Update report Stakeholder feedback template:

AEMO Review of technical requirements for connection

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Stakeholder: Solar Turbines

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	It is recommended a classification that as much as possible permits to define requirements associated to components of the unit rather than a complete system. This would help manufacturer in provide and design a suitable product, it would help integrators in complete the plant assessment, it would permit to speed up a process which seems to be frequently pretty long and complex and it would limit cost associated to compliance verification. We also consider, as a general comment, that requirement shall not necessarily be technical agnostic, but viceversa shall be tailored to best use the specificities of each technology.. This should be valid also for mixed plants (plants with multiple technologies) It is difficult to evaluate if the proposed changes would go in such direction.
NER S5.2.5.1 – Reactive power capability	
Voltage range for full reactive power requirement	• It is considered that the provided wording is not self-exhaustive without a figure (as the one in the presetantion) which shall be part of the documentation. • It is not so clear the aim of having a mid point in addition to the nominal/rated voltage which is floating within the +/-5%. It is expected that requirements will be based on nominal/rated voltage. • For synchronous generators (4-pole generators) a symmetrical reactive power limit is unusual and typical reactive power in underexcitation condition is PF 0.95, corresponding to Q/Pref 0.328 while in overexcitation condition this can range between 0.9 and 0.8 (corresponding to Q/Pref 0.484 respectively 0.75). Such values could be used as a better reference, in particular for requirements on the underexcitation side since higher Q/P values will lead for bigger generators (longer generator shaft).
Treatment of reactive power capability considering temperature derating	It is not clear in which format the derating factor shall be represented (or maybe any representation is acceptable) or how the requirements is stated. In the draft recommendation Update report dated 26th of July 2023 (see page 14 of the pdf) it is indicated that the there are three main variants possible. At present they seems not to be integrated in the draft document. For the sake of clarity any specific variant shall be clearly specified by the relevant party to which the plant shall be connected to. The information shall be made publicly available and it is not expected to change when applying for connection. That would permit manufacturer to properly quote a solution that is in line with what is requested. Later change would lead to unnecessary costs.

NER Schedule 5.2 issue	Schedule 5.2 (Generators) – feedback on revised recommendations and relevant draft NER amendments
	Regarding the requirements, reactive power capability is normally defined for a reference power (for Gas Turbine for example it can be used Prated at ISO condition); reactive power capability corresponds to such a value and it is valid considering voltage range and operational temperature. It has also to be noted that AVR limiters are typically fixed values or characteristic (static); dynamic characteristic can be found as function of voltage (eg underexcitation limiter) in advanced AVR, not as function of temperature. Operational capability may be affected on how limiters can be set for properly protecting the generators. That is to say that limiters can frequently be considered the operational limits at any given condition.
Compensation of reactive power when units are out of service	There could be multiple reason for which a generating plant is not in operation, but basically this can be summed in market driven reasons or maintenance/repairing/modifying activities. There are also multiple plant type (pure generation, mixed pure generation, Combined Heat & Power, part of industrial plant) that can drive the requirements and the way this shall be fulfilled. In case of market driven reasons and for pure generating plant, the system is most probably completely off or it will be on minimum loads to keep it operational. It is not considered that any requirement shall be applicable in such condition. In case of reactive power becomes a system need it is recommended to create an appropriate ad-hoc market for reactive power and inertia. In case of maintenance/repairing/modifying activities of pure generating plant, where a single unit is present, then no reactive power requirement has to be considered. When multiple units are present, then the expectation is that the overall reactive power requirement decreases as a function of the units connected. Basically the Pref used for calculating the reactive power contribution is function of the number of units connected, it is not economically viable to install a compensating system to keep on with such activities and there is merit to used the resources available instead of having the complete generating plant off. Different consideration can be made for CHP plant and generating plants embedded in industrial power plant when the generation is considered a by-product and the target could be the Heat (steam) production. When generating plant is disconnected from the grid (both for market reason or for maintenance/repairing/modifying activities, it is likely the plant will still be a generation or load to the grid. It is still recommended that reactive power requirements remain proportional to the operational generation when exporting (or when the generation is in operation). In case all generation is off then the applicable requirement shall be of a load.
S5.2.5.7, S5.2.5.8, S5.2.5.13	
Simplifying small connections	•
NER S5.2.5.2 – Quality of electricity generated	
Reference to plant standard	
NER S5.2.5.4 – Generating system response to voltage disturbances	
Overvoltage requirements for medium voltage and lower connections	Additional note to stated requirements • (2), (3) are unlikely to be field testable for generating units for generating units that shall be field tested. Therefore that would be based on manufacturer declaration from manufacturer. It is recommended to have this clearly stated.
Requirements for overvoltages above 130%	• AAS peak voltage of at least 184% of nominal voltage… and a fast overvoltage (lightning impulse) at the connection point.. This should correspond to a lightning event and associated protection and capabilities shall be addressed as part of the design of an electrical installation, correspondent AS or IEC std shall be used to define protection against overvoltages in such installation. The reference std provide much more detailed information associated to component capabilities than the indicated std This has not to be addressed in a Grid Connection requirement except for introducing a reference to such std and the fact such protection shall be installed in the plant (other than the mentioned IEC 60071-1) (Note that IEC 60071-1 refers to low voltage system up to 1 kV; point of connection is 66kV or above)

