



# **Advisian Submission Regarding AEMO's proposed rule changes for the Generator technical performance standards**

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**Project No: - – Advisian Submission Regarding**

**AEMO's proposed rule changes for**

**the Generator technical performance standards:**

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## 1 Introduction

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Advisian acknowledges the challenges faced by AEMO in managing the changing power systems within Australian power networks, and supports the need to review the technical standards to ensure they are sufficient.

Advisian have prepared this overview of AEMO's proposed changes to the technical requirements that generating systems need to meet in Chapter 5 of the NER in response to a request from the AEMC.

## 2 Methodology

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Advisian carried out the task of reviewing the proposed rule changes in the following simple manner:

- A working document was created that tabulated all the proposed rule changes contained in the document "Electricity Rule Change Proposal – Generator Technical Requirements – August 2017". This working document has been attached in Appendix A.
- Two subject matter experts reviewed the proposed rule changes against the previous rules to ensure clear understanding and clarity.
- Comments were written for each proposed rule change in a separate comments column.
- Feedback has been provided on specific proposed rule changes.

In addition, the AEMC has prepared a questionnaire which allows respondents of the proposed rule changes to make submissions based on principles used to govern the National Electricity Market. Advisian has completed this questionnaire which has been attached as Appendix B.

## 3 Key Findings

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The key findings are as follows:

### 3.1 Summary

The rules proposed by AEMO appear to create several issues for the industry should they be implemented as drafted.

The issues that Advisian have identified are as follows:

- Advisian believes there appears to be a lack of alignment between the proposed changes to the rules and the national electricity objective potentially creating uncertainty as to the basis of the rules and therefore allowing greater interpretation around implementation. This could create disparity in relation to connection requirements across different NSPs.



- Some of the proposed rule changes appear to be impossible for generation plant to meet, or are more related to characteristics of the network than those of the generators. Advisian believe this is a very serious issue and not just because they cannot be physically achieved. There is the possibility of reputational damage to the Australian power industry that would arise if the rules were passed, and then found to be unworkable. This could have a negative impact on investment because investors would lose confidence in the ability of the industry to manage technical change.
- The principles for the rules regulating the connection of generators to the NEM have been well established by AEMO's former organisation NEMMCO - the proposed rules do not uniformly align with these established and industry agreed approaches. Advisian believe that this could also have a negative impact on investment because investors may perceive this as an unnecessary change in well-established prior practice within the industry, and radical changes will lead to investor uncertainty.
- If the rules were to be passed as drafted, Advisian believe they would place unusually onerous requirements on new and (if clauses were not grandfathered) existing generation. We believe some of the requirements are so onerous they could prevent many projects from being able to proceed, and add significant cost to any remaining. This approach would clearly not deliver power at a low cost and security of supply because it will severely limit the number of projects that will be financially viable.
- In Advisian's opinion, the proposed rules present technical issues to particular forms of generation in many instances, although the types of generation that are disadvantaged are dependent on the rule in question. Some rules will prevent the connection of synchronous machines of all types; others prevent the connection of inverter connected plant. In combination as is discussed in this document, a literal interpretation of these proposed rules in their entirety would prevent the connection of all new generation plant.

### **3.2 Lack of Alignment with the National Electricity Objective**

The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to—

- (a) price, quality, safety, reliability and security of supply of electricity; and
- (b) the reliability, safety and security of the national electricity system.

As an example where the National Electricity Objective (NEO) is not met, the proposed new clause 5.3.4A requires a generator proponent to meet automatic access unless it cannot be practically achieved.

**Clause 5.3.4A** Automatic access can always be achieved (if physically possible) if expensive resources are allocated; this clause seems to insist that these be instigated which is contrary to providing an installation which meets technical and cost requirements as is laid out in the NEO.



Specifically, the clause makes no allowance for price, quality, safety, reliability and security of supply of electricity produced by the generation plant, which is the first part of the NEO.

