AUSTRALIAN
ENERGY
REGULATOR

The Black System Event Compliance Report

Investigation into the Pre-event, System Restoration, and Market Suspension aspects surrounding the 28 September 2016 event

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Introduction

This is the AER's final report into the Black System Event in South Australia (SA) on 28 September 2016.

The AER's report is a review of compliance by various National Electricity Market (NEM) participants against the applicable National Electricity Rules (the Rules) regarding the operation of the South Australia region of the NEM in the period surrounding the state-wide blackout that occurred on the afternoon of 28 September 2016.

This report is divided into the following sections:

- Chapter 1—*Overview*, which provides a high-level overview of the subsequent chapters, including the AER's role and its investigation, key findings, recommendations and next steps.
- Chapter 2—*The Pre-event (AEMO)*, which focussed on AEMO's actions in the lead up to the storm event, and how it managed power system security under the Rules.
- Chapter 3—*The Pre-event (ElectraNet)*, which focussed on ElectraNet's actions in the lead up to the storm event, and how it met its obligations under the Rules in relation to power system security.
- Chapter 4—*System Restoration*, in which we examined the actions of certain participants in relation to the provision and use of System Restart Ancillary Services to restore the network following the black system conditions of the 28 September 2016.
- Chapter 5—*Market Suspension*, in which we assessed compliance with how participants operated during the 13 day period in which the spot market in South Australia was suspended, including how AEMO managed power system security.
- Chapter 6—*Implications for the Regulatory Framework*, which identifies areas for potential change to improve the overall effectiveness of the regulatory framework.

The AER's work surrounding the actual Event is ongoing and is therefore not a focus of this report.

References to times in this report are in "market time" (Australian Eastern Standard Time).

Executive summary

This report is a review of compliance by various NEM participants against the applicable National Electricity Rules (the Rules) regarding the operation of the SA region of the NEM in the period surrounding the state-wide blackout that occurred on the afternoon of 28 September 2016. In this report we deal with the Pre-event period, System Restoration and Market Suspension. Our work concerning the actual Event is ongoing.

The state-wide blackout on 28 September 2016 resulted from unprecedented circumstances. It was triggered by severe weather that damaged transmission and distribution assets, which was followed by reduced wind farm output and a loss of synchronism that caused the loss of the Heywood Interconnector. The subsequent imbalance in supply and demand resulted in the remaining electricity generation in SA shutting down. Most supplies were restored in 8 hours, however the wholesale market in SA was suspended for 13 days.

This blackout, known as a 'Black System Event', affected the entire state-wide network and is the most significant market event since the establishment of the NEM 20 years ago. Market suspension has only occurred once before, in April 2001 for two hours; this time the market was suspended for 13 days.

As such, the scope of the AER's investigation has also been unprecedented.

With the investigation not limited to particular parties or regulatory obligations, we have assessed all relevant compliance obligations as they relate to market participants, Network Service Providers and AEMO.

We have found some areas where AEMO did not comply with administrative requirements during the pre-event period, but do not consider that these contributed to the sequence of events leading to the state going black. We also found further non-compliance around administrative requirements during the market suspension period. Common elements of AEMO's non-compliance in both of these periods relate to inadequate communication and transparency with stakeholders.

We have identified some similar issues with administrative processes in our consideration of the system restoration period. While we have not found any breaches of the Rules in relation to this period, we have made recommendations for future action, including in regard to strengthening joint communication protocols.

We have not found that AEMO breached any of its core obligations around operating the market or managing power system security. Rather, the areas of compliance concern relate to AEMO not meeting all of the process requirements set out in the Rules for reclassification and notifications to participants. These stem from deficiencies in AEMO procedures and guidelines.

Given the nature of the findings, the circumstances under which the non-compliances occurred, and the actions that have been taken by AEMO and others since September 2016 to address some of the issues identified we do not intend to take formal enforcement action in respect of these matters.

Rather, we consider that the National Electricity Objective (NEO)—to promote efficient investment in and efficient operation and use of energy services for the long term interests of consumers with respect to price, quality, safety, reliability and security of supply of energy—is best served through:

- the implementation of recommendations for improved processes.
- the AER submitting rule change proposals and conducting compliance reviews, and
- reviewing the market framework to enable it to better accommodate the rapid changes in technologies currently being experienced, and changing the Rules where required.

The AER undertakes its compliance role not only for the NEO, but to ensure confidence in the market and that participants have clarity about their roles and responsibilities.

Drawing from our findings, the importance of AEMO complying with obligations around communication and transparency is growing given the introduction of new types of participants and increasing numbers of participants.

Actions proposed by the AER include:

- implementing more rigorous weather monitoring processes
- standardising notifications for market participants during abnormal weather conditions
- more broadly reviewing the criteria under which risks to the power system are classified
- improving AEMO operator training, and
- clarifying roles and responsibilities of the market operator and network providers regarding system restoration.

Our goal in identifying future improvements is to ensure there is better management by all relevant parties including with regard to transparency and clear communications should similar circumstances arise again in the future. We recognise that some steps have already been taken, or are underway.

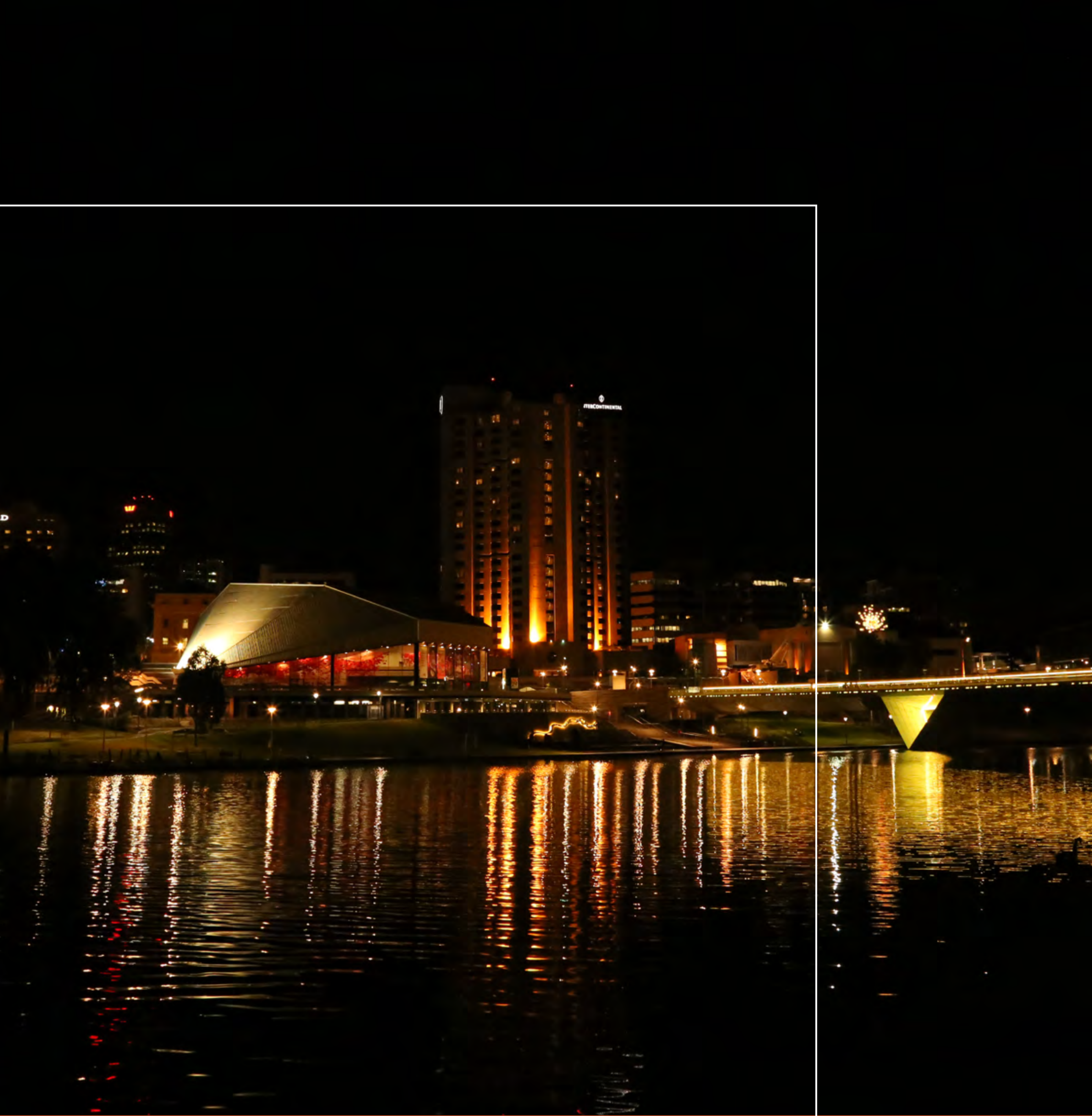
The AER will be working closely with the AEMC, not only in regard to proposed rule changes, but also in relation to the broader framework issues that have arisen where it is clear that the AER and AEMO have very different interpretations of the Rules.

The AER will also be undertaking follow-up monitoring and compliance reviews in relation to the key issues we found, particularly around communication and transparency, not only concerning AEMO's conduct, but also that of all relevant Registered Participants.