NER Schedule 5.2 issue	Schedule 5.2 (Generators) – feedback on revised recommendations and relevant draft NER amendments
Clarification of continuous uninterrupted operation (CUO) in the range 90% to 110% of normal voltage	Looking at Draft Recommendation, there is mention to reactive power capability within the normal voltage range (and outside it). It seems this is covered in S5.2.5.1. Makes sense to have reference to S5.2.5.1 when it comes to voltage deviation.
NER S5.2.5.5 – Generating system response to disturbances following contingency events	
Definition of end of a disturbance for multiple fault ride through	20ms when voltage is within +/-10%Un seems too short, but also not consistent in defining the system in stable condition for active power recovery (most probably the voltage is still obscillating leading to associated power measurement obscillation). That would allow to consider the end of the disturbance when the voltage happens to just recover to 90% Un. It is recommended that the end of the disturbance is normally considered when the voltage is considered back to stable condition (eg not obscillating and within +/-5%Un from nominal). This definition is needed to apply for any associated requirements. Some general remarks to the proposed draft S5.2.5.5 (c) (1), (2), (3) / The requirement identify fault condition, but it does not provide detailed information regarding clearing times and typical grid set-up and therefore it is not possible to assess generating unit capability in advance. The requirement is pretty generic so it is difficult to provide any answer, less a statement of compliance for manufacturers. / The requirements provide no obligation to look for an optimization on the protection settings by the relevant parties (including system operator) which is desirable for lifecycle of the generating unit and for the safety (availability) of the system. It is recommended to add a note in such respect (worst case scenario shall in any case be based on best achievable protection scenario for the generating unit, protection settings shall be set with the best possible configuration from generating unit perspective). / It is recommended to create a pre-defined grid system to be used as reference for proving compliance and correspondent system characteristics and clearing times. This shall be based on the list of events as described in the definition of credible contingency event in S5.1.2.1. S5.2.5.5 (c) (4) There is a general indication on 3-phase, two phase to ground, phase to phase or phase to ground fault in distribution network cleared in (i) "the longest time expected to be taken for the breaker fail protection system to clear the fault" / breaker failure protection is triggered to open the circuit breaker above the one that did not open (the protection can be delayed). Stated this way the requirements does not impose any obligation in keeping the time for coordinating protection to the minimum requested, which cannot be acceptable. Please provide clear obligation stating that primary protection time and associated breaker failure protection shall be set to the minimum viable; in case of time longer than 250ms, settings shall be coordinated in cooperation with the schedule 5.2 plant owner. (ii) "if a protection system referred to in subparagraph (i) is not installed, the greater of 430 milliseconds and the longest time expected to be taken for all relevant primary protection systems to clear the fault, .." / 3-phase fault for synchronous generating units directly connected to the distribution system (without any step-up transformer between the generating unit and the grid) the requested 430ms (as specified it seems this time can be even longer) is an unrealistic requirement since it is not associated to a voltage dip curve. Such long time can be expected for 3-phase faults far away from the plant (corresponding to voltage dip dropping to max 50% Un and on a grid consistently strong 8-10 times the nominal power of the generating unit). / any fault at the connection point will separate the generating plant from the grid, meaning the generating plant will not be able to remain connected from the grid; It is recommended for claity sake to add such condition to the text. / It is recommended to create a pre-defined grid system to be used as reference for proving compliance and correspondent system characteristics and clearing times. "S5.2.5.5 (e) (1) supply to or absorb from the network, to assist the maintenance of power system voltages during the fault, capacitive reactive current, in addition to its pre-disturbance reactive current, of 4% of the maximum continuous current of the generating system or integrated resource system including all

