RULE CHANGE

Australian Energy Market Commission

CONSULTATION PAPER

National Electricity Amendment (Emergency under-frequency control schemes) Rule 2016

National Electricity Amendment (Emergency over-frequency control schemes) Rule 2016

Rule Proponent(s)

Minister for Mineral Resources and Energy (South Australia)

8 September 2016

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About the AEMC

The AEMC reports to the Council of Australian Governments (COAG) through the COAG Energy Council. We have two functions. We make and amend the national electricity, gas and energy retail Rules and conduct independent reviews for the COAG Energy Council.

Contents

1 Introduction

These rule changes relate to the effectiveness of emergency frequency control schemes. These schemes represent the last line of defence to protect the power system and prevent major blackouts from occurring due to sudden system disturbances.

Currently, these schemes automatically shed load in an orderly, coordinated manner to arrest a sudden frequency drop.[1] They are an integral part of the overall framework for maintaining the security of the NEM power system.

The Rules already establish frameworks for emergency frequency control schemes. The South Australian Minister for Mineral Resources and Energy (the proponent) has proposed a number of changes to these frameworks. The proponent considers these changes will make the frameworks effective in the face of the significant changes underway in the power system.

These rule changes are related to a broader package of work being progressed by the Australian Energy Market Commission (AEMC or the Commission) and the Australian Energy Market Operator (AEMO) related to power system security. This chapter provides a brief overview of that package of work, and how these rule changes are related.

1.1 A period of change in the NEM

The electricity industry in Australia is undergoing a fundamental transformation. The last decade has seen a rapid rise in the penetration of new generation technologies, such as wind farms and rooftop solar. In the past, these technologies accounted for only a small fraction of total electricity supply. Now they are a critical part of our power system, and their significance is continuing to grow.

As these technologies make up an increasing proportion of Australia's electricity needs, challenges in maintaining power system security are emerging. The AEMC and AEMO are therefore undertaking various work packages to address these challenges so the NEM continues to deliver a secure and reliable supply of electricity to consumers.

Emerging system security issues

System security refers to maintaining the power system in a secure and safe operating state, to manage the risk of major supply disruptions. It deals with the technical parameters of the power system such as voltage, frequency, the rate at which these might change and the ability of the system to withstand transient faults.

A number of physical parameters must be controlled to maintain the electricity system in a secure operating state. In particular, rapid changes in the frequency of the power

1 A special protection scheme has been implemented in Tasmania to facilitate shedding of generation following the credible loss of Basslink. However, as this scheme relates to management of frequency following a credible contingency, is it not classified here as an emergency frequency control scheme.

system can lead to instability in the system. This instability can lead to major blackouts if not addressed.

Large spinning conventional generators, such as coal, gas and hydro, resist large rapid changes in frequency and increase system strength. These are known as synchronous generators, as the rotation of their large generation units is synchronised to the electrical frequency of the power system. Expressed another way, the speed of the physical spin of the generating units is directly linked to the speed of the electrical frequency. This link means that the large physical mass of these synchronous units will tend to resist, and therefore slow down, the speed of any changes in electrical frequency. This effect, known as inertia, can support the stability of the power system by helping to maintain a consistent operating electrical frequency. [2]

Less conventional forms of electricity generators, such as wind and rooftop solar, are not synchronised to the electrical frequency of the power system. As such, they are limited in their ability to dampen rapid changes in frequency or respond to sudden large changes in electricity supply or consumption and may not provide as much inertia as synchronised generators.[3]

The shift to less conventional forms of generation and associated inertia issues has been more pronounced in some regions of the NEM. South Australia, in particular, has experienced a substantially faster potential rate of change of frequency (RoCoF) than other regions as increasing volumes of non-synchronous generation is integrated. Increases to the capability of interconnection with Victoria have also increased the potential impact of these issues. While the interconnector can support frequency stability during normal operation periods by sharing inertia from other regions, if it trips and separates South Australia from the rest of the NEM, this may cause excessive RoCoF if there is insufficient synchronous generation online in South Australia at that time.

1.2 Impacts on emergency frequency control schemes

These changes may impact on the effectiveness of existing emergency frequency control schemes. In particular, the reduction in system inertia and related increases in RoCoF may mean that existing schemes are not fast enough to arrest a sudden frequency change.

This is exacerbated by the potential impacts of increased penetration of distributed energy resources, such as rooftop PV. This is because increased distributed energy resources may reduce the amount of actual load that is available to be shed by emergency frequency control schemes, and can also change the direction of power

2 A more detailed description of synchronous / non-synchronous generators, inertia, frequency and power system security is provided in the consultation paper of the AEMC's System Security Market Frameworks review, available at www.aemc.gov.au

3 The currently installed technologies are not designed to provide inertia. However, there may be opportunities for these technologies to provide inertia support. This is being considered as part of AEMO's FPSS work and will also be considered in the AEMC's System Security review.

system flows. Due to the way that existing schemes have been physically implemented historically, they may not be able to account for these changes.

These impacts on emergency frequency control schemes are discussed in Chapter 2.

Emergency frequency control rule changes

The proponent has submitted these rule change requests as part of a broader package of rule changes. This package includes two rule change requests related to emergency frequency control schemes:

- the Emergency under-frequency control schemes rule change (described in Attachment B of the rule change request as the Emergency frequency control schemes - for generation deficit events rule change); and
- the Emergency over-frequency control schemes rule change (described in Attachment C of the South Australian rule changes as the Emergency frequency control schemes - for excess generation events rule change).

The package also includes two rule change requests related to rates of change of frequency and system strength. These rule change requests will be progressed as part of the AEMC's System Security Market Frameworks review (the System Security review).

The AEMC has prepared a single consultation paper to facilitate public consultation on these two emergency frequency control rule changes, which are closely related to one another.

These two rule changes propose a number of changes to the frameworks for emergency frequency control schemes. The proponent considers that these changes will support the security of the power system and assist in the process of adapting to the ongoing changes in the generation mix.

This paper:

- sets out a summary of, and a background to the two rule changes proposed by the proponent;
- identifies a number of questions and issues to facilitate the consultation on this Rule change requests; and
- explains the process for making submissions.

These rule change requests relate to issues that have to date arisen primarily in South Australia. Much of the discussion therefore refers specifically to South Australia. However, these issues may arise in other jurisdictions as the power system continues to change, particularly jurisdictions susceptible to separating from the rest of the power system. Assessment of these rule change requests will therefore consider the materiality of issues and applicability of solutions in the context of all participating jurisdictions of the NEM.

2 Background

This chapter provides an overview of the current power system issues emerging in the NEM, as well as the ongoing Australian Energy Market Operator (AEMO) and AEMC system security work programs. It also describes current arrangements for managing frequency in the NEM, including schemes for the management of extreme frequency events.