### **3.3 Physicality of proposed rules**

Two specific rule changes, those for clause S5.2.5.1 and S5.2.5.5 put requirements on new generator connections which would typically be physically impossible to comply with.

**S5.2.5.1 Reactive power capability** – The new clause requires that the generator be able to control the voltage at the connection point and specifies a range. The minimum access requirement is likely to be physically impossible if the generation system is connected to a strong fault level point on the system which would mean it cannot affect system voltage to any significant degree.

The original intent of this clause may have been to describe how a generating system can control voltage under open circuit conditions, but the text of the proposed rule does not make this distinction.

#### **S5.2.5.5 Generator response to disturbances following contingency events**

This clause required generation to be able to stay on line for fifteen disturbances within five minutes in all of the possible combinations of scenarios.

Due mainly to system transient stability considerations, no known generation technology can possibly guarantee compliance with this clause for all possible combinations of scenarios. There is also the obvious practical consideration to consider which is that if fifteen faults occur within a five minute period then the transmission system will likely have several lines tripped and locked out. If this happened within a single region the transmission system could fail and a blackout ensue regardless of the response of generation plant simply because the transmission would be insufficient to supply the load.

This clause puts the onus for compliance wholly on the individual generator. In real world power systems the ability to ride through faults is shared between the network protection systems (fault clearing times), network impedances and the interactions with other generators. This must be modelled and analysed in order to determine what the most appropriate transient design should be, and what contingent conditions can be safely ridden through.

### **3.4 Lack of Alignment with previously agreed Principles**

NEMMCO the antecedent organisation of AEMO engaged with industry in order to create general principles to guide the drafting of generator performance standards, these are listed below and the proposed rule changes are compared with the guiding principles.



The main issue to consider is that if the industry decides to deviate from these well-established principals and adopt an approach which differs significantly from past practices, there may be an adverse on attracting future investment for power system generation developments.

**Principle 1** *Technical standards must provide for adequate*

- a. *Power system security;*
- b. *Quality of supply; and*
- c. *Reliability of supply.*

This principle summarizes the second point of the NEO which has been discussed above.

**Principle 2** *Minimum automatic and mandatory standards should be defined so that the performance requirements are consistent with the impact of the plant on the power system*

In Advisian's opinion, the proposed rule changes overturn the agreed approach which had three levels of compliance:

1. A generating unit or generating system complying with the automatic access standard cannot be required to provide a higher performance standard. The automatic standard represents the maximum level of performance that could reasonably be expected.
2. A unit or generating system complying with a minimum standard should, at least, "do no harm" to the performance of the power system as a whole, although a higher standard may be required to meet the specific technical requirements of the Network Service Provider (NSP) or NEMMCO, which may arise from considerations about the specific location of the generating system, and potential interactions with other plant.
3. By insisting on automatic access or by rewriting the minimum access requirements so they are almost identical to automatic access, the previously agreed approach has been ignored.

**Principle 3** *Terminology used must support appropriate application. Where technically appropriate performance should be measured at the connection point*

Advisian believe this Principle has been ignored most specifically in the proposed clause **S5.2.6 Monitoring and control requirements**. In this clause AEMO is requesting monitoring well beyond the connection point.

**Principle 4** *Avoid technology-specific terms, unless necessary to clarify requirements for particular technologies*

- *Where possible write clauses in terms of technology non-specific terms so applicable when new technologies emerge*
- *Aim to achieve equivalent requirements for different technologies*



In some cases the proposed rules attempt to apply a different technical requirement on synchronous vs asynchronous generation which is contrary to this well established principle.

***Principle 5 Provide clear guidance on the basis for negotiation***

- *Intent of clause*
- *Factors to be considered*

Advisian believe the new rules attempt to avoid negotiation altogether by insisting on automatic access standards.

***Principle 6 Changes must include appropriate transitional arrangements***

If the new rules were to be adopted, Advisian believe a two tier system of generation requirements would necessarily come into being as the generation on the system will not be compliant. Necessarily they would have to be grandfathered which would favour incumbents over new entrants which will have significant commercial implications.