Shortened forms

Shortened form	Extended form
AEMC	Australian Energy Market Commission
AEMO	Australian Energy Market Operator
AEMO Final Report	AEMO's final report into the Black System Event in South Australia on 28 September 2016 published in March 2017
AER	Australian Energy Regulator
AEST	Australian Eastern Standard Time
AWEFS	Australian Wind Energy Forecasting System
BOM	Bureau of Meteorology
DI	Dispatch Interval
DNSP	Distribution Network Service Provider
DVAR	Dynamic Volt-Amp Reactor
EMS	Energy Management System
EMMS	Electricity Market Management System
EOI	Expression of Interest
FCAS	Frequency Control Ancillary Services
GPATS	Global Positioning and Tracking Systems Pty Ltd
GT	Gas Turbine
Hz	Hertz
Hz/s	Hertz per second
ITT	Invitation to Tender
Km/h	Kilometres per hour
kV	Kilovolt
LBSP	Local Black System Procedure
LVRT	Low Voltage Ride Through
MSTWG	Market Suspension Technical Working Group
MW	Megawatt
NEL	National Electricity Law
NEM	National Electricity Market
NEMDE	National Electricity Market Dispatch Engine
NEMMCO	National Electricity Market Management Company
NEO	National Electricity Objective
NER	National Electricity Rules
NMAS	Non-Market Ancillary Services
NOS	Network Outage Scheduler
NSP	Network Service Provider
PASA	Projected Assessment of System Adequacy
PSSG	Power System Security Guidelines
PSS Working Group	Power System Security Working Group
QPS5	Origin's Quarantine Power Station unit 5
RoCoF	Rate of Change of Frequency
SA	South Australia
SAPN	SA Power Networks
SCADA	Supervisory Control And Data Acquisition
SEC	State Emergency Service Centre

Shortened form	Extended form
SES	State Emergency Service
SRAS	System Restart Ancillary Services
SRWG	System Restart Working Group
SSP	System Switching Program
SVC	Static VAR Compensators
TIPS	Torrens Island Power Station
TNSP	Transmission Network Service Provider
TOA	Temporary Operating Advice
TTHL	Trip To House Load
VSAT	Voltage Stability Assessment
WF	Wind Farm



Overview

1. Overview

1.1 Summary

This report is a review of compliance by various National Electricity Market (NEM) participants against the applicable National Electricity Rules (the Rules) regarding the operation of the South Australia (SA) region of the NEM in the period surrounding the state-wide blackout that occurred on the afternoon of 28 September 2016. In this report we deal with the Pre-event period, System Restoration and Market Suspension. Our work surrounding the actual Event (the key events that triggered the Black System Event) is ongoing.

The state-wide blackout on 28 September 2016 resulted from unprecedented circumstances. It was triggered by severe weather that damaged transmission and distribution assets, which was followed by reduced wind farm output and a loss of synchronism that caused the loss of the Heywood Interconnector. The subsequent imbalance in supply and demand resulted in the remaining electricity generation in SA shutting down. Most supplies were restored in 8 hours,[1] however the wholesale market in SA was suspended for 13 days.[2]

This blackout, known as a 'Black System Event', affected the entire state-wide network and is the most significant market event since the establishment of the NEM 20 years ago. Market suspension has only occurred once before, in April 2001 for two hours; this time the market was suspended for 13 days.

As such, the scope of the AER's investigation has also been unprecedented. While other reports on the SA Black System Event have been released, the AER's independent regulatory review has focused on gathering the necessary evidence, both technical and legal, to ensure a comprehensive review of participants' compliance with applicable Rules obligations.

The purpose of this report is to detail our investigations into whether the Rules were complied with, and to recommend action in response to any identified areas of non-compliance to enable better management of any similar events in the future, in line with the National Electricity Law (NEL). Aside from the non-compliance, there are also other areas where we have made recommendations for future action.

We have found some areas where AEMO did not comply with administrative requirements during the pre-event period, but do not consider that these contributed to the sequence of events leading to the state going black. We also found further non-compliance during the market suspension period. Common elements of AEMO's non-compliance in both of these periods relate to inadequate communication and transparency with stakeholders.

We have identified some similar issues with administrative processes in our consideration of the system restoration period. While we have not found any breaches of the Rules in relation to this period, we have made recommendations for future action, including in regard to strengthening joint communication protocols.

We have not found that AEMO breached any of its core obligations around operating the market, or managing power system security including through system restoration. Rather, the areas of non-compliance relate to AEMO not meeting all of the process requirements set out in the Rules for reclassification and notifications to participants. These stem from deficiencies in AEMO's procedures and guidelines.

Options such as enforceable undertakings or instituting Court proceedings have been considered. However, given the nature of the findings, the circumstances under which the non-compliance occurred, and the actions that have been taken by AEMO and others since September 2016 to address some of the issues identified, we do not intend to take formal enforcement action in respect of these matters.

Rather, we consider that the National Electricity Objective—to promote efficient investment in and efficient operation and use of energy services for the long term interests of consumers with respect to price, quality, safety, reliability and security of supply of energy[3]—is best served through:

- the implementation of recommendations for improved processes
- the AER submitting rule change proposals and conducting compliance reviews, and
- raising potential framework issues in the Rules for the AEMC to consider in its upcoming policy review of the regulatory framework in the context of the Black System Event.

These next steps, detailed at the end of this chapter, not only address areas of non-compliance, but also seek to further improve the compliance regime more broadly for the benefit of energy consumers.

1 Load restoration continued on Thursday 29 September 2016 as transmission supply was restored to some areas in the north. Source: AEMO, *Black System South Australia 28 September 2016—Final Report*, published March 2017 ("AEMO, Final Report"), p. 75.

2 Whilst the final restoration of electrical supply was completed on 29 September 2016, AEMO was required to keep the market in SA suspended via a Ministerial direction made under the *Essential Services Act 1981* (SA). The direction was extended on 4 October, and revoked on 11 October 2016.

3 Section 7 NEL, section 23 National Gas Law and section 13 National Energy Retail Law.

This framework review is timely to update the Rules to better accommodate further growth of renewables, other technologies and new entrants in the market.

1.2 About this report

This report presents our findings on whether the Rules were complied with during the circumstances leading up to the blackout and then the operation of the SA region including system restoration and market suspension up until the wholesale spot market in SA resumed on 11 October 2016.

As stated above, our work surrounding the actual Event is ongoing and we therefore cannot comment any further on that at this stage. As such, commentary of that aspect of our work is limited in this report.

The AER's investigation has focused on four key areas as per Table 1 below:

Table 1 AER's investigation streams

1	The Pre-event	AEMO's and ElectraNet's actions in the lead up to the storm event, in particular whether they fulfilled obligations around managing power system security.
2	The Event	The period immediately prior to the system going black in SA.
3	System Restoration	The actions of System Restart Ancillary Service (SRAS) providers, ElectraNet and AEMO in restarting the system, including the preparatory steps taken in the preceding years.
4	Market Suspension	Compliance with the NER during the 13-day period in which the spot market in SA was suspended, including AEMO's actions in managing power system security during the suspension.

1.3 Our role

The AER is Australia's national energy market regulator. Among other functions, the AER is responsible for monitoring, investigating and enforcing compliance with obligations under the NEL, National Gas Law, National Energy Retail Law and the respective Rules and Regulations (national energy laws). The enforcement functions and powers of the AER are set out in section 15 of the NEL and are designed to ensure confidence in the market.

In particular, the Rules set out a framework for how the power system should operate, including at times of system stress. This framework is intended to ensure that the roles of relevant participants and the system operator are clear, and the operation of the system is transparent to market participants and stakeholders.

As well as monitoring compliance, the AER has powers to investigate breaches or possible breaches of the national energy laws and to take appropriate enforcement action, such as:

- issuing warning letters
- accepting voluntary undertakings to remedy breaches
- accepting Court enforceable undertakings to remedy breaches
- issuing infringement notices for civil penalty provisions, and
- instituting Court proceedings seeking declarations, injunctions, penalties, and other orders as appropriate.

In determining its enforcement response, the AER assesses the impact of breaches against the objectives of the national energy laws, that is: to promote efficient investment in and efficient operation and use of energy services for the long-term interests of consumers with respect to price, quality, safety, reliability and security of supply of energy.[4]