2.1 The changing NEM power system

The NEM is currently going through a period of significant change. This has involved the retirement of many large, centrally dispatched synchronous generation units, coupled with the entry of significant volumes of non-synchronous intermittent generation (including an increasing amount of distributed generation). New approaches for the maintenance of power system security will be required for a number of reasons, including:

- reduced system inertia which increases the susceptibility of the electricity system to high rates of change of frequency for which existing system security services under normal operating conditions are unable to effectively respond;
- reduced system strength in certain areas of the network which may mean that generators may not be physically able to meet their national electricity Rules (NER or the Rules) defined technical performance standards under some circumstances and may therefore be unable to remain connected to the system at certain times; and
- rates of change of frequency may be too fast for existing emergency frequency control schemes to operate effectively. Furthermore, an increase in distributed energy resources may also mean that existing schemes are less effective in shedding load to control frequency.

This chapter provides a brief overview of the current arrangements for managing frequency in the NEM, as well as a brief overview of broader system security issues. A more detailed summary of system security issues is provided in the consultation paper of the AEMC's System Security review.[4]

2.2 Current arrangements for management of frequency in the NEM

The Rules currently set out a number of obligations on AEMO for the maintenance of system frequency within specific limits.

4 See: http://www.aemc.gov.au/Markets-Reviews-Advice/System-Security-Market-Frameworks-Review

2.2.1 Maintenance of frequency during system normal, credible and non-credible contingencies

In an alternating current power system, generators export and consumers use electricity within a given frequency band. Generating equipment and some loads are finely tuned to operate at specific frequencies, so it is important the entire power system remains within this frequency range.

One of AEMO's key obligations is to maintain the power system in a secure operating state, which includes keeping system frequency within the normal operating frequency band.[5]

While AEMO aims to keep system frequency within this band, actual frequency levels are affected by events that change the supply / demand balance. Increases in supply relative to demand will tend to increase the frequency, while decreases in supply relative to demand will tend to decrease the frequency. AEMO utilises different tools to maintain or return the system to the normal operating frequency band, depending on the nature of the event that has disturbed the frequency.

Minor disturbances during normal operation

When the power system is operating normally, minor fluctuations in supply and demand occur within each 5 minute dispatch interval. These variations can move the frequency away from the normal operating frequency by a small amount. To manage this, AEMO procures specific services from generators and loads, known as "regulation" raise and lower FCAS, and coordinates their use to maintain the frequency within the normal operating frequency band.

Credible contingency events

From time to time, the power system may experience more significant disturbances, where there is a temporary and unexpected imbalance of supply and demand. These disturbances, which AEMO considers reasonably likely to occur, are known as credible contingencies and may be caused by events such as the loss of a single generator, single load or a single line in the network.[6]

AEMO is required to maintain the power system frequency within the operational frequency tolerance band when these kinds of events occur, and must return the

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5 The frequency requirements that AEMO must meet are defined in the NER and the power system security standard (known as the frequency operating standard (FOS)) determined by the Reliability Panel. NER Chapter 10 defines the normal operating frequency band as: the range 49.9Hz to 50.1Hz or such other range so specified in the *power system security standard*.

6 NER clause 4.2.3(b) defines credible contingencies as: a *contingency event* the occurrence of which *AEMO* considers to be reasonably possible in the surrounding circumstances including the *technical envelope*. This definition goes on to describe examples of credible contingencies as: the unexpected automatic or manual *disconnection* of, or the unplanned reduction in capacity of, one operating *generating unit*; or the unexpected *disconnection* of one major item of *transmission plant* ... other than as a result of a three phase electrical fault anywhere on the *power system*.

frequency to the normal operating frequency band within a specified time period.[7] To do so, it procures contingency raise and lower FCAS, which increase or decrease the frequency in response to these more significant frequency variations.[8]

Non-credible contingency events

More rarely, the power system can experience very significant disturbances to the supply/demand balance. These events, which AEMO considers are not reasonably likely to occur, are known as non-credible contingencies and may include the simultaneous loss of multiple generators, or the loss of interconnection with a neighbouring region.[9]

Currently the Rules do not allow AEMO to procure FCAS or constrain generation dispatch in anticipation of non-credible contingencies. Instead, AEMO and network service providers (NSPs) utilise under frequency load shedding (UFLS) schemes.

2.2.2 Under frequency load shedding schemes

UFLS schemes are emergency mechanisms that are designed to arrest a fall in frequency. They operate only during rare events (usually following a non-credible contingency)[10] where a drop in frequency has not been arrested by FCAS.

UFLS schemes typically consist of a series of relays linked to circuit breakers, which progressively disconnect load blocks in response to a frequency drop. This disconnection occurs in a coordinated and automatic manner that is designed to arrest frequency drop and begin the process of restoring frequency to the normal operating frequency band.

These schemes include specific responsibilities for different parties, including:

- Jurisdictional System Security Coordinators (JSSCs), who advise AEMO of the priority in which loads can be shed when UFLS schemes are activated, and any restrictions on the shedding of sensitive loads;[11]

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7 Chapter 10 of the NER defines the operational frequency tolerance band as: The range of *frequency* within which the *power system* is to be operated to cater for the occurrence of a *contingency event* as specified in the *power system security standards*. The actual values of this range, and related time periods for restoration, are established in the FOS.

8 These contingency FCAS are measured in terms of how rapidly they respond to restore the system to the normal operating frequency. They include 6 second, 60 second and 5 minute frequency raise and lower services. They are typically provided by dispatchable generators who act independently of AEMO to increase or decrease output in response to frequency changes.

9 NER clause 4.2.3(e) defines a non-credible contingency as: a *contingency event* other than a *credible contingency event*. The definition then describes examples of non-credible contingencies as: three phase electrical faults on the *power system*; or ... simultaneous disruptive events such as: multiple *generating unit* failures; or double circuit *transmission line* failure (such as may be caused by tower collapse).

10 The exception to this is in South Australia, where load shedding can occur in response to certain credible contingency events.

- AEMO, who develops load shedding procedures for each jurisdiction which adhere to the schedules defined by the JSSC; and[12]

- NSPs, who are required to ensure that sufficient load is under the control of under-frequency relays at the frequency settings developed by AEMO, to ensure that in the event of the sudden, unplanned simultaneous occurrence of multiple contingency events, the power system frequency does not move outside of the extreme frequency tolerance limits. During an under-frequency event, these loads are automatically disconnected in accordance with the procedures established by AEMO. This requirement is set out in NER clause S5.1.10.1. The primary obligation on NSPs is to ensure that sufficient load is available for shedding. This is relevant to considerations of whether the current NER are unclear in terms of obligations on NSPs

- Market customers with expected peak demand at their connection point in excess of 10MW, who are required to provide automatic interruptible load. The level of this interruptible load is required to be a minimum of 60% of their expected demand, or at a level determined by the Reliability Panel.[13]

Under the current NER arrangements, AEMO is obliged to return the power system to a secure operating state following ***any*** contingency event, including all non-credible contingency events.[14] This may include restoring the power system following a range of different events, including the loss of interconnection between two regions to the simultaneous trip of every generating unit within a region. There are very different probabilities associated with these different events. This issue is discussed in further detail in section 5.2.2.