***Principle 7 Changes must be technically justified***

- *Need to demonstrate adequate technical justification for change*

*Must consult with industry, power system experts and specialists from any new technology that the changes seek to incorporate*

In the proposed rule changes, Advisian believe AEMO have not demonstrated technical justification for many of the proposed changes, specifically the clauses:

- S5.1a.4 Power Frequency voltage
- S5.2.5.1 Reactive Power Capability
- S5.2.5.3 Generating system response to frequency disturbances
- S5.2.5.4 Generating system response to voltage disturbances
- S5.2.5.5 Generating system response to disturbances following contingency events
- S5.2.5.11 frequency control
- S5.2.5.13 Voltage and reactive power control
- S5.2.5.14 Active power control
- S5.2.5.15 System Strength
- S5.2.6 Monitoring and control requirements

Advisian has provided a detailed commentary on each of these rule change clause proposals in Appendix A.

The initial proposed clause 5.3.4A in particular is of concern.





*"A connection applicant submitting a proposal for a negotiated access standard under clause 5.3.4(e), clause 5.3A.9(f) or paragraph (h)(3) must provide with that proposal evidence (to AEMO and the Network Service Provider's reasonable satisfaction) that it is not practicable for the applicable plant to achieve the relevant automatic access standard (including where there is a material risk that the applicable plant will be damaged if the level is set higher than a specified level)."*

Excluding physically impossible requirements automatic access can always be achieved if expensive resources are allocated however this clause seems to **insist** that these be instigated which is contrary to the principal of providing a fit for purpose cost effective installation which meets the necessary requirements of the power system and the market.

It is unclear whether this clause requires a generator to be prepared to accept damage from system operation or be allowed to trip to prevent damage. Other clauses discussed below seem to imply the former interpretation was meant.

Advisian recommend this clause be reworded to comply with the intent of the National Electricity Objective.

### 3.5 Impact on Generation Assets

Assuming the clauses which require non-physical capabilities are amended, the main impact the proposed rules will have will be to increase the costs associated with generation plant compliance.

A cause for concern is the disregard expressed for the possibility of equipment damage, and the non-acceptance of this as a reason not to set protection at a high level. This would force the generator into applying dangerous settings which could potentially have severe health and safety consequences in addition to the potential to permanently damage generation plant.

### 3.6 Discriminatory impacts

In an attempt to ensure a reliable and secure system the rule proposal put forward by AEMO discriminates in many ways against new technologies such as solar, wind and batteries by writing rules around the technical behaviour of synchronous generators.

In many cases the rules discriminate against new entrant synchronous generators. In particular, the voltage control and fault ride through and short circuit ratio provisions are impractical and, if implemented, would effectively prevent all new generation being connected to the system.

### 3.7 Specific Rule Commentary

In Advisian's opinion, significant issues of physicality, safety, consistency of treatment and unnecessary allocation of resources for different generation technologies have been identified in the analysis.

Specifically:

#### **S5.3.4A**



The proposed changes to **Clause 5.3.4A** require generators to meet automatic access unless there is a practical reason why they cannot be met. Excluding physically impossible requirements, Automatic access can always be achieved if expensive resources are allocated; this clause seems to insist that these be instigated which is contrary to the principal of providing a cost effective installation which meets the necessary requirements of the power system and the market.

Advisian recommend this clause be reworded to comply with the intent of the National Electricity Objective which is listed below for reference.

***National Electricity Objective***

*The objective of this Law is to promote efficient investment in, and efficient operation and use of, electricity services for the long term interests of consumers of electricity with respect to—*

- (a) price, quality, safety, reliability and security of supply of electricity; and*
- (b) the reliability, safety and security of the national electricity system.*

**5.3.4A Advisian Suggestion**

Advisian propose this change be rejected as drafted because it is clearly in contradiction to the National Electricity Objective.

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**S5.8.4**

Proposed changes to **Clause 5.8.4** draw a distinction between normal power flows and reversal of power flows. There appears to be an inconsistent approach to connections to a distribution network which cause export to the transmission network relative to connections which may have been prior but does not cause a reversal of power flow.

