Draft report Stakeholder feedback template:

AEMO Review of technical requirements for connection (NER 5.2.6A)

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Stakeholder: Organisation name

Schedule 5.2 Conditions for Connection of Generators

Issue	Schedule 5.2 Generator Recommendation feedback
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	In principle, Hydro Tasmania (HT) supports AEMO's recommendations for both parts A and B with the caveat of further review to proposed drafting (for part B) to ensure minimal drafting effort does not result in complexity that could have been avoided with part B option 3. It is noted that Hydro Tasmania has a significant number of existing NEM registered Generating Units that also operate in Synchronous Condenser mode generally to provide inertia and fault level support to the power system. These units are registered as generating units only. Although the reference in the paper appears to reference stand-alone synchronous condensers it is unclear from the proposed changes what the implementation of Schedule 5.2 requirements to 'synchronous condenser' means with respect to an existing synchronous generator that can also operate in synchronous condenser mode. Clarity around this issue is important as these generators are regularly upgraded, with revisions to the performance standards assessed under the NER 5.3.9 process. For the sake of clarity Hydro Tasmania requests that AEMO provide a clear outline of how the performance standards and related matters (do or do not) relate to Synchronous Generators that also operate as Synchronous Condensers so that a more detailed response could be considered
NER S5.2.5.1 – Reactive power capability	
Voltage range for full reactive power requirement	HT is of the opinion that the 10% centre line should not be nominated by TNSP but should be +/-5% consistent with S5.2.5.13 (2B) (iii). If the TNSP is able to nominate the centre line conflicts may arise with this clause. Furthermore, it releases the possibility of the TNSP biasing the centre line prohibitive of achieving 0.395*Pmax, and thus negating the intent of this change. The basis for this amendment is that a synchronous machine's limits for reactive power capability are fixed to plant design and not easily, if at all adjustable for existing units in so meeting MAS or AAS is somewhat academic, i.e., whilst the proponent could maximise capability, the limits are ultimately fixed by import stability limits and export thermal field thermal constraints. Furthermore, HT notes the proposal of a symmetric reactive capability requirement around a reference point does not reflect the main transformer reactive power consumption between the GS terminals and the connection point. As a result, the transformer reactive power consumption facilitates the GS leading reactive capability, but being a burden for lagging reactive capability, hence being challenging to be satisfied. For greenfield applications compliance can be resolved during the preliminary applications process.

Issue	Schedule 5.2 Generator Recommendation feedback
	In summary, HT preference would be option 2 to simplify the connection application process and encourage capital expenditure for refurbishment or renewal in that the generator will not be subject to prohibitively uneconomical designs to achieve high capability that may not be required. HT supports option 3 only based on fixed +/-5% band from nominal connection point.
Treatment of reactive power capability considering temperature derating	HT has doubts on how temperature derating would be applied in practice for synchronous machines and if it is indeed necessary. HT proposes option 1 should remain for synchronous machines where options 2 or 3 would create much unnecessary documentation, increase connection application inefficiencies and costs, and typically counter the objective of streamlining the connection process without adding any more value to the process. HT is of the opinion consideration should be given to AEMO potentially providing some criteria for exceptions. Considerations into this proposal are as follows: • In practice how will temperature derating be applied: would dynamic capability or temperature required to be transmitted to the TNSP / AEMO in real terms and/or capability diagrams created at various temperatures? • How would/should compliance be demonstrated at various temperatures, including requirements around accuracy? • Given also commissioned reactive capability may not be representative of maximum or minimum values, by applying further criteria the reactive capability may be restrictively offered to meet performance standards. For synchronous machines the true temperature derating cannot be correctly known due to limitations in determining field winding temperature, and as commissioning and compliance testing is only ever performed at the maximum temperatures obtainable at that time (e.g. following a heat-run at current ambient temperature), the full range can never be entirely known. This is particularly true for Hydro and/or other air-cooled synchronous generators.
Compensation of reactive power when units are out of service	HT supports option 2 and 6 based on streamlining the connection process. Where it is identified that the limits will not be met, HT supports option 5 to achieve minimal compliance burden but maintain flexibility in how this would be achieved once the Generator and NSP have agreed to this option.