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11 NER clause 4.3.2(f) sets out the processes whereby the relevant JSSC provides AEMO with a schedule of what loads should be shed following a credible contingency.

12 NER clause 4.3.2(h).

13 This requirement is set out in NER clause 4.3.5. The proponent has argued that this clause "does not reflect the practical implementation of load shedding arrangements". This issue is considered in more detail in Chapter 5.

14 This obligation is established in the NER and the Frequency Operating Standards. This includes clause 4.3.2, which places an obligation on AEMO to: achieve the *AEMO power system security responsibilities* in accordance with the *power system security* principles. NER clause 4.2.6(c) then sets out these principles, which include a requirement that: Adequate *load shedding* facilities initiated automatically by *frequency* conditions outside the *normal operating frequency excursion band* should be available and in service to restore the *power system* to a *satisfactory operating state* following significant *multiple contingency events*. The FOS also require AEMO to maintain the frequency of the power system within the extreme frequency excursion tolerance limits, for any multiple contingency event.

2.2.3 Management of over frequency events

Currently, the Rules only describe emergency schemes to manage frequency drops following a non-credible contingency; there is no equivalent mechanism in the Rules to deal with increases in frequency due to a non-credible contingency.[15]

To date, the impacts of over frequency events have been less material than under frequency events, as the size of relevant contingencies have been smaller. Over frequency events also typically result in generators tripping, which acts to lower the frequency. Mostly over frequency events have been managed through measures such as FCAS.

The Rules do place some requirements on generators to have the capability to ramp down their output following an over frequency event. However, this applies only to generators connected after 2007.[16] Furthermore, the Rules do not include any framework that describes the way in which generators should be shed following a non-credible contingency.

2.3 Relevant policy developments in power system security

There are several work programs underway that consider these power system security issues, including:

- AEMO's Future Power System Security (FPSS) program;[17] and
- The AEMC's System Security review.[18]

The matters explored in these projects are relevant to the issues that will be considered in assessment of this rule change.

2.3.1 Technical power System Issues - FPSS work program

AEMO established the PSI TAG group in 2015 to help identify some of the technical issues related to system security. This group consisted of representatives from

15 An over-frequency mechanism has been introduced in Tasmania. This mechanism is not explicitly accounted for in the NER. This mechanism is used to manage the tripping of Basslink as a credible contingency.

16 Clause S5.2.5.8(a)(2) of the NER requires generators with nameplate capacities in excess of 30MW to "have facilities to automatically and rapidly reduce ...*generation*...by at least half, if the *frequency* at the *connection point* exceeds a level nominated by *AEMO*...by reducing the output of the *generating system* within 3 seconds, and holding the output at the reduced level until the *frequency* returns to within the *normal operating frequency band*.

17 See: https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/FPSSP-Reports-and-Analysis

18 See: http://www.aemc.gov.au/Markets-Reviews-Advice/System-Security-Market-Frameworks-Review

consumer groups, industry, regulatory bodies and government. Based on the initial issues identified by PSI TAG, AEMO established its FPSS work program to:

- clearly define the technical nature of potential future operational challenges and thereby future power system needs; and
- explore the range of potential technical solutions based on the expected future power system needs.

The FPSS work programs has identified and will consider the following four areas:

- **Frequency control**: Higher rates of change of frequency (RoCoF) and reductions in the availability of frequency control ancillary services (FCAS) were identified as issues. AEMO's current work on this issue includes identifying underlying RoCoF system limits, examining a fast frequency response service, examining the use of existing and new FCAS technologies and undertaking an international review of how other systems have adapted.
- **Managing extreme frequency events**: The effectiveness of emergency frequency control schemes are challenged by high RoCoF and increased distributed energy resources (DER). AEMO's current work on this issue includes redesigning existing under frequency load shedding (UFLS) schemes and designing a new over frequency generation shedding (OFGS) scheme, assessing roles, responsibilities and mechanisms to address these events; and reviewing procedures for operating South Australia as an island.
- **Information, models and tools**: Lack of visibility of DER and the ongoing development of AEMO's tools for effectively capturing changing system dynamics were identified as issues. AEMO's current work on this issue includes assessing data requirements to perform its functions in future and consulting with industry on ways to capture data.[19]
- **System strength**: Fault levels and their impact on system security were identified as issues. AEMO is developing capability to better model the dynamics of reduced system strength.

The identification of future power system security limitations and requirements and the examination of potential technical solutions will be progressed by AEMO and will be run in parallel to work being undertaken by the AEMC on system security. The AEMC's review will identify the changes to market and regulatory frameworks that can deliver the technical solutions that AEMO identifies.

19 This falls outside of the scope of work being considered by the AEMC in conjunction with AEMO in the System Security review.

2.3.2 AEMC System Security Market Frameworks Review

The AEMC has commenced the the System Security review, which will consider the market frameworks relevant to system security in the NEM.[20] This review builds on and will be run in collaboration with AEMO's work on technical solutions to system security issues.

The System Security review will consider several core issues, including potential market solutions to address increased RoCoF and reductions in system strength.

The System Security review incorporates parts of a package of rule changes proposed by the South Australian Minister for Resources and Energy. This package includes:

- Parts A and D, which relate to rates of change of frequency and system strength, and which are being considered as part of the System Security review; and
- Parts B and C, the under-frequency and over-frequency rule changes requests, which are being considered separately as standalone rule change requests.

The AEMC recognises that these over-frequency and under frequency rule changes, and the reforms that may stem from them, are closely related to the matters considered in the System Security review. The AEMC will therefore monitor and address these interactions over the course of both projects.

20 More information available at: http://www.aemc.gov.au/Markets-Reviews-Advice/System-Security-Market-Frameworks-Review

3 Details of the Rule Change Requests

Changes in the generation mix and interconnector capability mean that the issues raised in this rule change are currently most relevant to South Australia. However, as the generation mix and consumer demand profiles continue to change across the NEM, these issues may arise in other jurisdictions. Similarly, while the solutions proposed are primarily likely to benefit South Australia in the short term, they will be assessed in terms of their applicability to all NEM regions.

This chapter provides a summary of the key issues and solutions proposed by the proponent. More detailed technical information is also available in AEMO's most recent FPSS update report.[21]

The proponent's rule change requests do not include drafting for a proposed rule.

3.1 Issues the rule changes are seeking to address

The key issue raised by the proponent is that the NER do not set out an effective framework for the management of emergency frequency events.