The key issue is not whether a power flow reversal occurs or not but whether a significant change to power flows on the distribution network is likely to cause a network operational management issue or not. By focusing on an arbitrary threshold of power reversal, the key issue is being missed.

**5.8.4 Advisian Suggestion**

Advisian suggest this proposed change be redrafted to better reflect the key issue which is whether substantial changes to power flows cause an issue on the network or not.

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**S5.1a.4**



Proposed changes to **S5.1a.4** significantly raise the voltage levels that generators must remain connected. These power frequency overvoltage requirements appear to be very onerous and many generators currently connected to the system will not be able to meet these over voltage levels without sustaining damage.

No justification above a 115% level has been offered and there does not appear to have been any investigation of what the impact this change will have on generation plant. Advisian also note that the proposed changes to the voltage standards seem to exceed long established industry standards such as ANSI and IEC requirements.

#### **S5.1a.4 Advisian Suggestion**

Advisian counsel that this proposed change be rejected by because if adopted it would put plant at risk which could severely impact on power system reliability, and personnel safety.

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#### **S5.2.5.1**

The proposed changes to **S5.2.5.1 Reactive power capability** require generators to be able to change the voltage levels in very prescriptive ways at the point of connection - The minimum and automatic access requirement is likely to be physically impossible if the generation system is connected to a strong fault level point on the system which would mean it cannot affect system voltage to any significant degree.

Potentially the minimum access standard could be more onerous than the automatic access standard which appears to be against the guiding principles previously understood for generator performance standards.

#### **S5.2.5.1 Advisian Suggestion**

Advisian recommend this proposed change be rejected by because it fails to take into consideration how power systems actually behave and is unphysical.

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#### **S5.2.5.3**

Changes to the clause **S5.2.5.3 Generating system response to frequency disturbances** makes the clause confused. For the minimum access standard there appears to be an inconsistent treatment of synchronous vs asynchronous generators. The interpretation could mean that there is no minimum access requirement for non-synchronous generators.

The negotiated access clause is ill-defined and is more dependent on the system parameters than on the generator parameters and will be ineffective in practice.



### **S5.2.5.3 Advisian Suggestion**

Advisian propose this change be rejected because it discriminates against asynchronous generation in removing the possibility of registering under minimum access requirements. This is contrary to the general principle that the rules be technology neutral as far as possible.

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### **S5.2.5.4**

Changes to the clause **S5.2.5.4 Generator response to voltage disturbances** – In Advisian's opinion, the proposed clause provides little difference between the minimum and automatic access standards.

This clause is already confused in its intent and the redrafting appears to have made the requirements less clear. One sentence in the clause seems to imply that generators cannot reduce their power output by more than 100 MW regardless of system voltage level. This is clearly a violation of basic physics and appears to have been mistakenly drafted.

Although not explicitly detailed in the text of the rules, the way AEMO and some NSP's have already been interpreting this clause (and the clause for automatic access) in practice is contrary to normal engineering design in that they require the generation plant to operate at rated output even if the connection point voltage is low – which would typically overload the current rating of most generation plant. (E.g. by requiring the generator to continuously output ~ 110 % of its current rating whenever the voltage falls to 90%).

### **S5.2.5.4 Advisian Suggestion**

Advisian counsel that the proposed change to the minimum access standard be rejected by AEMC.

The changes to the negotiated access standard appear arbitrary and the clause should be redrafted to make it clearer.

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### **S5.2.5.5**

Changes to the clause **S5.2.5.5 Generator response to disturbances following contingency events** require generators to stay on line for 10 – 15 disturbances within a five minute period for all of the possible combinations of scenarios.

This is impractical, no known existing generator technology is able to stay on line for fifteen disturbances within five minutes in all of the possible combinations of scenarios, due to system transient stability considerations, and compliance with this clause depends more on the transmission system remaining intact than on generator response.