S5.2.5.1, S5.2.5.5, S5.2.5.7, S5.2.5.8, S5.2.5.10

Simplifying standards for small connections	HT supports simplifying standards for small connections but also highlights the risk of cumulative small connections presenting a power system security issue for smaller regions (e.g., Tasmania) or intra-regional locations with low system strength. [30MW] seems somewhat of an arbitrary number and HT believes consideration should be given to either be a proportion of the regional generation capability, or possibly better a value proposed by AEMO / TNSP based on regional operational risks and constraints with agreement from regional participant. HT acknowledges that whilst this approach may result in different "MW-thresholds" within the NEM it may also be a technically sounder approach. HT also raises the potential to exploit this rule e.g., for non-synchronous or inverter-based generation comprised of multiple smaller generators feeding into a common connection point which is maintained below 30MW. This would then place the burden on the remainder of the base-load generation, i.e., if a 'small' generator is not adequately defined it could detract from future investment to large scale generators whereby multiple 'smaller' generators present a more attractive investment case, with reduced technical requirements (also goes toward cumulative small connections risk). HT believes consideration should be given to perhaps a better solution of defining small, medium and large generators with small being entirely exempt, medium needing to satisfy only the MAS for AAS, and large following normal connection requirements. But with each definition based on regional requirements. HT notes that CUO relaxation also increases cumulative risk. There is scope to relax this to a more practical level and simplify the connection process, but the intent to ensure CUO through credible event should be maintained. Without this it is inevitable a power system security risk will result. S5.2.5.1 AAS:

Issue	Schedule 5.2 Generator Recommendation feedback
	• No issue. S5.2.5.3 AAS: • Supports relaxation of any requirement for small generators once a regional based definition is established to ensure the stability of the network for frequency excursions prior to any relaxations. S5.2.5.5 AAS MAS: • Supports relaxation of any requirement for small generators once a regionally based definition is established. S5.2.5.7 AAS MAS: • As above.

NER S5.2.5.2 – Quality of electricity generated

Reference to plant standard	HT supports option 2 in principle of maintaining alignment to the current version of the standards as at time of registration for new generators or for upgrade of components to new. However, HT believes allowance should be made that a generator must only comply with the standards noted in the version of the NER as at original commissioning for an existing generator, and where generator manufacture pre-dates NER exceptions should be allowed.

NER S5.2.5.4 – Generating system response to voltage disturbances

Overvoltage requirements for medium voltage and lower connections	HT notes that this rule omits any consideration to flux capabilities of generators and supply transformers. In the case of supply transformers with online tap-changers, generator over-fluxing can be managed as secondary regulation. However, in the case of fixed or offline taps, protection of the generator must be allowed for in the connection application for existing generators. Furthermore, HT would like to highlight that by taking the (existing) maximum over-voltage and considering it to occur with (minimum) under-frequency, it is proposed that no current or future synchronous generator would be capable of CUO, and that no new synchronous machine specification would, or does allow for this due to the uneconomical specification that would result. Enforcing a rule that cannot be met without potential damage to a generator would disincentivise capital investment to modernise plant that would trigger connection application process. In summary as a general comment, HT is of the opinion that the interpretation and compliance of over-voltage, under-frequency and over-fluxing should be more clearly defined to streamline the application process. HT otherwise supports option 3 with the additional comment that provision should be allowed for MAS that requires only agreement with the TNSP.
Requirements for overvoltages above 130%	HT supports option 3, this would provide the simplest solution but requests further consultation. It should also consider worst-case under-frequency such that over-fluxing protection is also bound.
Clarification of continuous uninterrupted operation in the range 90% to 110% of normal voltage	HT nominally supports option 2 but allowance should be made for existing transformer taps which may present difficulties in achieving the reactive output specified at all voltages where tap-changers are not installed, and the transformer tap ratio is not ideally matched to the connection point voltage.