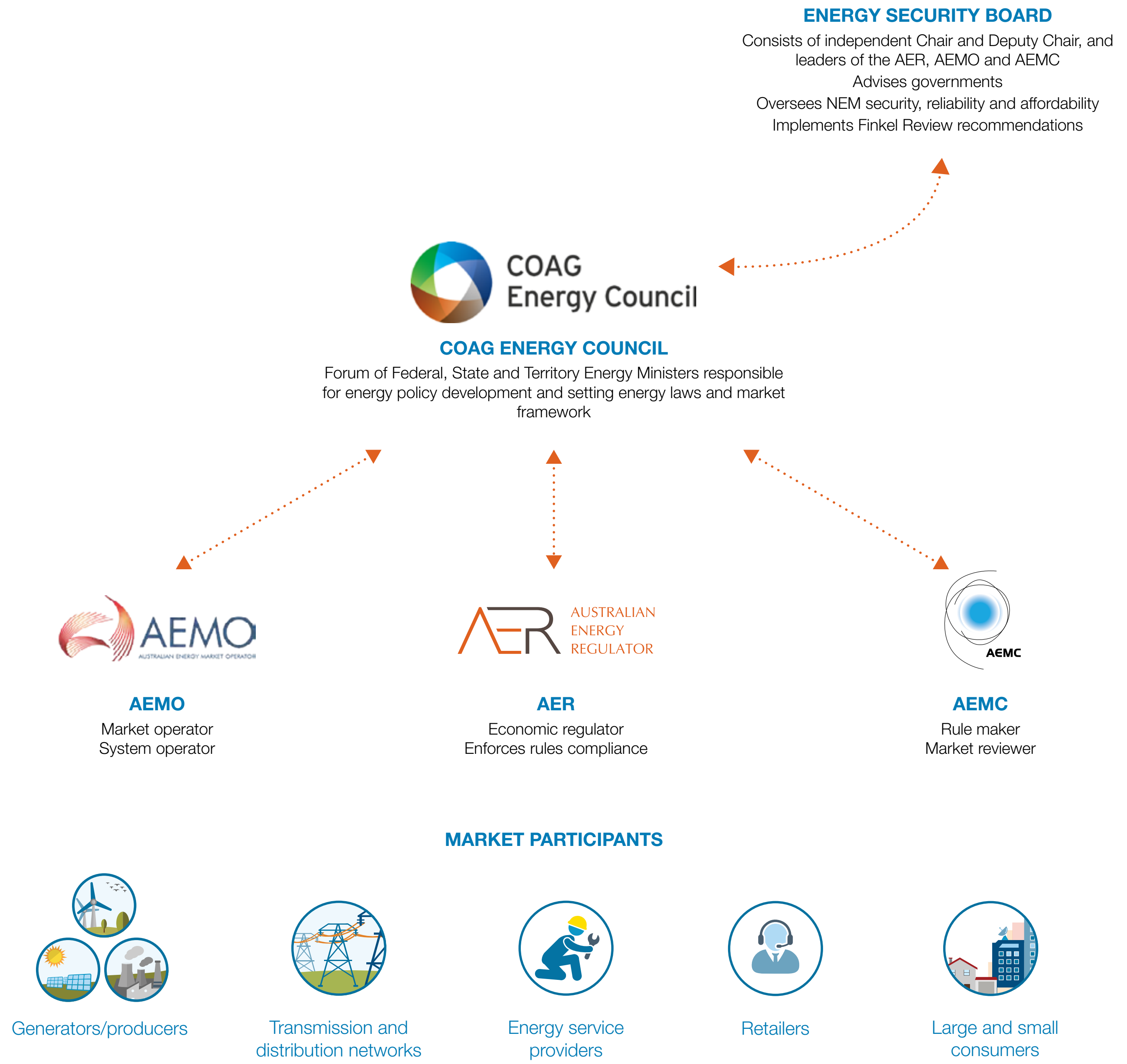
While all obligations in the national energy laws are subject to compliance requirements, greater weight is given to breaches with the potential to have a significant impact on the achievement of the relevant national energy laws objective. The factors the AER takes into consideration when determining what, if any, enforcement response is required are set out in the AER's compliance and enforcement Statement of Approach.[5]

It is important to note that of the non-compliance identified in this report, none of the obligations are civil penalty provisions. This means that in the course of determining an appropriate compliance and enforcement outcome, a financial penalty is not available in this instance.

The AER undertakes its compliance and enforcement roles not only for the National Electricity Objective, but also to ensure confidence in the market and so that participants have clarity about their roles and responsibilities.

4 Section 7 NEL, section 23 National Gas Law and section 13 National Energy Retail Law.

5 See: https://www.aer.gov.au/publications/corporate-documents/aer-compliance-and-enforcement-statement-of-approach.



1.4 The South Australian Black System Event

On 28 September 2016 a severe storm damaged transmission and distribution electricity assets in the lower Eyre Peninsula and mid-north region of SA triggering a chain of events leading to a state-wide power outage. Three major 275 kV transmission lines were damaged in the mid-north of the State. According to a special report published by the Bureau of Meteorology (BOM), the main damage was associated with tornadoes and supercell thunderstorm activity.

At approximately 16:18 hrs,[6] multiple power system faults occurred in quick succession due to the storm activity and damage to transmission lines. The faults created significant voltage disturbances, which then rapidly caused several of the wind farms operating at the time to shut down. This resulted in a sustained reduction of 456 MW of wind generation[7]—a significant loss given that around 48% of SA's electricity supply overall was from wind farms.[8] Under

6 All time references in this report are in "market time", being Australian Eastern Standard Time.

7 AEMO, Final Report p. 32.

8 AEMO, Final Report p. 25.

these circumstances, with high levels of power flowing into the state from Victoria and only four thermal generators operating,[9] power system inertia in SA was low. Higher inertia ensures the grid can better withstand frequency deviations caused by electricity supply-demand imbalances.

The shutting down of wind generation resulted in a rapid increase of power flow into SA from Victoria over the Heywood Interconnector to a peak of around 890 MW[10] within a very short period. This led to a large shock to the power system and in turn activated the automatic loss of synchronism protection system on the Heywood Interconnector, causing the interconnection to be shut down. The loss of the Heywood Interconnector separated SA from the rest of the NEM and substantially reduced the available supply to meet SA demand. This saw power system frequency in SA fall rapidly due to the imbalance in electricity supply and demand and low inertia, resulting in the remaining online generators tripping off and the state going black.[11]

After the state went black, AEMO in conjunction with ElectraNet determined a system restoration strategy at around 16:30 hrs. The strategy consisted of using System Restart Ancillary Services (SRAS) from Quarantine Power Station (QPS) to provide contracted auxiliary supplies to the Torrens Island power station, in combination with the Heywood Interconnector to provide power to the auxiliary plant of other SA power stations and high priority loads. However, due to technical issues, QPS was not able to provide this service. The other SRAS provider, Mintaro Power Station (which is owned by Synergen Power),[12] was also unavailable due to a technical fault.[13]

Given these circumstances, AEMO then proceeded with the planned restart of the system using the Heywood Interconnector. The first customers had power restored by 19:00 hrs on 28 September. AEMO reported that 40 per cent of the load in SA capable of being restored had been restored by 20:30 hrs, with 80 to 90 per cent restored by midnight.[14]

AEMO suspended operation of the spot market in SA immediately after the collapse of the power system into a black system and invoked the market suspension pricing schedule as required by the Rules. On Thursday, 29 September 2016, AEMO was directed to keep the market in SA suspended via a Ministerial direction made under the Essential Services Act 1981 (SA). The direction was extended on 6 October, and revoked on 11 October 2016.

9 Two Torrens Island units and two Ladbroke Grove units.

10 The nominal capacity of the Heywood Interconnector is 650 MW. Works to upgrade the capacity of the Interconnector from 460 MW to 650 MW were completed early in 2016.

11 AEMO, Final Report pp. 52–56.

12 Synergen Power is jointly owned by ENGIE (72 per cent) and Mitsui & Co Ltd (28 per cent).

13 We note that AEMO advised that Mintaro was not, and would not have been, called upon to provide SRAS on the day.

14 Load restoration continued on Thursday 29 September 2016 as transmission supply was restored to some areas in the north. Source: AEMO, *Black System South Australia 28 September 2016—Final Report*, published March 2017 ("AEMO, Final Report"), p. 75.

PRE-EVENT 1
Chapters 2 and 3

27 September	From 17:16 hrs	BOM issues severe weather warnings for maximum wind gusts of up to 120 km/h on 28 September
28 September	From 12:56 hrs	BOM issues updated severe weather warnings for maximum wind gusts of up to 140 km/h (actual conditions were not forecast)

EVENT 2

28 September	From 16:16:46 hrs	Severe weather damages transmission and distribution assets
		Resulting voltage disturbances cause shut down of several wind farms (about 456 MW)
		Loss of generation cause loss of synchronism between SA and Victoria – Heywood Interconnector trips off (as designed) separating SA from rest of the NEM
		Loss of interconnection exacerbates supply and demand imbalance, causing remaining online generators to also trip off
	16:18 hrs	South Australia goes black – no electricity supply from 16:18 hrs to 19:00 hrs
	16:25 hrs	Spot market in SA suspended

SYSTEM RESTORATION 3
Chapter 4

	16:30 hrs	Restart strategy identified using the Heywood Interconnector and Quarantine Power Station (QPS)
		Technical issues make QPS and another SRAS provider Mintaro unavailable
	19:00 hrs	Power to first customers, with 40% available load restored by 20:30 hrs and to 80–90% of customers by midnight
29 September	18:25 hrs	AEMO clears restoration of all remaining available load, advises black system condition no longer exists

MARKET SUSPENSION 4
Chapter 5

	20:39 hrs	SA Ministerial direction requires market to remain suspended, AEMO manually dispatching generators by telephone
4 October		AEMO advises SA Government the spot market in SA can be resumed. However, the market remains suspended
5 October		Dispatch instructions to Market Participants recommenced being issued by NEMDE. However, AEMO is still also dispatching generators by telephone
6 October	15:05 hrs	SA Government extends market suspension by seven days
11 October	22:30 hrs	Normal market operation resumes – SA Government direction revoked

WHERE NON-COMPLIANCE OCCURRED

Clause 4.2.3A(b) – Among other things, AEMO must take all reasonable steps to ensure that it is promptly informed of conditions posing added risks to the power system (defined as "abnormal conditions").

Clause 4.2.3A(c) – As soon as practicable after AEMO identifies a non-credible risk to the power system which is more likely to occur because of the existence of abnormal conditions, AEMO must provide Market Participants with a notification regarding the conditions and the risk, as well as whether AEMO has reclassified the risk as credible.

Clause 4.2.3B – Among other things, AEMO must:

- establish criteria to use when considering whether the existence of abnormal conditions makes the occurrence of a non-credible risk to the power system reasonably possible; and
- review those criteria at least every two years in consultation with relevant stakeholders while ensuring that the criteria include a requirement to evaluate any risk(s) to the power system associated with the various types of abnormal conditions that might arise.

Clause 4.8.5A – Among other things, AEMO must immediately publish a notice advising of any foreseeable circumstances that may require AEMO to intervene in the market through its reliability and reserve trader or clause 4.8.9 powers.

Clause 4.8.9(b) – AEMO must develop procedures for the issuance of 4.8.9 directions which reflect specified principles.