NER Schedule 5.2 issue	Schedule 5.2 (Generators) – feedback on revised recommendations and relevant draft NER amendments
	operating synchronous production units and synchronous condensers (in the absence of a disturbance) for each 1% reduction (from the level existing just prior to the fault) of connection point voltage voltage during the fault;" / Synchonous generators and AVR during fault do not control reactive power or current injected. The AVR reacts to support the voltage looking at the voltage input error (out of the +/-10% Un and as described in AEMO presentation as primary control). The wording drafted seems to try to describe a minimum expected behaviour (is it possible to get this confirmed?). If the above understanding is not correct, it is expected a more detailed explanation of what is requested defined on the specific technology component (typical generator representation, typical AVR etc.). If the understanding is correct it is recommended to replace the wording in the chapter by stating that -the synchronous generators are expected to support voltage during a system event (voltage below 90%Un) by injecting current in the system above their rated current. "S5.2.5.5 (e) (2) supply to or absorb from the network, after clearance of the fault, reactive power sufficient to ensure that the connection point voltage voltage is within the range for continuous uninterrupted operation under clause S5.2.5.4; and .." Same comment as above, the requirement seems inconsistent with the control behaviour expected during faults in case of voltage deviation. Synchronous generating units use AVR control which, when voltage is out of boundary, has the voltage control function becoming predominant above all other controls (except limiters). This corresponds to the primary voltage control as in AEMO presentation.
Form of multiple fault ride through clause	• See above comments to the disturbances requirements described in S5.2.5.5(c). • 3-phase automatic reclosure shall be as part of the credible contingency event scenario, however they shall not separate (and reconnect) the generating plant to the grid • (4) the requirements in S5.2.5.4(a)(7) and a(8) foresees both voltage ranges (eg a(7) voltage between 80%Un and 90%Un and 10sec and a(8) voltage between 70%Un and 80%Un and 2sec) it is not clear if only one event shall be tested (ed 78%, 2sec) or two events need to be triggered. It seems the requirement is for a single event • It is possible to get a recommendation of the event to be tested, but as indicated above, it is recommended a credible contingency event scenario (single line diagram with grid representation) to be provided with the correspondent event and grid characteristic information. It is recommended involvement of manufacturers in defining such requirements. • It is recommended also to define a credible list of events pre defined sequence, however system information shall be as well properly defined. It is recommended involvement of manufacturers in defining such requirements. • S5.5.2.5 (l) (9) There is reference to a fault level for which the generating plant has been tuned. It is recommended to better specify what "tuned" means (primary control mode vs secondary control mode? Protection settings?).. Note also that normally fault level is considered the Scc or Icc (eg fault level specified for MV distribution), however it is not clear if this is the intention here. Whereas fault level is expected with a different meaning, it is recommended to replace "a three-phase fault level at the connection point" with "a 3-phase fault causing the voltage to drop at the connection point...
Number of faults with 200 ms between them	S5.2.5.5(c) calls for faults that belong to credible contingency events. Is this a realistic credible scenario? 6 consecutive faults each withing 200ms do not seem applicable for a system based on reliable design. In addition no further detail regarding such events is provided. In general all events (faults) as they are described in S5.2.5.5(d) are expected to happen in a very short time in the proximity of the generating unit, which seems unusual. A different and more realistic approach is recommended. See comments above on event proposal and grid scenario proposal.
Reduction of fault level below minimum level for which the plant has been tuned	This requirement is not clear not the draft wording or in the Draft Recommendation Update Report Specifically, it is not clear what is the lower range for which the plant had been tuned (primary control mode vs secondary control mode? Protection settings?). It is recommended to remove the requirement or better define the expectation or at least better define what is the expected tuning.