The obvious issue with this clause is that it puts the onus for compliance wholly on the generator and none on the network or market operators. In actual power systems the ability to ride through faults is dependent on the network protection systems (fault clearing times), network impedances, the interactions with other generators and the envelope of operation. This must be modelled and analysed in order to determine what the most appropriate transient design should be, and what contingent conditions can be safely ridden through.

Engineering practice has always been to design for ride through after one fault so long as the fault is cleared within a clearly defined period (normally the backup protection clearance time).

#### **S5.2.5.5 Advisian Suggestion**

Advisian counsel that the proposed change be rejected by AEMC for the reasons set out above. Specifically the clause imposes impractical requirements on all generating plant and fails to consider the actual technical behaviour of power systems during faults.

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#### **S5.2.5.7**

The proposed change to **S5.2.5.7 Partial Load Rejection** – removes the requirement on the NSP's to consult with AEMO which seems to allow NSP's to avoid consultation with AEMO for Negotiated Access standards.

#### **S5.2.5.7 Advisian Suggestion**

Advisian question the proposed changes particularly the removal of the NSP's to consult with AEMO. The reasons for making this change are not clear and appear likely to cause issues.

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#### **S5.2.5.11**

The clause **S5.2.5.11 Frequency Control** has been redrafted.

There is confusion about specific requirements in the redrafted clause which need to be clarified.

#### **S5.2.5.11 Advisian Suggestion**

Advisian believe the proposed changes should be redrafted to make the intent clearer in some areas as discussed above.

The industry as a whole has been struggling with the concept of system frequency control, not necessarily because it is technically difficult but because the FCAS market is ill-designed and being disrupted by new technologies. A root and branch reform of this part of the NEM is required to resolve the various issues.



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### **S5.2.5.13**

The clause **S5.2.5.13 Voltage and Reactive Power Control** has been redrafted to make it complex and unclear.

In Advisian's opinion, there is much confusion and duplication in this clause. Requirements that are physically impossible to meet have been repeated in this clause which will make it un-workable.

### **S5.2.5.13 Advisian Suggestion**

Advisian counsel that the proposed change be rejected by AEMC for the reasons set out above. Specifically, the impractical requirements on all generating plant and the incorrect technical assumptions that have been made. Many subclauses are unclear with respect to their actual intent; the clause should be redrafted to make the intention clear.

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### **S5.2.5.14**

**S5.2.5.14 Active Power Control** - The 30 MW requirement has been removed and this could cause very small generators to be required to meet these requirements which is contrary to established practice, and would lead to increased costs being imposed on small generation systems.

### **S5.2.5.14 Advisian Suggestion**

Advisian suggest the proposed change be rejected by AEMC for the reasons set out above. Specifically, the onerous requirements on small scale generating plant which would make small installations non-commercially viable.

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### **S5.2.5.15**

A new clause **S5.2.5.15 System Strength** has been added. The clauses requirements are not practical for any generation system connected to the system via an inverter. The clause requires a generation system to provide at least 3 times its rated current when supplying a system fault. This would require overrating inverter connected plant by a factor of nearly 3 which would greatly increase the cost of the installation.

The clause does not allow for an engineering assessment to be made to clarify if the network requirements are met or not, which would be a more cost effective approach.

### **S5.2.5.15 Advisian suggestion**



Advisian counsel that the proposed change be rejected by AEMC for the reasons set out above. Specifically the impractical requirements on inverter based generating plant which would make the installations non-commercially viable or result in a misallocation of resources leading to an unnecessarily more expensive power system.

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#### **S5.2.6.1**

##### **S5.2.6.1 Remote Control and Monitoring**

This clause seems to simplify existing requirements.

In Advisian's opinion, there is very little difference between Minimum access standards and automatic access standards. This appears to be an example of placing excessive and expensive technical constraints on generation requirements.

##### **S5.2.6.1 Advisian Suggestion**

Advisian counsel that the Minimum access requirements be rejected by AEMC because if this clause were to be mandated in the NEM it would lead to an over investment in new generation assets or would make them uncompetitive with existing assets already registered (and presumably grand fathered from the effects of this clause). This would lead either to a gold plated fleet of generation assets, or prevent any further generation developments being implemented, ultimately causing the system to be run down with old assets and eventual failure.