1.5 Key findings

We consider that there was non-compliance with five clauses of the Rules in relation to actions during the pre-event and market suspension periods. We have found no specific incidents of non-compliance with respect to system restoration. Our work in relation to the Event itself is ongoing.

1.5.1 AEMO

We have found non-compliance by AEMO with five clauses of the Rules. Three breaches concern administrative processes relevant to the period immediately prior to the Black System Event that can be best addressed through remedial actions by AEMO. A further two contravened clauses related to transparency and communication by AEMO during the 13-day market suspension period, which can be resolved through procedural improvements.

Pre-event compliance

Under the Rules, AEMO is obliged to use reasonable endeavours to maintain power system security. Under normal conditions, AEMO uses its reasonable endeavours to operate the power system so that it can cope with the unexpected loss of any single element such as the failure of a generator, or the failure of a single circuit transmission line.

The Rules enable AEMO to operate the system to allow for the simultaneous loss of more than one network element or generating unit where abnormal conditions (including severe weather, lightning, storms, and/or bush fires) are such that multiple failures become reasonably possible (having regard to criteria published in its Power System Security Guidelines). If that happens, AEMO must notify the market as it can lead to technical changes in the way power system security is maintained.

The Rules impose specific obligations on AEMO and market participants to ensure that all relevant parties are fully informed about any threats to power system security so that AEMO is able to decide whether to reclassify risks to the power system (also known as 'contingency events') appropriately and as transparently as possible.

In assessing compliance with the rules, we have considered whether AEMO:

- took all reasonable steps to inform itself of abnormal conditions as they developed
- was sufficiently transparent in its communication with the market about the potential effect of abnormal conditions on risks to the system
- complied with its obligations concerning reclassification of contingency events, including appropriately reviewing the reclassification criteria in its Power System Security Guidelines, and
- used reasonable endeavours to achieve its power system security responsibilities, including to maintain power system security.

During the pre-event period, power system imports into SA across the Heywood Interconnector were being limited at times by a transient stability limit.[15] For stability limits, there is little or no time for operator action to manage the power system after a contingency event and if the power system is not managed proactively the consequences are severe. Additionally, stability limits cannot be determined in real time. Hence, when these limits apply, it is important for AEMO to take more active steps to maintain flows on the interconnector at or below the secure operating limit in readiness for a contingency event.

At times during the pre-event, however, actual measured 4-second and 5-minute interconnector flows exceeded the import limit by up to 183 MW and 156 MW, respectively. As stability limits cannot be determined in real time, we cannot conclusively state that the power system was known to be in a secure operating state during the pre-event period. However, AEMO stated that modelling it had undertaken after the event demonstrated that the power system did remain in a secure operating state throughout. Furthermore, we accept that there was no information before AEMO about the loss of double circuit towers.

We have identified non-compliance by AEMO with some provisions of the NER relevant to the pre-event period which relate to administration and communication processes. We do not consider any of these breaches were material to the Black System Event that ultimately occurred. However, while we do not consider these breaches were material in this event, we consider that attention to these issues would improve preparedness for, and management of, similar events in the future. Administrative processes relating to communication flows will become increasingly important as the market evolves, with an increasing number of participants operating different technologies in the NEM.

The specific breaches are:

1. Abnormal conditions (NER clause 4.2.3A(b)): Failure to take all reasonable steps to keep itself informed of abnormal conditions. While AEMO took several steps to keep itself promptly informed about the abnormal conditions on the day, we consider an additional reasonable step could have been taken.
2. Notification to market participants (NER clause 4.2.3A(c)): Failure to provide formal notification to market participants that the loss of multiple generating units or transmission elements, which would not be a credible risk in normal operating circumstances, was more likely to occur because of the abnormal weather conditions on the day. Although the evidence indicates AEMO considered this and communicated with some market participants about it, it failed to provide the appropriate notification as required by the NER.
3. Review of criteria for reclassifying contingency events (NER clause 4.2.3B): Failure to conduct formal reviews of the reclassification criteria in the manner required by the NER in the three years prior to the Black System Event. The specific consultation documents we have reviewed are limited in scope to bushfires and lightning, and do not invite relevant stakeholders to comment on other criteria in the Power System Security Guidelines or criteria that could potentially be included.

Despite these administrative breaches, we have found that overall AEMO satisfied its obligation to use reasonable endeavours to maintain power system security during the pre-event period considering the various steps it took to maintain a secure operating state. The steps AEMO took included:

- considering whether the Heywood Interconnector target flows and flow limits were appropriate
- reallocating its internal resources to focus on power system events in SA, including wind farm output and the potential impact on the SA transmission network due to lightning
- discussing with AusNet the possibility of cancelling outages to provide additional capacity on the interconnector
- identifying that abnormal conditions made risks to power system security more likely and considering whether to reclassify the Heywood Interconnector due to lightning, and
- considering on a regular basis whether the occurrence of a non-credible contingency was reasonably possible.

15 AEMO, Final Report p. 96.

System restoration compliance

When there is a major supply disruption and the power system is de-energised, one or more generators may be required to restart the system. SRAS is provided by contracted generators with the ability to restart themselves independent of the electricity grid. These generators provide enough energy to re-energise the network and restart other generators to allow the restoration of the system.

Given the nature of black system events, there are a number of preparatory steps that AEMO has to undertake and coordinate in order to achieve a successful system restoration. These include:

- procuring sufficient and appropriate SRAS from SRAS Providers
- overseeing annual testing for SRAS Providers to demonstrate capabilities
- reviewing and approving local black system procedures (LBSPs) submitted by NSPs and generators
- preparing a system restart plan for each region and distributing the requirements to relevant market participants, and
- having in place joint communication protocols with NSPs to facilitate exchange of information relevant to the roles of various participants in the implementation of the system restart plan.

AEMO's Final Report shows that the time taken to restore the SA power system compared favourably with international restoration timeframes.[16] This was notwithstanding that both SA generators contracted to provide SRAS were incapable of delivery due to technical issues (noting that Synergen Power's Mintaro Power Station was not and would not have been called upon to provide SRAS on the day). Origin's Quarantine 5 unit was unable to provide SRAS because the switching arrangements used on the day by ElectraNet were not compatible with Origin's auxiliary equipment. Neither AEMO nor Origin were aware that the switching arrangements ElectraNet had prepared were different to those used in Origin's annual testing.

While successful restart requires coordination between AEMO, SRAS Providers, NSPs and all generators, AEMO has ultimate responsibility as system operator.

While the AER has determined that AEMO used reasonable endeavours to meet its power system security responsibilities by procuring and utilising SRAS and undertaking the mandated preparatory steps, several gaps have been identified in the regulatory and administrative framework which led to a lack of:

- clear understanding of roles and responsibilities
- clear guidance on what is required at each step, and
- rigorous approval processes at each step.

During the investigation, it was clear that all SA participants were motivated to restore power as fast as possible and that they worked well together. However, it was also clear that the sharing of information between SRAS providers, NSPs and AEMO throughout the preparatory process—from procuring SRAS to developing the System Restart Plan—could be improved.

We consider it was a general lack of clarity in the Rules around roles and responsibilities and linkages between different steps in the procurement and testing processes, including the sharing of technical information, which was fundamental to the failure of SRAS on the day. We consider improved administrative processes and communication protocols may assist in reducing future risks.

This is the subject of AER actions to change the Rules and our recommendation for AEMO to provide additional guidance regarding LBSPs. We acknowledge that AEMO's revised SRAS Guidelines released in December 2017, to which we contributed, go a material way to addressing many of the underlying issues by strengthening the SRAS procurement and testing regime.

Compliance during market suspension

Market suspension is rare, having only occurred once before,[17] and involves specific rules and procedures that have had limited precedents. The lengthy period of the market suspension, 13 days, posed several challenges for AEMO, including in respect of the administration of market suspension pricing as well as the dispatch of generators and managing power system security.

Following the restoration of the power system after the Black System Event, from 30 September 2016 to 4 October 2016, AEMO was manually dispatching generators by telephone instead of its usual electronic system. This was because AEMO lacked confidence in the pre-dispatch and dispatch outcomes of NEMDE (the dispatch engine).[18]

This is unusual, but we note that the Rules, as well as AEMO's procedures, allow for instructions to be issued other than electronically (i.e. manual dispatch instructions via telephone) if normal processes are not available.[19] AEMO commenced electronic dispatch via NEMDE on 5 October 2016.

16 AEMO, Final Report p. 7.

17 The first market suspension occurred on 8 April 2001 for a period of two hours affecting all regions of the NEM following a market systems (IT system) failure.

18 AEMO, Final Report, p. 86.

19 See clause 3.8.21(e) and AEMO System Operating Procedure: 'Failure of Market or Market Systems', paragraph 10.1.

In assessing AEMO's compliance with its market suspension obligations and management of power system security during the period in which the spot market in SA was suspended, we have considered:

- whether AEMO followed proper processes in its decisions to suspend and restore the market, and whether market participants had a sufficient understanding of the process
- how market suspension pricing was administered, including impacts on other regions, and
- AEMO's management of power system security, including when it reclassified wind farms, how it intervened in the market, as well as the publication of market notices.

The specific areas of identified non-compliance by AEMO with the Rules at a high level are:

1. Publication of notices (NER clause 4.8.5A): Failure on several occasions to issue market notices when there were foreseeable circumstances that may have required AEMO to intervene in the market. There was also an occasion when AEMO did issue a market notice, but we assessed that it was not sufficiently immediate.
2. Operating procedures (NER clause 4.8.9(b)): Failure to adequately develop procedures for the issuance of directions in line with the legislated principles as required.