Historically, UFLS schemes were developed by TNSPs, DNSPs and AEMO and have been largely effective at managing extreme frequency events. However, both the proponent and AEMO argue there are a number of emerging issues that may reduce the effectiveness of existing UFLS schemes.[22] These include:

- Increases in RoCoF may mean existing UFLS schemes may no longer be effective. Existing UFLS schemes rely on relays designed to open circuit breakers when they sense a fall in frequency.[23] These schemes may work effectively under existing levels of RoCoF. However, under increasing levels of RoCoF these relays may not be sufficiently fast to sense the frequency fall and open circuit breakers. This occurs because increased levels of RoCoF may result in multiple generation units tripping following the original frequency disturbance, resulting in further increases in RoCoF, before the UFLS relays can operate.

- Increased levels of DER may mean existing UFLS schemes may not effectively increase frequency following a non-credible contingency, if the event occurs during a time of day when there is material generation output from DER such as rooftop solar PV. This occurs because rooftop solar PV is generating additional power and therefore reduces the amount of load supplied via the grid. This in

21 AEMO, *Future power system security program - update report*, August 2016.

22 Ibid., pp.29-32.

23 These relays include inbuilt delays, in order to prevent the triggering of load shedding for transient fluctuations. The relays sense the frequency as it drops through specified thresholds, and open circuit breakers accordingly. Increased RoCoF means that the frequency can move through these thresholds more rapidly, potentially too quickly for the equipment to sense.

turn reduces the amount of potential load that can be shed when a UFLS circuit breaker is opened following a frequency disturbance.

- Furthermore, increased levels of DER could actually mean the triggering of an UFLS scheme results in an exacerbation of an under frequency event. This could occur where levels of DER in an area are sufficiently high to reverse power flows (i.e., output from all the DER in the area exceeds consumption and the area acts as a net generator). Under such conditions, power could actually be flowing from a load block, across a UFLS circuit breaker and into the main power system. Opening the circuit breaker to "shed" such a load block would actually be equivalent to shedding generation, worsening the under-frequency event it was intended to mitigate.

- Over frequency events could result in uncontrolled generator shedding, potentially resulting in an under frequency event. There is currently no mechanism in the NER to effectively address this risk.

Emergency frequency control schemes represent the last line of defence to arrest a sudden rise or fall in frequency. On the basis of the issues discussed in this chapter, both the proponent and AEMO argue that in the absence of a rule change, it will become increasingly difficult for existing emergency schemes to perform this function – the last line of defence will be compromised. Furthermore, the existing frameworks may not be able to allow for future developments and new technologies that could be used to provide emergency frequency response in a changed power system environment.

Ultimately, a failure of emergency frequency control schemes could cause uncontrolled shedding of load and generation, resulting in a major black out potentially affecting an entire region.[24] While mechanisms exist to restore the power system following such an event, there are time delays associated with this restoration, with significant economic costs for consumers.

3.1.1 Impacts of increased RoCoF

Changes in the generation mix are increasing the potential RoCoF that may occur in the NEM. This is due to changes in the levels of inertia in the power system and exacerbated by the changes in the size of potential contingencies.[25]

Historically, large synchronous generation units have provided a degree of inertia in the system, slowing the rate at which the frequency changes following a disturbance. As these units are retired or displaced from dispatch, and replaced with non-synchronous units that do not provide the same kind of inertial response, the level of inertia inherent in the system has decreased.

24 This kind of major supply disruption is referred to as a black system condition, where the power system has collapsed to a condition of zero voltage and frequency, all generators have tripped off the system and there is no supply of electricity to consumers.

25 More information on the relationship between inertia, contingency size and RoCoF is provided in the FPSS progress report, available at www.aemo.com.au; and the Consultation paper of the System Security review, available at www.aemc.gov.au.

This situation is particularly material under specific non-credible contingency conditions. In particular, the loss of interconnection with other regions of the NEM resulting in separation of a region can result in very high RoCoF in that region. This occurs because a separated region cannot rely on the inertia provided by generators in other parts of the NEM and must rely on inertia provided by generators within the region. If there is little or no generation capacity with the ability to provide inertia in that region, the frequency could be subject to very high levels of RoCoF.

Existing UFLS schemes utilise relays that detect a change in the frequency and open a circuit breaker to shed successive load blocks in a controlled manner. However, these relays have been designed in reference to the historically slower RoCoF levels in the NEM. As such, their design does not anticipate faster levels of RoCoF, which may be capable of triggering generator tripping before UFLS are activated. This could occur where faster RoCoF triggers generator protection systems and cause generators to trip, further increasing the level of RoCoF and resulting in a cascading failure. All of this may occur before existing UFLS relays are able to detect and respond to the original frequency excursion.

The difficulty of existing relays to deal with faster RoCoF following a separation event may mean that existing UFLS schemes are unable to prevent a cascading failure of the power system.[26]

This situation is further exacerbated in particular regions of the NEM where interconnector upgrades have increased the size of the potential contingency events.[27]

3.1.2 Increased levels of DER

Increased levels of DER are exacerbating these RoCoF impacts.

Levels of DER are increasing across the NEM, including in South Australia. Increases in rooftop solar photovoltaic are changing the way consumers use electricity and patterns of aggregate demand and power flows on the network.

As noted by AEMO, existing UFLS schemes have been designed around a power system with relatively predictable, one-way power flows. This means that the relay equipment that has been installed under these schemes is "static", to the extent that it assumes a given volume of load exists in the relevant load block. However, the increase in distribution connected DER means some parts of these networks are now operating with reduced power flows at some times and potentially in reverse flow (if the volume of DER is large enough). These may be the same parts of the power system that UFLS schemes have been designed to shed to suppress frequency excursions.

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26 This summary of the impacts of increased RoCoF is largely taken from AEMO's recent update to the FPSS work program, and from comments received directly from AEMO. For more information see: AEMO, *Future Power System Security Program - progress report*, August 2016.

27 In particular, the recent upgrade to the Heywood interconnector between Victoria and South Australia, coupled with the potential for increased loading of that interconnector, means that the potential impact of a non-credible failure of Heywood interconnector resulting in separation of the South Australian region has increased.

This means that during periods of high output from DER, distribution network feeders that are tripped by UFLS could have a lower impact on an under frequency condition, if they have high DER penetration. If these feeders are tripped following UFLS action, the effectiveness of the scheme will be reduced, resulting in UFLS shedding more distribution feeders to arrest the frequency deviation. This means that, ultimately, more customer load would be disconnected.[28]

Furthermore, if a UFLS relay was activated while some feeders were operating in reverse, the underlying low frequency disturbance would be exacerbated. Again, UFLS would have to shed more feeders to restore frequency than would be the case in the absence of DER generating.[29]

3.1.3 Over frequency events

Historically, extreme frequency events have most frequently involved a sudden frequency drop. However, factors such as changes in the generation mix, shifting demand patterns and increased interconnection between regions means that extreme over frequency events may occur more frequently in the future.[30]

The Rules currently account for over frequency by requiring generator protection systems to automatically disconnect the generating unit on detection of over frequency conditions. However, these requirements do not apply to all generators.[31] The Rules do not specify when and what generators should be tripped to manage an over frequency event.

