issue	Consequential amendments – feedback on revised recommendations and relevant draft NER amendments
Definitions	

Issue	Consequential amendments - feedback on revised recommendations and relevant draft NER amendments
Definitions changes	• Active power capability: The definition refers to the term "bid-validation data" for scheduled plants. Transgrid suggests to use a term that refers to the physical status of the plant, for example the number of "in-service generating units". Bid validation data is also not available to plants that are in the connection process, and not yet connected. This term has been referred in multiple clauses such as S5.2.5.1, S5.2.5.10, S5.2.5.11, S5.2.5.13 and S5.2.5.15. Further consideration should be given to how this term is used across various clauses; it appears that in some clauses the term is used as a reference to the maximum amount of active power at the connection point with all generating units in-service, while in other clauses it appear to refer to a level of active power below the maximum active power. • Continuous uninterrupted operation: Transgrid support acknowledging inertial response and PFR in CUO definition. Further considerations are outlined in the section 'Definition – continuous uninterrupted operation'. • Rise time: As per commentary for S5.2.5.13 above, AEMO has proposed to amend the definition of rise time, such that longer-term dynamics and external influences following the step change are disregarded. Transgrid agrees with this in principle noting that there is ambiguity in what constitutes 'longer term dynamics'. In addition, AEMO should clarify whether an 'external influence' is separate to the Schedule 5.2 plant entirely or can be a separate control system within the Schedule 5.2 plant (separate to the main control system controlling the change output quantity). For example, the unit level voltage control response might be subject to slower dynamics of the plant controller.
Technical changes	
Incorporating synchronous condensers	Transgrid is intending to provide further feedback on the consequential amendments.
Additions to information provision	
Relevant system - in relation to small plants exempt from some requirements	
S5.2.5.8 Over-frequency emergency generation reduction requirements	
S5.2.5.8 Protection settings and relationship to ride through clauses	
S5.2.5.8 Conditions for which the plant may trip and recording of conditions	
S5.2.5.8 Network Service Provider liability	
S5.2.5.11 Minimum operating level	
S5.2.5.11 Response direction for bidirectional units taking power from the system	

Issue	Consequential amendments - feedback on revised recommendations and relevant draft NER amendments
Drafting changes	
Drafting changes	

Confidentiality disclaimer

Under clause 5.2.6A(d)(2), AEMO is required to publish all submissions received about this Review on its website. Please identify any part of your submission that is confidential, which you do not wish to be published. Please note that if material identified as confidential cannot be shared and validated with other interested persons, then it may be accorded less weight in AEMO's decision-making process than published material. AEMO prefers that submissions be forwarded in electronic format.