Evidence from the call recordings, as well as from discussions with generators, show that this non-compliance resulted in confusion among generators as to whether they were being formally directed, reducing their ability to make informed decisions. Our recommendations therefore relate to transparency through the publication of timely market notices as well as clarity of verbal communications.

1.5.2 ElectraNet

We reviewed ElectraNet's compliance with numerous obligations in relation to the pre-event and system restoration periods and have determined that ElectraNet met the applicable obligations under the Rules.

Pre-event compliance

ElectraNet in its capacity as a Transmission Network Service Provider (TNSP), System Operator and Registered Participant has obligations under the Rules to notify AEMO of any circumstances that could pose a risk to power system security or any equipment owned or operated by the participant.

These obligations include:

- ensuring that the transmission network elements are operated within appropriate operational or emergency limits, and
- promptly informing AEMO, when it becomes aware, of:
  - the state of the security of the power system (including assessing the impacts of the transmission network elements on the operation of the power system)
  - whether there are any actual or anticipated threats to power system security (including any threats to the secure operation of any equipment owned or controlled by ElectraNet), and
  - whether any action is, or is contemplated to be, carried out to maintain or restore the power system to a satisfactory operating state.

We have examined ElectraNet's actions during the pre-event period in relation to monitoring weather conditions, assessing any threat to transmission network assets and communicating its assessment of power system security with AEMO.

Based on the information before us we consider that ElectraNet monitored weather conditions and the state of its network on a continuous basis during the pre-event period such that it was able to be aware of, and assess, any risks to power system security to the degree expected of a TNSP. This included being aware of, and assessing, the impact and likely impact of the storm on its transmission network elements, as well as their impact on the operation of the power system.

We assess that ElectraNet took account of the forecast weather conditions in operating its transmission network within appropriate operational and emergency limits. We formed this view based on the information before us that:

- there was no information that would have led ElectraNet to advise AEMO of the need to reclassify any non-credible contingency event to a credible contingency event, specifically in relation to the loss of a double circuit transmission line or the simultaneous loss of multiple single lines
- ElectraNet took appropriate risk mitigation actions available to it, including recalling planned outages, having additional crew and maintenance providers on standby, and having additional control room staff on hand, and
- there was no information that would have caused it to proactively de-energise lines.

We consider that ElectraNet communicated in a manner consistent with its established communication practices. ElectraNet had no concrete evidence of likely damage to specific assets, which would, based on past practice, normally form the basis of discussions regarding reclassification. ElectraNet communicated to AEMO its intention to recall planned outages and have standby crews available.

System Restoration compliance

Switching arrangements carried out by ElectraNet played a central role in Origin's QPS5 being unable to provide contracted SRAS during the system restoration period. As highlighted above, ElectraNet used a switching procedure on the day (utilising what is called a hard start to energise relevant auxiliary plant) which was different to that used during Quarantine's annual SRAS testing (which used a soft start). Our investigation determined that ElectraNet's system restart switching plans had always specified a hard start for Quarantine, just as Origin's SRAS testing had always used a soft start. ElectraNet advised us that hard starts are standard during actual system restarts; we found this was not conveyed to Origin or AEMO. We were provided with information that showed that Origin directly informed AEMO that a soft start was required at all times but we were not presented with conclusive evidence that this was directly conveyed to ElectraNet. There was a lack of clarity about responsibilities for sharing of relevant information between AEMO, ElectraNet and Origin.

ElectraNet had two sets of obligations under the Rules—to negotiate in good faith with a prospective SRAS provider (in this instance Origin) and facilitate SRAS testing during the procurement process, and to assist AEMO with its power system security responsibilities (including system restoration). The latter includes overarching obligations to assist AEMO to discharge its power system security responsibilities, undertake certain system operation functions delegated by AEMO and requirements to prepare detailed system switching for restoration options specified by AEMO.

On the information before us, ElectraNet met its obligations during the SRAS procurement process. We also consider that on balance, ElectraNet used reasonable endeavours in respect of its broad obligations to cooperate and assist AEMO in relation to system restoration. At the same time, we consider that there were possible steps ElectraNet could have taken, namely, to have consulted with AEMO and Origin on the system restart switching program. The development of more detailed communication protocols with AEMO may have facilitated such consultation.

Requirements in the Rules regarding communication protocols and the role of NSPs in the delivery of SRAS are the subject of AER future actions set out below.

1.5.3 Origin Energy, Synergen Power and other generators

Origin (QPS5) and Synergen Power (Mintaro Power Station) were the contracted SRAS providers for South Australia. On review and assessment of Origin's actions, while Quarantine was not successful in delivering restart services, we consider Origin met its obligations during the restoration by following directions from AEMO and complying with the provisions under its SRAS Agreement and the LBSP it was required to develop. We also assessed Synergen Power's LBSP as compliant.

Regarding the market suspension period, we assessed that AGL and ENGIE in Australia[20] complied with obligations around AEMO's issuance of directions to them. Overall, the AER acknowledges that this period was challenging for generators, many of whom have advised they were incurring losses due to the low market suspension pricing schedule that was in operation.

1.6 Recommendations

While we have found some areas of non-compliance with administrative requirements in the Rules, we do not intend to take formal enforcement action in respect of these matters, as we consider that it would be more effective to focus on remedial recommendations for improved processes. Further, we have noted the unprecedented circumstances as part of our consideration of all the available information.

We have adopted this compliance response in recognition of both the actions that have been taken by AEMO and others since September 2016 to address some of the issues identified, and the objectives of the national energy laws, that is: to promote efficient investment in and efficient operation and use of energy services for the long term interests of consumers with respect to price, quality, safety, reliability and security of supply of energy.[21]

With regard to several of the remedial recommendations, we acknowledge that AEMO has already undertaken measures that may satisfy the requirements of a particular recommendation. As set out in the final section below, we will take into account these measures through our ongoing compliance engagement activities.

20 ENGIE in Australia is a group of companies which encompass Pelican Point Power Ltd, the registered participant for the Pelican Point power station.

21 Section 7 NEL, section 23 National Gas Law and section 13 National Energy Retail Law.

Table 2 Remedial recommendations to address non-compliance

Obligation/clause	Summary assessment of non-compliance	Ref.	Recommendation
Pre-event			
Abnormal conditions AEMO to take all reasonable steps to keep itself informed of abnormal conditions (Clause 4.2.3A(b))	We consider that by failing to utilise the updated weather warnings issued by BOM from 12:56 when constantly reviewing the early morning decision not to reclassify, AEMO did not take all reasonable steps to ensure that it was promptly informed on a continual basis of how the abnormal conditions were evolving. AEMO, on receipt of the updated warnings, should have taken the reasonable step of reviewing and taking into account that information for the purpose of identifying whether a contingency event was more likely to occur, consistent with clause 4.2.3A(b)(2).	2.1	To keep itself promptly informed of abnormal conditions, AEMO to put in place more rigorous processes to monitor weather warnings and forecasts at all times, not just at times of extreme weather.
Notifications to Market Participants AEMO notification to market participants regarding non-credible contingency events and abnormal conditions (Clause 4.2.3A(c))	We have concluded that AEMO did consider a non-credible contingency event during the pre-event period was more likely to occur because of the existence of abnormal conditions. It was not necessary for AEMO to conclude that a reclassification was necessary at that point in time, in order to trigger this obligation. However, AEMO did not provide Market Participants with a notification as required by clause 4.2.3A(c). Hence, our finding is that AEMO did not fully comply with clause 4.2.3A(c).	2.2	AEMO to review its processes for issuing notifications to Market Participants during abnormal conditions. AEMO's processes should be standardised and clearly communicated to Market Participants, such that if AEMO is of the view that: • a non-credible contingency event is more likely to occur due to abnormal conditions, it must issue a notification to Market Participants in accordance with clause 4.2.3A(c) • material new information has arisen relevant to its consideration of whether the event is reasonably possible, it must update the notification in accordance with clause 4.2.3A(d), or • abnormal conditions are no longer materially affecting the likelihood of a non-credible contingency event, it must issue a notification to Market Participants to this effect.

Obligation/clause	Summary assessment of non-compliance	Ref.	Recommendation
Reclassification criteria AEMO to establish and review reclassification criteria for assessing a non-credible contingency (Clause 4.2.3B)	We consider that AEMO's reclassification criteria were not reviewed in the manner intended under the Rules in the three years prior to the Black System Event, namely that only individual criteria were reviewed.	2.3	AEMO to holistically review the criteria at least once every two years and in that process consult with Market Participants, Transmission Network Service Providers (TNSPs), Jurisdictional System Security Coordinators, relevant emergency services agencies and other relevant stakeholders such as BOM. In conducting this review, AEMO should not only assess whether existing criteria are adequate, but also whether there are any gaps in the criteria. This also includes assessing any non-credible contingency events that have happened and considering whether the criteria need to be adjusted, developed, expanded or explained in more detail, in light of that experience.
		2.4	AEMO to ensure that the criteria include a requirement to have regard to the particulars of any risk(s) associated with any abnormal conditions that AEMO and relevant stakeholders identify through the consultation process.
		2.5	AEMO to introduce a framework and criteria regarding its approach to the reclassification of non-credible contingencies due to abnormal conditions that are not explicitly identified in the Power System Security Guidelines (PSSG), including a risk assessment framework.
Market suspension (dispatch of generation and power system security)			
Market Notices AEMO to publish a notice without delay when it may need to intervene (Clause 4.8.5A)	We assess that aside from the formal clause 4.8.9 directions issued to ENGIE's Pelican Point and AGL's Torrens Island power stations respectively (which are considered in the next row below), that it is clear that there were multiple occasions in which there were foreseeable circumstances that may have required AEMO to implement an AEMO intervention event.	5.1	Improved training for AEMO operators regarding the specific language used to ensure operators clearly state whether they are making a request, issuing instructions, or otherwise issuing clause 4.8.9 directions.
		5.2	AEMO ensures that it publishes market notices, without delay, after it becomes aware of any foreseeable circumstances that may require AEMO to implement an intervention event and that it updates its procedures and guidelines accordingly.