AEMO has stated that these issues could result in an uncoordinated response to an over-frequency event. In a joint study with ElectraNet, it was identified that if a non-credible contingency trip of both circuits of the Heywood interconnector resulting in separation of the South Australian region were to occur at times of high export from South Australia to Victoria, this could result in a significant and sudden rise in frequency within the South Australian power system, potentially leading to an uncoordinated loss of generation.[32] This uncoordinated loss of generation could in turn

28 NER clause S5.1.10.1 refers to shedding sufficient volumes of load through under-frequency relays to prevent the frequency from moving outside of the extreme frequency excursion tolerance limits. This clause of the NER makes no mention of feeders, or the tripping of feeders, to shed load in order to arrest a frequency drop. This is relevant to considerations of whether the current Rules actively prevent, are silent on or are unclear regarding potential solutions to providing emergency frequency control, as discussed in section 5.1.2.

29 AEMO, *Future Power System Security Program - progress report*, August 2016.

30 As an example, there is an increased possibility of a large over frequency event if the South Australia / Victoria Heywood interconnector were to trip and separate South Australia during periods of low domestic demand, while heavily loaded with export flows to Victoria.

31 NER clause S5.2.5.8 requires generators to reduce their output by at least half, if the frequency exceeds a level nominated by AEMO, within three seconds. However, this requirement only applies to generators connected after 2007. It is not clear what trip settings apply to generators connected prior to 2007. For more information see: AEMC, *Technical Standards for Wind Generation and Other Generator Connections – Final determination,* March 2007. Available at: www.aemc.gov.au

32 *AEMO and ElectraNet, Update to renewable energy integration in South Australia*, February 2016, p.4.

result in an under frequency event, if too much generation were to trip off the system at once.

The proponent stated that a key problem related to over frequency events is that there is currently no single mechanism in the Rules to manage these events. As opposed to UFLS, the Rules may not provide guidance on how over frequency should be managed, or the roles of different parties and what kinds of events should be protected against.

3.2 Solution proposed in the rule change requests

Generally, the proponent suggests that the AEMC should consider whether a new or expanded framework is needed to deliver effective over and under frequency emergency control schemes.

The proponent suggests a number of issues that the Commission should consider when developing this framework; these are addressed separately for under and over frequency schemes.

In regards to the management of under frequency events, the proponent identified the following issues for consideration by the AEMC:

- **Definition of contingency events:** the proponent stated that currently, there is some uncertainty regarding what kind of multiple, non-credible contingencies for which AEMO should be capable of maintaining system frequency. To address this, the proponent suggests that an independent body, such as the Reliability Panel, should be able to define specific non-credible system events for which AEMO must maintain system frequency, in addition to credible events. In effect, this would create a new subset category of specified non- credible contingencies that would sit between the two current categories of credible and non-credible contingency events. By defining the nature of these specified events, AEMO would be able to procure specific services to protect against their impacts on the frequency.

- **Consideration of new technologies:** relays that have been installed as part of existing UFLS schemes may not be sufficiently advanced to deal with rapid RoCoF or to sense changing load volumes. The proponent therefore suggested the AEMC consider how a framework can allow for the consideration of new technologies to improve relay function.

- **Roles of NSPs, JSSCs and AEMO:** the proponent stated that there is currently no framework for NSPs to invest in new technologies to provide more effective emergency frequency control. The AEMC should therefore develop a framework to enable AEMO and JSSCs to identify the need for new investments and direct NSPs to make these investments.

- **Network planning and operation:** changes should be made to clarify how emergency frequency control schemes should be accounted for in network planning. Greater clarity is also needed in terms of operation of these schemes.

- **Network cost recovery:** the proponent stated that chapters 6 and 6A should be reviewed to ensure that NSPs can recover the cost of emergency frequency control schemes.
- **Automatic interruptible customer load shedding:** Currently, the Rules require market customers to have automatic load shedding capability.[33] The proponent argued that this requirement does not reflect the practical implementation of current load shedding arrangements. The proponent stated it is unclear how this requirement is relevant and that is should be amended to reflect current practices.

In regards to the management of over frequency events, the proponent identified the following issues:

- **New framework for generator shedding:** the proponent stated there is a need for an explicit framework for an OFGS in the NER for the establishment of flexible emergency frequency management control schemes that can manage frequency should a non-credible over frequency event occur. The proponent suggests that the following principles should guide the design of the scheme:
  - the scheme should take minimal action by tripping or reducing the least amount of generation to arrest the over frequency;
  - criteria should be established to determine which generating units are initially shed or how the generation is reduced;
  - the scheme should contain sufficient redundancy to be effective under a range of operating conditions; and
  - generating units chosen to participate in the scheme should have high availability factors.
- **Roles and responsibilities:** organisational roles and responsibilities within this framework should be clearly defined.
- **Scheme guidelines and procedures:** AEMO should be required to prepare and update guidelines that describe scheme design, including how it will coordinate response to over frequency. AEMO should then develop procedures on how generation will be shed.
- **Generator obligations:** the Rules should create clear obligations for generators to comply with any OFGS.

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33 It is worth noting that this reference to market customers appears to include retailers with loads in excess of 10MW at given connection points.

4 Assessment Framework

The Commission's assessment of these rule change requests must consider whether the proposed Rules promote the National Electricity Objective (NEO).

The NEO is:[34]

> "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."

4.1 Assessment approach

Assessment of these rule change requests will focus on efficient investment and operation of the power system, with a particular focus on security, price and reliability:

- **Security:** Security refers to the maintenance of the power system within certain technical operating limits, including frequency and voltage. Emergency frequency control schemes represent the "last line of defence" that maintain the operation of the power system. An effective framework for emergency frequency control schemes should be capable of identifying where security issues may emerge and the optimal solution to mitigate those issues.

- **Price:** There are potential costs associated with managing extreme frequency events, including physical equipment costs and potentially FCAS / energy market impacts. These costs may be passed through to consumers through increases in the price of electricity. An effective framework for emergency frequency control should be capable of identifying the most efficient solution to maintain a given level of security. This will help to minimise price impacts of these schemes for consumers

- **Reliability:** Reliability of the NEM refers to the capability of installed generation and network infrastructure to supply consumer demand, under system normal conditions. These system normal conditions can only be achieved when the power system is in a secure operating state. An effective framework for emergency frequency control schemes is therefore a precondition to the maintenance of a reliable supply of electricity to consumers.

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34 As set out under section 7 of the National Electricity Law (NEL).

Given these aspects of the NEO, assessment of the rule change requests will include consideration of the following principles:

- **Proportionality:** When considering the introduction of new regulatory frameworks for emergency frequency control, it will be necessary to first consider the materiality of current issues and whether they can be adequately addressed under existing frameworks.

  This is necessary as the introduction of more complex regulatory mechanisms will result in higher implementation and compliance costs, at least some of which will be passed on to consumers as higher prices. The complexity of a regulatory framework should therefore be in proportion to the materiality of the issue it is designed to address.