The Negotiated access standard for this clause is superfluous given that Minimum access and automatic access requirements are virtually the same.

## **3.8 Simplification of existing generator performance requirements**

In direct discussions with the AMEC, Advisian stated that we believe the generator connection schedules of the rules could be much simplified if a root and branch reform were to occur and the relevant clauses were rearranged in a more logical format. A brief outline of how this could be implemented is presented in **Appendix D** of this submission.

## **3.9 Concluding remarks**

The rules proposed by AEMO appear to create several issues for the industry should they be implemented as drafted.

The issues that Advisian have identified are as follows:



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- Advisian believes there appears to be a lack of alignment between the proposed changes to the rules and the national electricity objective potentially creating uncertainty as to the basis of the rules and therefore allowing greater interpretation around implementation. This could create disparity in relation to connection requirements across different NSPs.
- Some of the proposed rule changes appear to be impossible for generation plant to meet, or are more related to characteristics of the network than those of the generators. Advisian believe this is a very serious issue and not just as they cannot be physically achieved. There is the possibility of reputational damage to the Australian power industry that would arise if the rules were passed, and then found to be unworkable. This could have a negative impact on future investment as investors lose confidence in the ability of the industry to manage technical change.
- The principles for the rules regulating the connection of generators to the NEM have been well established by AEMO's former organisation NEMMCO - the proposed rules do not uniformly align with these established and industry agreed approaches. Advisian believe that this could also have a negative impact on investment because investors may perceive this as an unnecessary change in well-established prior practice within the industry, and radical changes will lead to investor uncertainty.
- If the rules were to be passed as drafted, Advisian believe they would place unusually onerous requirements on new and (if clauses were not grandfathered) existing generation. We believe some of the requirements are so onerous they could prevent many projects from being able to proceed, and add significant cost to any remaining. This approach would clearly not deliver power at a lower cost and higher security of supply because it will severely limit the number of projects that will be financially viable.
- In Advisian's opinion, the proposed rules present technical issues to particular forms of generation in many instances, although the types of generation that are disadvantaged are dependent on the rule in question. Some rules will prevent the connection of synchronous machines of all types; others prevent the connection of inverter connected plant. In combination as is discussed in this document, a literal interpretation of these proposed rules in their entirety would prevent the connection of all new generation plant.

Moreover, Security, Reliability, Affordability and Sustainability of the National Electricity Market were the key aims defined by COAG and investigated in the Finkel review going forward for the NEM. In this regard:

- **Security and Reliability** – Advisian believe that the proposed rule changes will have a negative impact on security and reliability for AEMC simply because many of the requirements are impractical and betray an alarming lack of understanding of power system behaviour.
- **Affordability** – Advisian believe the proposed rule changes will have a negative impact on affordability because many of the new requirements impose unnecessary costs on generation plant.
- **Sustainability** - Advisian believe the proposed rule changes will have a negative impact on sustainability for AEMC because many of the new requirements impose unnecessary limits on





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converter connected plant which is usually the way new energy technologies of wind, solar and battery technologies are interfaced to the power system.



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## **Appendix A Working Document**

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## **Appendix B Responses to AEMC Questionnaire**

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## **Appendix C    Response to Redrafting of Rules advised 24/10/2017**

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AEMO have clarified and made some changes to the drafting of the rules. The changes are listed below for reference. Advisian is of the view that the clarifications make little change to the original submissions and suggest they should be treated in accordance with our original analysis.



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## **Appendix D Proposed approach for a revised Draft of the Generation Connection Requirements**

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In direct discussions with the AEMC (18<sup>th</sup> October 2017), Advisian indicated that a root and branch reform of the generator connection requirements could be implemented which would greatly simplify the existing rules and address many of the issues of the proposed rules addressed herein. This appendix briefly sketches out how such an approach can be realised.