Obligation/clause	Summary assessment of non-compliance	Ref.	Recommendation
Market Notices AEMO to publish a notice without delay when it may need to intervene (Clause 4.8.5A)	*ENGIE Pelican Point direction:* AEMO did not publish a market notice advising that it may need to intervene through an AEMO intervention event prior to issuing the relevant direction, therefore AEMO did not comply. We found that it is reasonably practical to publish a market notice within the space of one hour and 50 minutes. *AGL Torrens Island direction:* The evidence indicates that AEMO was anticipating an intervention event and did not issue a market notice for six hours 32 minutes. We assess that this length of time is not sufficiently immediate[22] to be compliant with clause 4.8.5A(a), and in any event failed to comply with clause 4.8.5A(c) as it did not estimate and publish the latest time it would need to intervene.	5.2	As above
AEMO's directions procedures AEMO must develop procedures for the issuance of directions (Clause 4.8.9(b)) AEMO's System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions	While AEMO did develop procedures (titled System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions"), clause 4.8.9(b) states that the procedures must reflect the principles within that clause. However, AEMO's procedures (System Operating Procedure SO_OP_3707) do not fully reflect the principles. Further, AEMO did not follow all the steps outlined in section five of the procedures in respect of "AEMO actions when issuing a direction or clause 4.8.9 instruction".[23]	5.1	As above
		5.2	As above
		5.3	AEMO ensures that its procedures more closely align with what is prescribed in the Rules particularly regarding directions (clause 4.8.9) and market notices (clause 4.8.5A).

22 We consider 'immediate', as used in this context, to mean 'without delay'. Once AEMO becomes aware of circumstances that may require it to implement an intervention event then it should publish a notice of these foreseeable circumstances 'without delay'. We consider that the term 'immediately' in the NER would have been included to ensure that the market is given the maximum available time to respond. This is consistent with the extrinsic material that accompanies the 2008 rule change.

23 AEMO, *System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions"*, section 5, p. 6 (V 19).

1.7 Further recommendations and remedial actions

We are making recommendations not only regarding non-compliance, but also more broadly where we have identified other issues. Our goal in identifying future improvements is to ensure there is better management by all relevant parties—including with regard to transparency and clear communications—should similar circumstances arise again in the future. We recognise that some steps have already been taken, or are underway, to address this, which is discussed below in section 1.8—Changes to the energy industry since the Black System Event. The AER's further recommendations and remedial actions are as follows.

Pre-event (ElectraNet)

In reviewing the material before us, we have become aware of some asymmetry between ElectraNet's and AEMO's interpretation of ElectraNet's role and responsibilities in relation to reporting information to AEMO. The provision of information by participants can be critical to AEMO's management of power system security. We therefore intend to conduct an industry-wide compliance review of clauses 4.3.3(e), 4.3.4(a) and 4.8.1 to verify that there is alignment between Registered Participants' and AEMO's expectations in relation to the extent and type of information to be communicated by Registered Participants to AEMO.

System restoration

Our investigation into system restoration has determined that there were no specific incidents of non-compliance with respect to system restoration. We have identified, however, improvements that could be made to address some gaps in SRAS processes.

These recommendations, including AER actions, are outlined in Table 3 below.

Table 3 Further recommendations and remedial actions

Framework component	Ref.	Recommendation/remedial action
SRAS process	4.1	AER to propose a rule change to clarify the TNSP's involvement in the SRAS process beyond procurement. This involvement to extend to include facilitating ongoing testing of SRAS to ensure that SRAS continues to be capable of being delivered and the actual deployment of SRAS during system restoration. This includes complying with applicable requirements in the SRAS Guideline.
SRAS Procurement	4.2	AER to propose a rule change to amend clause 3.11.7(d) of the Rules to specify that the SRAS Guideline set out that the testing of SRAS is to include a comparison with the arrangements planned to be utilised during a major supply disruption.
LBSPs	4.3	AEMO, during its next review of the LBSP Guidelines, consult with Generators and NSPs on providing more detailed content in the LBSPs and on the level of guidance provided in the LBSP Guidelines. This will assist and guide the growing number of new, smaller participants who will be required to develop LBSP.
Communication applied through the entire SRAS process	4.4	AER to propose a rule change to require AEMO and NSPs for each region to jointly prepare written communication protocols which set out the timing of and manner in which information will be exchanged and between which parties, both in preparation for and during a major supply disruption specifically, and the nature of that information including: • AEMO to liaise directly with all TNSPs and generators, including through the dissemination of LBSPs to other parties where appropriate and the System Restart Working Group • TNSPs to liaise directly with: – DNSPs and customers connected to their transmission network regarding the nature of connection point and load characteristics – Generators regarding connection point characteristics and the nature of switching that may need to be conducted during the process of system restoration • DNSPs to liaise directly with parties (including embedded generators) connected to their distribution network regarding the nature of connection point and load characteristics. We note that the exchange of information may include information that is confidential or protected and that any communication protocol will need to address such matters in accordance with the relevant legal requirements and powers.

Framework review

Following the completion of our investigation, the AEMC is required to undertake a policy review of the regulatory framework as it relates to the Black System Event.

As set out in the 'Implications for the Regulatory Framework' chapter, through the course of our investigation we have identified issues with the regulatory framework that warrant further policy consideration and assessment.

This includes providing greater clarity and transparency about roles and responsibilities, not only to address gaps in the framework but also to address areas in which the AER and AEMO have differing viewpoints as to what the framework requires.

Where the Rules provide parties such as AEMO with the flexibility to apply judgment and expertise, this power is usually accompanied by a requirement to establish a decision-making process in consultation with affected participants and by obligations ensuring transparency of decision-making. This recognises that participants require certainty and transparency around decisions that may fundamentally impact their investment and operational outcomes, as well as the overall efficiency of the market.

More broadly, the basis of having rules such as the NER is that the stakeholders - in this case, AEMO and participants alike - are aware of the governing framework in which they operate. If there is doubt about how the Rules should be applied in a particular set of circumstances, this needs to be resolved to provide clarity both to the person(s) on whom the obligation is imposed and to other affected participants.

It is also necessary for the market framework to be reviewed to enable it to better accommodate the rapid changes in technologies currently being experienced, and in changing the Rules where required.

Importantly, whilst we have raised specific aspects of the framework that relate to the Black System Event, we do not consider that the deficiencies outlined in this chapter caused the Black System Event.

1.8 Changes to the energy industry since the Black System Event

Since the Black System Event, the AEMC, AEMO and other industry participants have worked together to reduce the likelihood of a similar event occurring in the future and improve the power system security framework. The recommendations outlined above build on this body of work which to date has included:

- the 'Independent review into the future security of the National Electricity Market' (Finkel review), released in June 2017, which is intended to provide a blueprint for the energy industry to adapt to new and emerging issues[24]
- AEMO's 'Black System Report'—its direct response to the Black System Event, in which it identified 19 recommendations involving AEMO action or input. AEMO has since endeavoured to implement these changes, as evidenced through various publications and operational actions,[25] and
- the AEMC's 'System security and reliability action plan', which has involved a number of reviews and rule changes.[26]

A number of other organisations have also considered how power system operations might be improved, including:

- the Council of Australian Governments (COAG) Energy Council's 'market transformation program',[27] and
- the Essential Services Commission of South Australia's (ESCOSA's) 'Inquiry into the licensing arrangements for generators in South Australia'.[28]

Finkel Review

The Finkel Review was commissioned by COAG energy ministers on 7 October 2016, and published on 9 June 2017. The review sets out a blueprint with four deliverable key outcomes:

- increased security
- future reliability
- rewarding consumers, and
- lower emissions.

The blueprint consists of 50 recommendations intended to achieve these outcomes. The Federal Government ultimately accepted 49 of these recommendations. The review emphasises that delivering a secure and reliable electricity supply is the highest priority, and that "low emissions and affordable supply must be delivered through a power system that is secure and reliable". The review states that its guiding objective is "to ensure a secure and reliable electricity supply that meets our emissions reduction targets at the lowest cost".

Many of the recommendations state that AEMO and the AEMC should take certain actions. Both market bodies have undertaken various projects as a result of, or in fulfilment of,

24 A. Finkel et al., *Independent review into the future security of the National Electricity Market*, published June 2017. See www.energy.gov.au for more details.

25 AEMO, Final Report. See www.aemo.com.au for more details.

26 AEMC, *AEMC's system security and reliability action plan*, https://www.aemc.gov.au/our-work/our-current-major-projects/keeping-energy-system-secure-and-reliable.

27 COAG Energy Council, Energy Market Transformation, http://www.coagenergycouncil.gov.au/council-priorities/energy-market-transformation.

28 ESCOSA, *Inquiry into the licensing arrangements for generators in South Australia*, published August 2017. See www.escosa.sa.gov.au for more details.

the recommendations—where relevant to this report, these projects are explained below.