Issue	Schedule 5.2 Generator Recommendation feedback
NER S5.2.5.5 – Generating system response to disturbances following contingency events	
Definition of end of a disturbance for multiple fault ride through	HT supports option 4.
Form of multiple fault ride through clause	HT strongly supports this rule change and supports AEMO's recommendation as proposed but notes the common suite of tests should consider the following item as noted in relation to machine stability as outlined in the following subsections for this Clause. Furthermore, without any additional details on the proposed "suite of tests" at this stage consideration should be given to balancing the need for demonstrating compliance via testing vs stress put on generating units as part of testing. HT would also like to seek confirmation/clarification that the requirement "throughout the life of the plant" is limited to actual events rather than being expected to routinely test / apply faults to demonstrate compliance.
Number of faults with 200 ms between them	For synchronous generators the application of multiple close-in faults may see individually recoverable faults accumulate to irrecoverable instability due to machine inertia and governor systems and turbine control response limitations. As such the number of faults and suite of tests should be carefully determined to ensure a credible performance benchmark is established that is consistent with the intent of ensuring power system security whilst minimising academic compliance activities. HT also notes complexities may arise with identifying a credible fault scenario in relation to the standard suite of tests, and allowance should be made where multiple fault ride through is not credible (e.g., the location of the 'multiple faults' is not credible based on TNSP protection having operated to disconnect a generating unit requiring operating initiated machine reconnection).
Reduction of fault level below minimum level for which the plant has been tuned	In principle, HT supports AEMO's recommendation of options 4 and 6. However, HT would like to seek clarification, what extent would a fault level need to change for NSP to request retuning. Without any additional details or criteria, it may expose participants to excessive/frequent requests from the NSP to retune plant and/or apply setting changes even though triggering factors are outside respective participant's control. Consequently, providing a heightened level of uncertainty for participants. Furthermore, at this stage it seems unclear who would carry the financial impact of implementing changes when requested by the NSP. HT would also like to highlight the fact that for synchronous machines the sub-transient reactance of the generator and positive sequence reactance of the transformer are inherent to their design and as such do not provide much scope for fault level tuning. More generally, HT notes that while coal fired synchronous machines will gradually be phased out, the green and synchronised hydro machines will remain. This fact should be well considered and incorporated in the discussion for this Clause S5.2.5.5
Active power recovery after a fault	HT principally supports AEMO's position but shares concerns on how AEMO deals with frequency, inertial and active power response. HT believes this should not be finalised until the draft determination is published such that the exact wording to this clause can be confirmed.
Rise time and settling time for reactive current injection	HT supports options 2, 4, 5 and 6, however HT is of the opinion that the 10ms commencement time is too quick. A minimum of 20ms should be allowed, with allowance under the MAS for slower commencement times for e.g., DC rotating or brushless excitation systems (i.e., to allow investment to digital regulation technology whilst preserving power stage until further investment can be afforded).
Commencement of reactive current injection	No comment.
Clarity on reactive current injection volume and location and consideration of unbalanced voltages	HT has no issue with option 2. HT is of the opinion that options 3 and 5 should not apply to synchronous generators or 3-phase induction generators. For these types of machines this should be an outcome of the performance standard requirement of the machine as it is not possible to control voltage level for different phases. Further, this clause should also consider how the voltage regulator measures voltage as systems may measure from e.g., 'Vee' connected Vr-w and Vb-w phase only, and from this regulate to average voltage, possibly after deriving the third voltage.

Issue	Schedule 5.2 Generator Recommendation feedback
	- I.e., Synchronous machine cannot vary per-phase voltage and may not be able to respond to anything other than average voltage or positive sequence voltage based on 2 or 3 phase voltage measurement, in ph-ph or ph-e arrangement. - This could be due to regulator measuring requirements, or voltage transformer connections onsite (e.g., no 4 wire-Y connected VT). HT believes the risk to disincentivising investment in upgrading plant should be considered carefully for these clauses. With respect to option 4 HT has concerns regarding compliance testing and additional tests requirements introducing further ambiguity for little real gain. Consideration should be given whether this could be an outcome of the model / model verification only.
Metallic conducting path	HT supports option 2.
Reclassified contingency events	HT supports option 2.

NER S5.2.5.7 – Partial load rejection

Application of minimum generation to energy storage systems	HT supports option 2.
Clarification of meaning of continuous uninterrupted operation for NER S5.2.5.7	While there is no specific comment to the options proposed, HT is aware that this section has also been discussed in one of the AEMO GFM workshops with some questions raised. Take the opportunity, HT would encourage AMEO to provide some clarification on: 1) the technical intent of this assessment, particularly the specification of 30% load reduction in less than 10s. 2) whether or not the existing specification is practical to measure and to be considered as a performance reference, particularly given the power system is getting more scattered and the boundary is more blur between the generators and loads, or otherwise if there is a better definition.

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

Emergency over-frequency response	HT support option 2 and then the simplest approach to achieving the intent of this rule clause. However, regarding options 6 and 7 as previously noted a 30MW generator in the region of Tasmania should not be considered as small and that the risk to cumulative exemption of multiple 30MW generators also without PFR could be high without further study / verification of the definition.