- **Efficient framework design:** Any new framework should be fit for purpose in that it must be able to identify and balance all costs and benefits to determine the most efficient outcome. As such it must be able to:

  1. identify all the potential costs associated with an uncontrolled extreme frequency event;
  2. identify the full range of physical solutions, and parties responsible for implementing those solutions, that can be used to provide emergency frequency control; and
  3. weigh the costs of these different solutions, including any regulatory/administrative costs as well as the costs of physical infrastructure, against the materiality of the uncontrolled extreme frequency event they are designed to mitigate. This should include efficient allocation of costs and risks between parties under different solutions.

- **Effectiveness of framework:** To be effective, any new framework must be technologically neutral and able to recognise new solutions to emergency frequency control over time.

- **Effective governance:** A new framework for emergency frequency control schemes is likely to deliver more efficient security and price outcomes if it adheres to good governance principles. These include:

  1. **Stability and flexibility:** Efficient investment and operational decisions are supported by confidence in the ability of emergency frequency control schemes to maintain system security. This confidence will be maintained where frameworks are predictable and transparent. Equally however, these frameworks must be sufficiently flexible to adjust to changing market conditions.

2. **Appropriate allocation of responsibilities:** Roles and responsibilities should be allocated on the basis of experience of organisations. Allocation of responsibilities should also reflect the primary function of the organisation, whether that be of an operational or economic analytical nature.

3. **Clear and transparent objectives:** Organisations should have clearly defined objectives and adequate operational scope to meet those objectives.

4. **Accountability:** Organisations should be accountable for how they have met their objectives. This should be enabled through obligations to consult and regular reporting obligations.

4.2 Northern Territory Rule making responsibilities

In July 2016, the AEMC assumed rule making responsibility for parts of the NER in the Northern Territory. The National Electricity (Northern Territory) (National Uniform Legislation) Act 2015 allows for an expanded definition of the national electricity system in the context of the application of the NEO to Rules made in respect of the Northern Territory, as well as providing the AEMC with the ability to make a differential rule that varies in its terms between the national electricity system and the Northern Territory's local electricity system.

The AEMC's power to make a differential rule for the Northern Territory includes changes made to Chapter 6 of the NER. As the rule change requests include a suggestion the AEMC consider changes to Chapter 6, the Commission will consider the applicability of these rule change requests to the Northern territory.[35]

35 See http://www.aemc.gov.au/Energy-Rules/National-electricity-Rules/National-Electricity-Rules-(Northern-Territory) for a version of the NER as it applies in the Northern Territory

5 Issues for Consultation

This chapter identifies a number of issues for consultation relevant to these rule change requests. The issues outlined below are provided for guidance. Stakeholders are encouraged to comment on these issues, any other aspect of the rule change requests and this consultation paper itself, including the proposed assessment framework.

5.1 Materiality and effectiveness of current frameworks

5.1.1 Materiality of issues impacting management of extreme frequency events

The issues described in section 3.1 are likely to be most material in South Australia, reflecting some key changes in the South Australian power system that have occurred in recent years, including:

- **RoCoF increases:** The potential for high RoCoF has increased in South Australia, due to factors including lower system inertia following retirement of large thermal units, as well as capacity upgrades increasing the potential contingency size of a non-credible loss of the Heywood interconnector resulting in separation of the South Australian region from the rest of the NEM. AEMO and the proponent suggest this potential faster RoCoF means UFLS relays may not be able to open quickly enough to arrest frequency fall. Faster RoCoF may also increase the potential for uncoordinated tripping of generation, further worsening RoCoF and reducing the ability of existing UFLS schemes to arrest severe frequency disturbances.

- **Increased DER:** As in other NEM regions, South Australia has seen an increase in levels of DER. Due to the way that existing ULFS schemes have been designed, this could weaken the ability of these schemes to arrest frequency decrease by reducing load available for shedding.

- **Greater probability of over frequency events:** Decreases in residential demand, coupled with significant investment in non-synchronous intermittent generation and increased interconnector capacity, mean there is a greater possibility of significant South Australian export flows at times of low synchronous generation. This raises the probability of significant over frequency events following a interconnector trip that results in separation of the South Australian region from the rest of the NEM.

These issues are currently most relevant in South Australia. However, AEMO has stated that other regions, and particularly those that are vulnerable to separation from the rest of the NEM (e.g., Tasmania and Queensland) may also be affected in the future.[36]

The ongoing materiality of these issues in different jurisdictions (and whether there are any other issues that may arise) is relevant to considerations of what kind of framework

36 AEMO, *Future power system security program - update report*, August 2016, p.3.

should be established in the Rules for emergency frequency control. If the materiality of these issues remains static and if no new issues are likely to arise, then a less flexible but more specific Rules defined framework may be appropriate.

However, if the materiality of these issues changes over time and if new issue may arise, a more flexible framework may be appropriate, in order to develop solutions that are most effective given specific circumstances.

This recognition of the potential changing materiality and potential for new issues to arise is particularly relevant to considerations of appropriate governance frameworks. This is discussed in more detail in section 5.3.

Question 1 Materiality of issues impacting management of extreme frequency events

(a) Are the issues identified by the proponent likely to have a material impact on the NEM, over the medium to longer term?

5.1.2 Ability of current frameworks to deliver effective emergency frequency control schemes

The proponent stated that the existing NER arrangements are limited and may not provide a framework capable of identifying all solutions for the management of extreme frequency events.

There is evidence that new solutions can already be considered under existing frameworks. For example, AEMO and relevant NSPs are currently adapting existing emergency frequency control schemes to account for changes in the power system.[37] This suggests that there is already some scope under current frameworks to adapt emergency frequency control schemes to adapt to changing market circumstances.

However, the proponent stated that existing NER frameworks do not provide an appropriate framework to ensure that effective and efficient mechanisms are available to meet the requirements of maintaining a secure power system. AEMO has also suggested that the current NER frameworks may prevent it from effectively using all existing resources to manage extreme frequency events. For example, under existing arrangements, AEMO is prevented from procuring additional FCAS to pre-emptively address a non-credible contingency, even if doing so might prevent a severe system disturbance. It is also not clear whether AEMO can apply constraint equations to limit the potential frequency impacts of a non-credible contingency.

The proponent also stated that some uncertainties exist under current arrangements. For example, the NER currently require market customers to provide automatic interruptible load above 60% of their expected demand, or some other amount

37 AEMO, *Future power system security program - update report*, August 2016, p.27.

determined by the Reliability Panel.[38] The proponent suggested that this clause does not reflect the current practices for load shedding arrangements.

The proponent suggested that the current NER also provide no scope for the establishment of schemes to manage severe over frequency events. This is addressed in more detail in section 5.4.

Finally, the proponent suggested that the existing frameworks could be amended to provide increased clarity regarding the responsibilities of different parties, including JSSCs, NSPs and AEMO. In particular, the proponent considered that NSPs should be required to monitor the effectiveness of emergency frequency control schemes as the character of generation and load on the system continues to change, with AEMO and JSSCs responsible for directing NSPs to undertake investments if required.