For NER version 99, the table of contents of the conditions for connection of generators is as follows:

## **Schedule 5.2 Conditions for Connection of Generators**

S5.2.1 Outline of requirements

S5.2.2 Application of Settings

S5.2.3 Technical matters to be coordinated

S5.2.4 Provision of information

S5.2.5 Technical requirements

S5.2.5.1 Reactive power capability

S5.2.5.2 Quality of electricity generated .

S5.2.5.3 Generating unit response to frequency disturbances

S5.2.5.4 Generating system response to voltage disturbances

S5.2.5.5 Generating system response to disturbances following contingency events

S5.2.5.6 Quality of electricity generated and continuous uninterrupted operation

S5.2.5.7 Partial load rejection

S5.2.5.8 Protection of generating systems from power system disturbances

S5.2.5.9 Protection systems that impact on power system security

S5.2.5.10 Protection to trip plant for unstable operation

S5.2.5.11 Frequency control.

S5.2.5.12 Impact on network capability

S5.2.5.13 Voltage and reactive power control

S5.2.5.14 Active power control

S5.2.6 Monitoring and control requirements

S5.2.6.1 Remote Monitoring

S5.2.6.2 Communications equipment.

S5.2.7 Power station auxiliary supplies

S5.2.8 Fault current



There is a lot of duplication inherent in these sections of the rules which have developed over several years due to various revisions applied to address various issues. This has resulted in needlessly complex arrangements for the analysis and negotiation of generator connections.

When the table of contents shown above is examined from a systems perspective it can be seen that many of the separate headings can easily be consolidated. A suggested approach is given below which if adopted would effectively consolidate approximately 15 rules into 5, significantly increasing opportunities for clarity and decreasing the possibility of internal contradictions.

**Rule A – Generation system or energy storage device rating.**

This issue is currently dealt with in several sections of the rules which leads to much confusion and is often a difficulty in negotiations between the generator proponent, the NSP's and AEMO. It is common for plant to be overrated in terms of reactive power and power capability because the current rule provisions have been poorly drafted with little or no consideration of the actual needs of the network, and do not take account of recent changes in technology, e.g. inverter connected plant, battery systems or reactive plant.

We propose the following approach to redrafting the rule be applied:

- The *steady state* P-Q generator capability curve at nominal voltage and +/- 10% voltage at the connection point be proposed by the generator, and agreed to or not by the NSP's and AEMO. If the proposal by the generator is deemed insufficient, by either AEMO or the NSP than they must provide a valid technical reason for rejecting the proposed capability curve.
- The generation system shall be able to operate anywhere within the nominated P-Q capability curve if sufficient power or energy is available. The rating is the rating, the rules should prevent "rating creep" which currently occurs due to poorly defined or interpreted rulings about power and reactive power capabilities under different system voltage or ambient temperature conditions.
- The generator may offer to provide some funding of additional reactive plant on the network in order to support the transmission network in facilitating additional power transfer across the network if it is needed for the proposed generator connection.
- Currently the rules covering power and reactive power allow for Automatic, Negotiated and Minimum access levels. Advisian suggest the Automatic and Minimum access levels be removed and replaced with a single negotiated access approach. This reflects the fact that power and reactive power capability is linked and is network connection point dependent. We believe arbitrary limits are not appropriate in such circumstances.

Following on from the basic design parameters of the generation plant defined by the P-Q capability diagram, the control of the generation plant under normal operating conditions must be defined and agreed to by the affected parties.

Advisian recommend splitting the steady state power and reactive power control features, and avoid discussion of response to transients until rule 3. As power, reactive power, frequency and voltage transients cannot be physically separated from each other, we suggest they be treated together in one rule.





### **Rule 1 – Control and Capability of power output under normal operating conditions**

In this rule we propose discussion and definition of the following issues:

- Control modes ( constant power, constant speed, constant inverter frequency)
- Control to nominated set points – **dispatch ability of the generating system**
- Steady state response to changes in power system frequency

The current scheme of applying minimum, negotiated and automatic access requirements should be maintained for this rule.