NER S5.2.5.10 – Protection to trip plant for unstable operation

Requirements for stability protection on asynchronous generating systems	Issue 1: HT proposes the limit for exception should be regional based to best manage this risk but supports an exception. The thresholds should be regional based, proposed by AEMO and the TSNP for agreement with the market participants within that region to ensure fair and equitable distribution of investment to maintain network stability. Issue 2: HT supports the use of alternative control measures, e.g. anti-hunting detection and temporary governor lock. However, HT believes realistically guidance should be input from AEMO and/or the TNSP in relation to (1) what a proposed function would look like and (2) implemented settings as without AEMO / TNSP the connections and compliance costs for generators to determine these addition control functions would disincentivise their inclusion. However, whilst it is noted these wouldn't require inclusion if the costs and complexities are not warranted, what are the defining limits for costs and complexities being warranted, and possible borne by the connection applicant. Issue 3:

Issue	Schedule 5.2 Generator Recommendation feedback
	Following previous comment, HT supports the intent to identify these instabilities and by including the PSSG, a more flexible outcome is allowed for in further refinement to address changing network conditions over time. Issue 4: Given the provision of the MAS, HT has no objection to the proposed AAS if it is further amended to allow the detection device to include pole-slip detection for operation once a pre-determined number of pole-slips or power-swings within close proximity to the connection point has been detected by monitoring impedance trajectory. In this regard HT further supports removal of mandatory pre-emptive tripping as currently written. Whilst a generator may choose to implement this to mitigate pole-slip risk to large generators, the decision to do so should be optional (e.g. allow several pole-slip to occur prior to disconnection). Finally, HT strongly supports the TNSP to be responsible for the determination and disconnection due to unstable or oscillatory behaviour, whilst the generator should be focused only on the disconnect of plant for asset risk mitigation (i.e. pole-slipping or close in power-swings). Issue 5: HT would like to seek clarification for proposed requirement and implementation around "capability" for AEMO or NSP to send trip command. HT believes consideration should be given to balance capability for AEMO and NSP to trip machines vs stress on generator assets. Issue 6: HT has concerns with the AAS being too onerous for common recording equipment and imposes an unnecessary additional cost to the generator (e.g. refer the extremely high recording requirements for SRAS metering which HT was required to install specialist additional metering equipment to record at specifications unnecessarily high for any synchronous generator). Furthermore, it is unclear as to whether measurements are to be provided to AEMO/NSP in real time and also consideration should be given as to who would be required to pay for implementation. Issue 7: HT has no objection to the proposal. Recommendations: HT does not support compulsory PMUs under the AAS for reasons noted previously but does support the MAS

NER S5.2.5.13 – Voltage and reactive power control

Voltage control at unit level and slow setpoint change	HT has no issues with proposed amendments as options 2 and 3 are to allow additional control methods and not impose additional control methods in parallel / supplement those already in place (which meet the AAS).
Realignment of performance requirements to optimise power system performance over expected fault level (system impedance) range – Voltage control	HT supports options 3 and 7 in principle, however HT would like to seek confirmation if possible that the highest and lowest system impedance level are to be taken as at the time of application / commissioning and that future changes in network do not necessitate revisiting. HT is aware that system impedance is used in this section to describe the system electromagnetic strength or voltage stiffness. Compared with the conventional measurement - fault level, HT would believe that the system impedance has below shortfalls: 1) Disregards the system voltage amplitude impact. 2) Hard to reflect the fault level contribution from the GFM and need to distinguish GFM and GFL sources. 3) The IBR virtual impedance could be a variable. Hence, HT would like to clarify the intent of introducing system impendence in this section.

Issue	Schedule 5.2 Generator Recommendation feedback
Materiality threshold on settling time error band and voltage settling time for reactive power and power factor setpoints	HT supports options 2 and 3.
Clarification of when multiple modes of operation are required	HT supports option 2.
Impact of a generating system on power system oscillation modes	HT supports options 2, 3 and 4.

Definition – continuous uninterrupted operation	
Recognition of frequency response mode, inertial response and active power response to an angle jump	No comment.

Schedule 5.3a Conditions for connection of MNSPs

Issue	Schedule 5.3a HVDC Recommendation feedback
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.
New standards	

Issue	Schedule 5.3a HVDC Recommendation feedback
Voltage control	No comment.
Active power dispatch	No comment.

Multiple Schedules

Issue	Multiple schedule Recommendation feedback
NER Multiple clauses	
References to superseded standards	HT supports option 3.

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