In assessing these rule change requests, consideration will be given as to whether existing NER frameworks already enable the development of effective emergency frequency control schemes, or whether amendments are required for this to occur. If the former is the case, then existing frameworks may simply require clarification, rather than significant overhaul.

Assessment of the rule change requests will therefore consider whether the current NER frameworks:

- actively prevent the consideration or use of more effective solutions to provide emergency frequency management;
- are silent, or provide no guidance on what potential solutions may be used for emergency frequency control; or
- already allow for new solutions to be used for emergency frequency control but are not adequately understood by the market and therefore require clarification.

This will include consideration of what responsibilities are already imposed on parties under the current NER frameworks, whether these responsibilities are unclear (or ineffective), or whether there is a need for the frameworks to set out new responsibilities.

Question 2 Ability of current frameworks to deliver effective emergency frequency control schemes

(a) Do current frameworks, including currently allocated responsibilities of different parties, allow for the effective consideration of all physical solutions to extreme frequency events?

38 This obligation is set out in NER clause 4.3.5(a)

5.2 Potential changes to emergency frequency control schemes

5.2.1 New technologies to manage extreme frequency events

The proponent suggested that amendments are required to the NER to overcome issues associated with the suitability of current technologies, to ensure efficient and effective schemes are in place to manage the frequency following extreme events.

AEMO has also advised that current frameworks may not allow for the use of more effective technologies to provide better emergency frequency control schemes. For example, AEMO highlighted the Rules requirement that load shedding facilities should respond automatically to frequency conditions. It was suggested that this may not recognise other technologies, such as communications enabled smart relays that can respond automatically to specific network events (such as the opening of interconnector circuit breakers), rather than waiting for the frequency to drop across the system.[39] These kinds of relays could potentially allow for faster load shedding and help to address the impacts of faster RoCoF identified in section 3.1.

AEMO has also suggested that the existing NER frameworks do not allow for the use of relays that can respond dynamically to changes in load.[40] More responsive dynamic relays could potentially sense and account for the impacts of increased DER on changing consumption patterns within a load block, ameliorating some of the issues faced by current UFLS schemes identified in section 3.1.

As discussed in section 5.2.1, assessment of these rule change requests will include consideration of whether existing NER frameworks actively prohibit or do not explicitly allow for the consideration of new technologies, such as dynamic relays, or whether these new technologies could be adopted under existing arrangements.[41] The NER should be technologically neutral and capable of accommodating new technologies and services for the provision of emergency frequency control. This will allow for the lowest cost solutions to be recognised and adopted to maintain system security into the future.

5.2.2 Redefining non-credible contingencies

As described in section 2.3.1, AEMO is required to maintain system frequency within the requirements of the NER and the FOS, for a range of different events. For non-credible contingencies that can result in extreme frequency events, AEMO and NSPs establish emergency frequency control schemes, such as the existing UFLS schemes.

39 NER clause 4.2.6(c).

40 The Commission understands that existing UFLS schemes use "static" relays that do not sense any changes in the consumption patterns in the relevant load block.

41 For example, as noted in section 3.1.2, NER clause S5.1.10.1 refers to shedding sufficient volumes of load through under-frequency relays to prevent the frequency from moving outside of the extreme frequency excursion tolerance limits. The Rules do not appear to require the use of any particular type of relay, or to preclude the use of dynamic relays.

AEMO is required to maintain the power system within the extreme frequency excursion tolerance limits, following any non-credible contingency event.[42] However, the proponent and AEMO have stated that it may not be possible for AEMO to plan for and maintain the frequency within the FOS for ***any*** non-credible contingency. This is because the range of non-credible contingencies includes events that are more likely to occur (such as an interconnector trip resulting in separation of a region from the rest of the NEM), to events that are extremely unlikely (such as the simultaneous trip of all generating units in the NEM within a 5 minute period).

The proponent suggests that this may create difficulties for AEMO when designing emergency frequency control schemes, as it is not clear the size of the contingency and related frequency effects that need to be managed.

The rule change requests suggest this could be addressed by introducing a process to identify specific non-credible contingency events that AEMO could account for when designing emergency frequency control schemes. This might involve the establishment of a new subset of contingency events, such as the loss of an interconnector resulting in separation of a region from the rest of the NEM.

In practice, these specific events would form a subset of the existing non-credible contingency events, and sit between the two categories of non-credible and credible events. By specifying the nature of these events, AEMO may be able to pre-emptively procure emergency frequency control solutions to address these events.

The proponent states that an independent body, such as the Reliability Panel, be given responsibility for assessing these special events. This body would be responsible for weighing the costs of emergency frequency control solutions against the costs of the specific event they mitigate. If this approach is progressed, it would require consideration of appropriate governance arrangements, discussed in section 5.3.

A related issue is AEMO's ability to reclassify non-credible events as credible.[43] It is not clear what role this ability could provide as an alternative to introducing a new classification of specific non-credible events. It is also not clear what levels of protection, or allowable consequences, would be appropriate for credible and non-credible contingencies, or for any new defined subset of these events.

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42 The term multiple contingency event is also referred to throughout the NER and in the FOS. In the FOS, multiple contingency is used as a proxy for non-credible contingency and is defined as: either a *contingency event* other than a *credible contingency event*, a sequence of *credible contingency events* within a period of 5 minutes, or a further *separation event in an island*.

43 Under NER clause 4.2.3A, AEMO has the ability to reclassify contingencies if it considers that a non-credible event is now more likely to occur.

Question 3	Potential changes to emergency frequency control schemes
(a)	**Do the current NER frameworks already allow for, actively prevent, or fail to account for, new technologies that could be used to provide more effective emergency frequency control schemes? How would these new technologies work and what kind of solutions can they provide?**
(b)	**Is there a need for a framework to identify specific non-credible contingencies that AEMO should develop emergency frequency control schemes to address?**
(c)	**Could this issue be addressed by AEMO reclassifying certain currently non-credible events as credible, under NER clause 4.2.3A?**

5.3 Governance arrangements

5.3.1 Roles and responsibilities

A new framework for the development of emergency frequency control schemes may involve the allocation of new roles and responsibilities to different parties. Assessment of any such framework will consider the governance principles outlined in Chapter 4. These are intended to deliver a framework that is stable while being flexible, with a clear division of responsibilities and transparent processes.

As discussed in section 5.2, the proponent suggests that a new framework should involve a role for the Reliability Panel. The Panel would be responsible for defining the specific non-credible contingency events around which AEMO will design emergency frequency control schemes and which NSPs would be required to implement. The Panel would be required to undertake an economic assessment of the consequences of various events, such as the potential trip of an interconnector resulting in separation of a region from the rest of the NEM, and weigh these against the cost of different physical solutions to provide emergency frequency management.