AEMO's Black System Event Report Recommendations and other actions

In its 'Black System Event final report' released in March 2017, AEMO made 19 recommendations requiring AEMO action or input in relation to the pre-event, event, system restoration and market suspension periods of the Black System Event. The main publications AEMO has since released in relation to these recommendations include:

- 'South Australia system strength assessment'—establishes a requirement for a minimum level of synchronous generation to remain online in SA at all times until regulatory frameworks are able to adequately deal with system strength issues
- 'Power system frequency risk review 2017'—recommends the implementation of an Emergency Frequency Control Scheme (EFCS) to mitigate the risk that a non-credible loss of multiple generating units will lead to a black system in SA
- 'Power system frequency risk review 2018'—recommends upgrading the above-mentioned EFCS and states that AEMO intends to formally request the Reliability Panel create a new protected event to manage risks relating to transmission line failure causing generation disconnection during destructive wind conditions in South Australia. The risk would not have to be such that AEMO would reclassify the generation disconnection as a credible contingency event
- 'Integrated System Plan'—forecasts transmission system requirements for the NEM over the next 20 years and provides AEMO's 'key observations for the future of a successful NEM', including the importance of distributed energy resources, renewable energy zones, a broad portfolio of generation and the role of transmission
- 'System Restart Ancillary Services (SRAS) Guideline 2017'—strengthens the processes that AEMO and industry participants are required to follow when procuring SRAS. It helps clarify the respective roles and responsibilities of AEMO, the SRAS Provider, the TNSP and other relevant third parties, and
- 'Consultation on amendments to the Wind Energy Conversion Model (ECM) Guidelines—final report'—recommends changes to wind farm generation forecasts to improve forecasting accuracy in extreme wind situations.

AEMO's Black System Event recommendations formed part of its 'Summer Readiness Plan' for 2017/18. This plan also included dealing with issues relating to:

- acting with generation operators and state governments to increase the NEM's available generation capacity throughout summer
- increasing demand response capacity. To this end, AEMO and the Australian Renewable Energy Agency (ARENA) have conducted a joint demand response trial
- cooperating with state governments to monitor fuel availability, and intervene in the market if necessary
- working with TNSPs through the Power System Security Working Group to minimise planned maintenance outages and complete planned interconnector and other transmission network upgrades before summer where possible, and
- engaging in training and communication with key stakeholders in relation to summer readiness.

In relation to the monitoring of weather forecasts, AEMO states that since the Black System Event it has established more rigorous processes to monitor weather warnings and forecasts at all times (not just at times of extreme weather) including through the secondment of a weather forecaster to AEMO.

Furthermore, following the market suspension period:

- AEMO states it has clarified its communication of directions to generators by developing a standard script for its operators to use when issuing formal directions
- in October 2017, the AEMC also made an AEMO-initiated rule change in relation to market suspension pricing arrangements. The benefit of the rule change is that AEMO will be able to publish prices in real time and give greater certainty to the market. This Rule commenced operation on 1 December 2017, and
- on 15 November 2018, the AEMC made a final rule determination following an AEMO proposal for the addition of rules to allow for compensation to be paid to generators who operate at a loss during market suspension periods.

AEMC's System Security and Reliability Action Plan

Since the Black System Event, the AEMC has worked on implementing its 'System security and reliability action plan', involving a number of reviews and rule change proposals. It has made the following rule changes (some of which were proposed by AEMO) since the Black System Event in relation to power system security:

- 'Emergency frequency control scheme' rules (March 2017)—this rule change is intended to address non-credible contingency events that have significant consequences for power system frequency. Where the benefits of managing the event outweigh the costs, the Reliability Panel is obliged to declare the event to be a "protected event". In addition, where the efficient management option includes a new or modified emergency frequency control scheme, the Reliability Panel would set a “protected event EFCS standard”, or set of target capabilities, for the scheme. NSPs would then be required to design, implement and monitor the scheme in accordance with the standard. NSPs would be exempt from having to undertake the RIT-T (or RIT-D).

- ‘Managing the rate of change of power system frequency’ rule change (September 2017)—intended to manage the rate of power system frequency by requiring minimum inertia levels.
- ‘Managing power system fault levels’ rule change (September 2017)—TNSPs are now required to maintain minimum levels of system strength.
- ‘Generating system model guidelines’ rule change (September 2017)—helps improve guidelines for generating system models so that AEMO and networks have the data they need for planning and operational purposes.
- ‘Generator technical performance standards’ rule change (September 2018)—makes significant changes to technical performance standards for generators seeking to connect to the national electricity grid, and the process for negotiating those standards.
- ‘Register of distributed energy resources’ rule change (September 2018)—requires AEMO to establish a register of distributed energy resources, including small-scale battery storage systems and rooftop solar.

The AEMC and the Reliability Panel have also conducted various reviews of power system issues, including:

- the AEMC’s ‘System security market frameworks review’—the AEMC states that its ‘priorities in the review have been to develop recommendations that will result in a stronger system, a system better equipped to resist frequency changes, better frequency control and actions to further facilitate the transformation’. The review recommendations have largely been met through the rule change proposals AEMC has assessed as part of its ‘System security and reliability action plan’, as well as through AEMO’s System Strength Impact Assessment Guidelines and Power System Model Guidelines (published on 1 July 2018)
- the Reliability Panel’s review of frequency operating standards—stage one, which considered various issues including the new category of ‘protected contingency event’ in the frequency operating standard, is now complete. Stage two covers ‘a broader consideration of the settings of the frequency operating standard’, and consultation on this stage of the review is still open
- the Reliability Panel’s ‘Annual market performance review 2017’—notes that in 2016/17, the security performance of the NEM was mixed, with 11 instances of the power system “being operated outside its secure limits for greater than 30 minutes”, and
- the AEMC’s ‘Frequency control frameworks review’—highlights several issues with the existing market and regulatory arrangements for frequency control, and makes recommendations on how they could be addressed.

1.9 Next steps

Our assessment of the compliance outcomes of the extensive and unprecedented set of circumstances surrounding the Black System Event has identified areas where changes should be considered to improve the overall effectiveness of the regulatory framework.

This includes providing greater clarity and transparency about roles and responsibilities, both for the industry overall and also to address areas in which the AER and AEMO have differing viewpoints about what the Rules require.

Some of these changes are administrative, some are already underway, and others will require Rule changes to be implemented.

As the Rule maker, the results of this assessment will now be referred to the AEMC for a review of the legislative framework relevant to the Black System Event, which must be completed within six months of this report being published.

The AER will be working closely with the AEMC, not only in regard to the aforementioned proposed rule changes, but also in relation to the broader framework issues that have arisen where it is clear that the AER and AEMO have very different interpretations of the Rules.

The AER will also be undertaking follow-up monitoring and compliance reviews in relation to the key issues we found, particularly around communications and transparency, not only concerning AEMO’s conduct, but that of all relevant Registered Participants.

Pre-event compliance assessment (AEMO)

2. Pre-event (AEMO) compliance

2.1 Summary

During times of threats to power system security, the NER impose obligations on AEMO and Registered Participants that do not necessarily exist during times of normal power system operation. These obligations are aimed at ensuring AEMO and participants are fully informed about the threats and that AEMO is able to reclassify contingency events appropriately and as transparently as possible. Sitting above this is AEMO's overarching obligation to maintain power system security.

The pre-event period of the Black System Event covers the period on 27 and 28 September 2016 up until, but not including, the transmission line faults in SA which occurred from 16:16:46 hrs onwards on 28 September 2016.

On 28 September, and the days leading up, weather forecasting services warned about a severe storm heading towards SA. On the day, BOM issued a number of severe weather warnings, including predictions of damaging winds and thunderstorms.

The key events that triggered the Event were:

- the loss of multiple transmission lines, including as a result of tower failures, in quick succession
- in AEMO's assessment, multiple wind farms not riding through the voltage disturbances caused by the transmission faults,[29] and
- the subsequent activation of the loss of synchronism protection relays on the Heywood Interconnector separating SA from the rest of the NEM and substantially reducing the available capacity to meet demand.

These key events all occurred between 16:16:46 hrs and 16:18:16 hrs and were precipitated by storm supercells and tornadoes,[30] which were not forecast by BOM.

Consistent with our role of reviewing compliance with the NEL and the NER, we have examined the actions of AEMO and ElectraNet in respect of the pre-event period. This chapter considers AEMO's compliance, while a separate chapter addresses ElectraNet.

The key issues we have considered include whether AEMO:

- took reasonable steps to inform itself of abnormal conditions as they developed
- was sufficiently transparent in its communication with the market about the potential effect of abnormal conditions on risks to the system
- complied with its obligations concerning reclassification of contingency events, including having appropriate procedures in place for reclassification, and
- used reasonable endeavours to achieve its power system security responsibilities.

Given the significance of the Black System Event, our compliance assessment has gone beyond the key events that triggered the Black System Event to assess AEMO's approach to:

- reclassification processes in relation to non-credible contingency events that did not eventuate, and
- monitoring and managing risks that we consider, on the evidence before us, AEMO operators had identified.

AEMO did not reclassify any contingency events during the pre-event period. We are satisfied that it was a reasonable decision not to reclassify the loss of multiple transmission lines or the failure of multiple wind generator units as credible, having regard to all the circumstances.

More generally, we accept that there was no information before AEMO about the loss of double circuit towers. We also understand that AEMO claims not to have had any information about the multiple low voltage ride through (LVRT) settings in the wind turbines operating in SA during the pre-event period. We have identified some areas of non-compliance by AEMO with the NER, in particular:

- while AEMO took a number of steps to keep itself promptly informed about the abnormal conditions on the day, we consider other reasonable steps could have been taken, namely to have reviewed and taken into account, as it became available, the updated BOM forecast information about the developing storm
- although the evidence indicates AEMO considered non-credible contingency events (the loss of multiple generating units or transmission elements) were more likely to occur because of the abnormal conditions on the day, and communicated with some Market Participants about this, it failed to provide a formal notification to Market Participants as required by the NER

29 AEMO, *Black System South Australia 28 September 2016—Final Report,* published March 2017 ("AEMO, Final Report"), p. 6.