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Active power recovery after a fault	• See comments above. Active power recovery shall be expected after transient condition which do not corresponds necessarily to voltage within +/-10%Un and +20ms and +100ms. That's particularly true for system with inertia.
Rise time and settling time for reactive current injection	• During fault and for synchronous generating unit, the initial generator reaction is based on the behaviour of a rotating machine, then the AVR reacts to a voltage input error by increasing the excitation current to support the voltage. • AVR dynamic behaviour can be assessed as step voltage response, however this behaviour does not consider the initial reaction of the synchronous generator during an event. • The reactive current injected is not a controlled variable, but a by product of the AVR reaction reading an input voltage error. AVR performance is not normally evaluated based on reactive current injection, but by measuring the voltage behaviour against the a voltage setpoint step variation.
Commencement of reactive current injection	It is recommended to indicate that the AVR shall be set to react above 85%Un in case of undervoltage and below 115%Un in case of overvoltage.
Clarity on reactive current injection volume and location and consideration of unbalanced voltages	Note that synchronous generators and AVRs do not control reactive current injection on the single phases (unless the generator is 1-phase). It is recommended to define appropriate requirements considering synchronous generators technology.
Metallic conducting path	-
Reclassified contingency events	See comments on credible contingency events above.
NER S5.2.5.7 – Partial load rejection	
Application of minimum generation to energy storage systems	-
Clarification of meaning of CUO for NER S5.2.5.7	-
NER S5.2.5.8 – Protection of generating systems from power system disturbances	
Emergency over-frequency response	Some comments to the drafted requirement • The AAS requesting a power reduction of 50%Pref in 3s is not realistic for synchronous generators with inertia of size of more than 4 MW (most probably even less), much less applicable for bigger power units. • Power reduction with such fast ramp rates does not necessary lead to stable operating condition and in general has consistent power undershoot. They can result in very nervous behaviour of the generating unit that will tend to initiate large power reduction also for limited frequency deviation ad associated instability. • The requirement as it is stated seems to be targeting only the Pmax and 3s scenario. It is recommended to re adapt the requirement (at least for synchronous generators) so that the generating unit/generating plant shall reduce its active output power as fast as technically feasible and such capabilities shall be documented and recorded, as also suggested in the presentation slides. • It is also strange that AAS specifies such a fast requirements that seems non practical for synchronous generators and other technologies, but almost slow for inverter based technology (eg in Germany inverter technology are expected to reduce power of 50%Pref in 2s, wind units are expected to reduce 20%Pref in 5s, while synchronous generator 45%Pref in 8s, but with the exception of Gas Turbine and reciprocating engine for which is requested a ramp rate of 20%Pref per minute). • Note that the requirements does not describe any other condition different from power reduction in overfrequency, therefore std ramp rates are expected for any other behaviour.
NER S5.2.5.10 – Protection to trip plant for unstable operation	
Requirements for stability protection on asynchronous generating systems	-

NER Schedule 5.2 issue	Schedule 5.2 (Generators) – feedback on revised recommendations and relevant draft NER amendments
NER S5.2.5.13 – Voltage and reactive power control	
Voltage control at unit level and slow setpoint change	Voltage Control response time is compatible with 2.5 sed for a 5%Un variation. However fine tuning of gains could be needed.
Realignment of performance requirements to optimise power system performance over expected fault level (system impedance) range – Voltage control	Reactive power and Power Factor response time is normally expected longer being a secondary loop control. The requirements proposed in the Draft Recommendation Update Response of 2s seems to be unrealistic being faster than the requirement of the core loop (some AVR provide reactive power control as input to the voltage loop). Typically fast response time is around 5s (eg typical value in Germany); shortest response time of 3s associated to Q(U) control could lead to system voltage obscillation (reactive power deviation on big units is able to modify the voltage inducing a counter reaction etc.). Not clear reference to impedance value in the Presentation slides (to be possibly explained)
Materiality threshold on settling time error band and voltage settling time for reactive power and power factor setpoints	•
Clarification of when multiple modes of operation are required	Signal leading to control mode switching shall be defined. This shall include how the switching shall happens.
Impact of a generating system on power system oscillation modes	The proposed modification/addition is not clear. Better clarification is needed to provide feedback.
Definition – continuous uninterrupted operation	
Recognition of frequency response mode, inertial response and active power response to an angle jump	• Natural behaviour for synchronous generating expected to be already in line with requirements.

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	
NER S5.3a.8 – Reactive power capability	
Reactive power	
NER S5.3a.13 – Market network service response to disturbances in the power system	
Voltage disturbances	

Issue	Schedule 5.3a (HVDC links) – feedback on revised recommendations and relevant draft NER amendments
Frequency disturbances	
Fault ride through requirements	
NER S5.3a.4 – Monitoring and control requirements	
Remote monitoring and protection against instability	
New standards	
Voltage control	
Active power dispatch	

Multiple Schedules

Issue	Multiple schedules – feedback on revised recommendations and relevant draft NER amendments
NER Multiple clauses	
References to superseded standards	

NER structural amendments

Issue	NER structural amendments – feedback on revised recommendations and relevant draft NER amendments
NER structural amendments	
Drafting principles	
Proposed approach	

Consequential amendments

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

Issue	Consequential amendments – feedback on revised recommendations and relevant draft NER amendments
Definitions	
Definitions changes	
Technical changes	
Incorporating synchronous condensers	
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	It is not clear how the "proportional response" has been proposed in the draft (proportional response is not 50%P deviation in 3s). It would be good to better detail such alternative.
S5.2.5.8 Protection settings and relationship to ride through clauses	Enlarging protection setting does not necessarily reinforce system resilience, but it could rather limit generating unit lifecycle and availability. In the document it seems there is not much emphasys in appropriate grid system design optimization or protection scheme optimization in order to limit the event and protect important assets as generating units. Some examples of possible improvements: - Optimization on fault clearing delay times associated to contingency event; - System optimization to reduce the occurrence of almost contemporary multiple events (protection scheme definition), if the requirements of so many multiple events in such a short time shall be considered credible)
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	
Drafting changes	
Drafting changes	

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