To provide transparency, the NER could establish a series of principles the Panel must consider when assessing these events and developing solutions. The Panel's general approach to meeting these principles could be set out in public guidelines.

Jurisdictions (potentially through the JSSC) could also play a role in approving any specific contingency event that may be nominated by AEMO, as well as advising on and approving any specific schemes designed to address these events.

AEMO may play a role in the identification of contingency events and solutions. As market operator, AEMO would be uniquely placed to identify the contingency events that are most likely to have a significant impact on system security, as well as the various physical solutions that could be used to manage extreme frequency events. AEMO may therefore have a role in nominating these events and the range of potential solutions to the Reliability Panel. As with the Panel, AEMO may prepare guidelines or procedures to provide transparency regarding its approach.

Any new framework should involve clear processes for public consultation so that decisions are made in a transparent manner. However, public consultation processes take time and could potentially delay development of effective responses to emerging issues. Any new governance framework should therefore balance the benefits of a prompt process with thorough consultation.

5.2.2 NSP responsibilities and incentives

NSPs may also play a role in the implementation, monitoring and adaptation of any emergency frequency management schemes. Currently, the NER place some limited obligations on NSPs in regards to these events.[44] The proponent suggests that the NER should place further obligations on NSPs to invest in updated technology and monitor the ongoing effectiveness of emergency frequency control schemes. Network service and planning arrangements should also be subject to review.

It will also be necessary to consider NSPs incentives, if they face more specific or new responsibilities in terms of developing, monitoring and adapting emergency frequency control schemes. NSPs should be incentivised to develop any such schemes as efficiently as possible, to minimise costs for consumers while delivering a secure and reliable supply of electricity.

Question 4 Governance arrangements

a) **What roles should be played by different parties, including AEMO, NSPs, JSSCs, market participants and the Reliability Panel, in the framework for emergency frequency control?**

b) **What would an appropriate incentive regime for NSPs look like if they were tasked with additional roles in developing, monitoring and adapting emergency frequency control schemes?**

5.4 Costs to participants

There are a range of potential costs that could be faced by participants if a new framework for emergency frequency control schemes was introduced. These include:

- **AEMO:** the market operator may face some costs when developing new schemes with JSSCs and NSPs. It may also incur costs in setting up processes and engaging with the Reliability Panel when assessing specific non-credible contingencies.

- **Reliability Panel:** The Panel may face some costs in setting up processes and assessing specific non-credible contingencies.

44 NER clause S5.1.10.1 sets out limited requirements for NSPs in terms of establishment of relays for load shedding.

- **NSPs:** Network service providers may face some costs of installing new equipment and changing settings on relays.
- **Market participants:** Market participants may face increased costs, either through potentially through increased participant fees or network charges, for the development of a new emergency frequency control schemes.

It is not entirely clear how any costs to NSPs may be recovered. The proponent suggests that the AEMC consider Chapters 6 and 6A of the NER in regards to AER approval of these kinds of investment.

Question 5	**Costs to participants**
(a)	**What kinds of costs are likely to be faced by participants if a new framework for emergency frequency control schemes is introduced?**

5.5 Managing extreme over frequency events

Currently, the Rules do not explicitly allow for the development of a scheme to manage over frequency events.

The rule change requests propose that a new framework should be introduced into the NER to allow for an OFGS scheme. The core proposed components of this scheme are set out in section 3.2.

Many of the issues identified in the rest of this chapter would apply equally to the potential development of a framework for OFGS. These include questions relating to:

- the materiality of potential over frequency events;
- the extent to which emergency over frequency events can be managed under current arrangements;[45]
- what roles should be played by AEMO, the Panel, market participants and NSPs in developing, monitoring and adapting these schemes; and
- the costs for participants from the development of these schemes, and the costs to generators from interruption of their capability to export power to the network.[46]

The proponent has also stated that it is not clear what obligations generators face to provide data or adjust relays in response to high frequency events under the current

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45 It is noted that an OFGS has been developed in Tasmania under the current Rules frameworks. AEMO and ElectraNet are also currently developing an OFGS for South Australia.

46 While an OFGS scheme may result in some generators being pre-emptively disconnected in a controlled manner, the absence of such a scheme could potentially lead to uncontrolled generator shedding and a potential black system event. The costs to disconnected generators should account for both of these possible states of the world.

Rules. The proponent suggests that the NER should set out clear obligations on generators to comply with any OFGS or related scheme.

Finally, it is not clear how costs for the development of an OFGS might be allocated between NSPs and generators. While implementation of such a scheme could require generators to reset or install relays at their own power station, it is also possible that this could be managed by NSPs on their side of a generator connection point.

Question 6 Managing over frequency events

(a) What should a framework for managing extreme over frequency events look like?

6 Lodging a Submission

The Commission invites written submission on these rule change proposals.[47] Submissions are to be lodged online or by mail by **13 October 2016** in accordance with the following requirements.

Where practicable, submissions should be prepared in accordance with the Commission's Guidelines for making written submissions on Rule change proposals.[48] The Commission publishes all submissions on its website subject to a claim of confidentiality.

All enquiries on this project should be addressed to Christiaan Zuur on (02) 8296 7841.

6.1 Lodging a submission electronically

Electronic submissions must be lodged online via the Commission's website, www.aemc.gov.au, using the "lodge a submission" function and selecting the project reference code ["ERC0212" and "ERC0213"]. The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated.

Upon receipt of the electronic submission, the Commission will issue a confirmation email. If this confirmation email is not received within 3 business days, it is the submitter's responsibility to ensure the submission has been delivered successfully.

There may be some overlap in issues considered in this rule change and those considered in the System Security review. Stakeholders are invited to identify any relationships or interdependencies between these rule changes and the System Security review in submissions to either project.

6.2 Lodging a submission by mail or fax

The submission must be on letterhead (if submitted on behalf of an organisation), signed and dated. The submission should be sent by mail to:

Australian Energy Market Commission
PO Box A2449
Sydney South NSW 1235

The envelope must be clearly marked with the project reference codes: ERC0212 and ERC0213.

Alternatively, the submission may be sent by fax to (02) 8296 7899.

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47 The Commission published a notice under section 95 of the NEL to commence and assess these rule change requests.

48 This guideline is available on the Commission's website.

Except in circumstances where the submission has been received electronically, upon receipt of the hardcopy submission the Commission will issue a confirmation letter.

If this confirmation letter is not received within 3 business days, it is the submitter's responsibility to ensure successful delivery of the submission has occurred.

Abbreviations

AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
Commission	See AEMC
DER	Distributed energy resources
FCAS	Frequency control ancillary services
FPSS	Future Power System Security review
FOS	Frequency operating standards
JSSC	Jurisdictional System Security Coordinators
NEM	National Electricity Market
NEO	National Electricity Objective
NSP	Network service providers
OFGS	Over frequency generation shedding
PSI TAG	Power System Issues - Technical Advisory Group
UFLS	Under frequency load shedding