### **Rule 2 – Control and Capability of reactive power output under normal operating conditions**

In this rule we proposed discussion and definition of the following issues:

- Control modes, constant voltage, power factor and constant Var
- Steady state Control to nominated set point
- Reactive power sharing and applied limits, e.g. AVR droop
- Transformer tap changing controls
- Steady state Control of any static reactive plant, e.g. synchronous condensers, capacitor banks, SVCs or Statcoms.

The current scheme of applying minimum, negotiated and automatic access requirements should be maintained for this rule.

### **Rule 3 – Response of generation system to power system transients and disturbances**

Currently this issue is covered by several rules, e.g.:

S5.2.5.3 Generating unit response to frequency disturbances

S5.2.5.4 Generating system response to voltage disturbances

S5.2.5.5 Generating system response to disturbances following contingency events

S5.2.5.7 Partial load rejection

S5.2.5.8 Protection of generating systems from power system disturbances

S5.2.5.9 Protection systems that impact on power system security

S5.2.5.10 Protection to trip plant for unstable operation

S5.2.5.11 Frequency control.

S5.2.5.12 Impact on network capability

S5.2.8 Fault current

From the physical viewpoint of the generator, there is no *conceptual* difference between a system disturbance caused by switching or by the application of a system fault. The rules currently create such distinctions which may be known about after an event, but during an event all that is known is



that there is some sort of system disturbance which the generator is reacting to. Dividing the required generator response into several different categories (as is currently done) creates the risk of contradictions arising in the rules which then form a potential to cause confusion during connection negotiations.

Accordingly, it is suggested that all of the rules listed above be consolidated into one simplified approach.

The considerations covered by this rule should include:

- The amount and duration of fault contribution of the generating system to an external system fault. (This also addresses some of the issues associated with system strength).
- The response of the generation system to voltage disturbances caused by credible and non-credible contingencies
- The response of the generation system to system frequency disturbances caused by credible and non-credible contingencies
- The ability of the generation system to reject load and regulate system frequency and voltage in the event of a system islanding situation.

It is common to apply prescriptive requirements to each of these considerations, which are often derived from typical responses produced by synchronous generators. Advisian suggest that rather than applying approaches which are often ad-hoc, or based around behaviour of synchronous generators the requirements be drafted around what the network requirements actually are.

Suggested guiding principles being:

- a. Fault level contribution to be sufficient to operate power system protection systems but not so much as to cause existing switchgear rupture ratings to be exceeded.
- b. Reactive power injection sufficient to help support the network for remote faults (to be defined) or network switching events but not so much as to cause excessive over voltages after removal of the disturbance.
- c. Power and energy injection (rejection) during under (over) frequency events sufficient to provide *proportionate* support the network so that combined with other generation, the system security provisions are met, but not so much as to cause excessive frequency control over shoot.
- d. The generation system able to supply a portion of the network if it is islanded from the main network and the remaining load is less than the capacity of the generation plant to supply.
- e. The stability of the generating plant after a disturbance, and the ability of the plant to detect unstable operation and take corrective action or trip as required.
- f. The generation plant to remain stable and respond appropriately during power swings caused by events external to the generating plant.



**Advisian**

WorleyParsons Group

**Submission to AEMC  
Advisian Submission Regarding  
AEMO's proposed rule changes for  
the Generator technical  
performance standards**

Various generation systems will be able to address these issues to a greater or lesser degree depending on the details of the technologies used. Accordingly we suggest for this rule that the current approach of applying minimum, negotiated or automatic access requirements be retained.

**Rule 4 – Power Quality**

This rule will cover power quality issues such as voltage flicker, harmonics etc. as currently covered by:

S5.2.5.2 Quality of electricity generated.

S5.2.5.6 Quality of electricity generated and continuous uninterrupted operation

It is suggested that the provisions currently discussed in S5.2.5.6 relating to power output be moved to Rule 1 or Rule 3 as appropriate.