30 BOM defines "supercell" as "a very strong long-lived thunderstorm type in which the system can maintain an almost steady state for many hours. A highly organised cloud-scale circulation with a continuous large updraught and magnified size and impact make this a fascinating but dangerous cloud complex. Supercells account for most of the severe thunderstorm events we experience". Source: BOM, *Severe Thunderstorms*, http://www.bom.gov.au/weather-services/severe-weather-knowledge-centre/severethunder.shtml.

- we consider that AEMO's reclassification criteria were not reviewed in the manner intended under the NER in the three years prior to the Black System Event.

During the pre-event period, power system imports into SA across the Heywood Interconnector were being limited at times by a transient stability limit. For stability limits, there is little or no time for operator action to manage the power system after a contingency event and if the power system is not managed proactively the consequences are severe. Additionally, stability limits cannot be determined in real time. Hence, when these limits apply, it is important for AEMO to take more active steps to maintain flows on the interconnector at or below the secure operating limit in readiness for a contingency event.

At times during the pre-event, however, actual measured 4-second and 5-minute interconnector flows exceeded the import limit by up to 183 MW and 156 MW, respectively. Interconnector flows exceeding the limit and target were correlated with wind generation output being lower than expected. More generally, wind farm output was more variable than usual during the pre-event period, due in part to high wind speeds causing over-speed protection to shut down some wind turbines.

As stability limits cannot be determined in real time, we cannot conclusively state that the power system was known to be in a secure operating state during the pre-event period. However, AEMO states that modelling it had undertaken after the event demonstrated that the power system did remain in a secure operating state throughout.

While we consider AEMO could have undertaken additional reasonable actions in managing power system security, we conclude that AEMO satisfied its obligation to exercise reasonable endeavours to maintain power system security during the pre-event period in light of the various steps it took to maintain the power system in a secure operating state. The steps AEMO took included:

- considering whether the Heywood Interconnector target flows and flow limits were appropriate
- reallocating its internal resources to focus on power system events in SA, including wind farm performance and the potential impact on the SA transmission network due to lightning
- discussing with AusNet the possibility of cancelling outages to provide additional capacity on the interconnector
- identifying that abnormal conditions made risks to power system security more likely and considering whether to reclassify the Heywood Interconnector due to lightning, and
- considering on a regular basis whether the occurrence of a non-credible contingency was reasonably possible.

The instances of non-compliance that we have identified all relate to administration and communication processes; we do not consider any of these breaches were material to the black system event that ultimately occurred. However, while we do not consider these breaches were material in this event, we consider that attention to these issues would improve preparedness for, and management of, similar events in the future. Administrative processes relating to communication flows will become increasingly important as the market evolves, with an increasing number of participants operating different technologies in the NEM. We consider the appropriate remediation action would be for AEMO to address these issues in accordance with our recommendations, summarised in table 1 below.

Table 1: Summary of recommendations

Issue		Recommendation
Abnormal conditions	2.1	To keep itself promptly informed of abnormal conditions, AEMO to put in place more rigorous processes to monitor weather warnings and forecasts at all times, not just at times of extreme weather.
Notifications to Market Participants	2.2	AEMO to review its processes for issuing notifications to Market Participants during abnormal conditions. AEMO's processes should be standardised and clearly communicated to Market Participants, such that if AEMO is of the view that: • a non-credible contingency event is more likely to occur due to abnormal conditions, it must issue a notification to Market Participants in accordance with clause 4.2.3A(c) • material new information has arisen relevant to its consideration of whether the event is reasonably possible, it must update the notification in accordance with clause 4.2.3A(d), or • abnormal conditions are no longer materially affecting the likelihood of a non-credible contingency event, it must issue a notification to Market Participants to this effect.
Reclassification criteria	2.3	AEMO to holistically review the criteria at least once every two years and in that process consult with Market Participants, TNSPs, Jurisdictional System Security Coordinators, relevant emergency services agencies and other relevant stakeholders such as BOM. In conducting this review, AEMO should not only assess whether existing criteria are adequate, but also whether there are any gaps in the criteria. This also includes assessing any non-credible contingency events that have happened and considering whether the criteria need to be adjusted, developed, expanded or explained in more detail, in light of that experience.
	2.4	AEMO to ensure that the criteria include a requirement to have regard to the particulars of any risk(s) associated with any abnormal conditions that AEMO and relevant stakeholders identify through the consultation process.
	2.5	AEMO to introduce a framework and criteria regarding its approach to the reclassification of non-credible contingencies due to abnormal conditions that are not explicitly identified in the Power System Security Guidelines (PSSG), including a risk assessment framework.

2.2 AER approach to assessing compliance

In undertaking our assessment of compliance during the Black System Event, the AER recognised the level of interest from stakeholders—from industry participants, policy makers to members of the general public—in the causes and precipitating events which led to SA going black.

As market and system operator, AEMO played a crucial part in managing power system security during the pre-event, including by monitoring potential risks to the power system. When assessing AEMO's compliance we focused on two key areas:

- AEMO's reclassification obligations in light of the fact that the Black System Event was precipitated by two non-credible contingency events namely:
  - the loss of multiple transmission lines, including as a result of tower failures, in quick succession, and
  - the failure of multiple wind generators, and
- AEMO's overarching obligation to maintain power system security in accordance with the principles set out in the NER.

Assessing whether AEMO identified the above non-credible contingency events as credible, or ought to have done so, is relevant to both AEMO's compliance with its reclassification obligations and its overarching power system security obligations. However, we consider that an adequate assessment of whether AEMO met its power system security obligations requires a more holistic consideration of how AEMO was managing power system security in SA on the day.

Our approach has been to focus not on realised risks that AEMO could not have reasonably identified beforehand, but rather on the risks that AEMO did identify. On the material before us, we consider the main power system security risks AEMO was monitoring on the day were:

- the possibility wind farm output would be highly variable on the day due to high wind speeds, and that this might affect interconnector flows, and
- losing multiple transmission lines or generating units, although AEMO reasonably concluded on the available information that the loss of any specific lines or units was not reasonably possible.

During the pre-event, we did not identify any apparent material risks that AEMO failed to identify. Hence, in reviewing AEMO's compliance with the NER, we have primarily assessed how AEMO monitored and managed:

- all risks during the pre-event that, on the evidence before the AER, AEMO operators had identified—regardless of whether those risks eventuated, and
- All major power system conditions—regardless of whether those conditions had any bearing on the key events that triggered the Event.

As set out in further detail in the Legal Frameworks section below, the AER is required to assess whether AEMO used reasonable endeavours to maintain power system security in accordance with the NER. To some extent this involves assessing the adequacy of AEMO's operational decisions given the information available to AEMO. We note this does not involve an assessment of whether AEMO's operational decisions were correct in the circumstances.

During this investigation, it has become apparent that there are differences between the AER's and AEMO's understanding of certain provisions.

The key area where AER's and AEMO's respective interpretations of the NER provisions (as relevant to the pre-event) diverge relates to what can constitute a "contingency event". We consider AEMO has a broad, flexible discretion to decide what constitutes a contingency event. A contingency event is any event affecting the power system which AEMO expects would be likely to involve the failure or removal from operational service of one or more generating units and/or transmission elements. High wind speeds can potentially cause a loss or failure of wind farm output (including through the removal or material reduction in output of generating units, such as wind turbines within a wind farm due to feathering) or transmission elements. Hence, we conclude that it is open for AEMO to form the view that high wind speeds can affect the power system as a contingency event. We consider that the current reclassification framework allows AEMO sufficient flexibility to deal with new risks as they arise.

Conversely, AEMO considers that:

> *The contingency event framework caters for the loss of large generating units or transmission elements, which are sudden, completely unpredictable and cannot otherwise be managed. Dispersed and non-instantaneous variations in supply or demand, like feathering, are addressed by AEMO's dispatch process and are not considered a security issue.*

AEMO considers that, given its interpretation of what constitutes a "contingency event", the current reclassification framework does not provide it with enough flexibility to deal with new and emerging potential security risks. As an example, AEMO notes that the Event "resulted from two simultaneous shutdowns of about 200 relatively small wind turbines". AEMO advises:

> *A fit-for-purpose regulatory framework is needed to address the potential system security risks arising in the power system of today and the future, and the increasing potential for more extreme weather events. Using the existing contingency framework to expand contingency sizes comes at a very high cost to consumers, and a potentially unacceptable impact on the reliability of supply… AEMO considers that additional, detailed and accurate information combined with flexible adaptive processes will be central to maintaining a secure and reliable system.*

We note that AEMO has recently submitted a request to the Reliability Panel to have certain non-credible contingency events (including the potential loss of multiple generating units) associated with destructive wind conditions in SA declared as a protected event.[31] AEMO submits that it cannot use forecasts of destructive wind conditions to identify the loss of a specific generating unit as reasonably possible and hence cannot sufficiently manage the loss of multiple generating units using the current reclassification framework.[32]

AEMO does not agree with significant aspects of our analysis in this chapter. We note these differences both in this chapter and in the final chapter "Implications for the Regulatory Framework" of the report where relevant. That chapter raises NER framework issues for the AEMC to consider in its forthcoming review of the Black System Event.

2.3 Background

2.3.1 AEMO's power system security responsibilities

AEMO's roles, responsibilities and powers with respect to achieving and maintaining power system security are set out in Chapter 4 of the NER.[33] Among other things, Chapter 4 of the NER aims to:

- detail the principles and guidelines for achieving and maintaining power system security, and
- establish processes to enable AEMO to plan and conduct operations within the power system to achieve and maintain power system security.[34]

31 AEMO, *AEMO request for protected event declaration: Potential loss of multiple generators in South Australia*, submitted November 2018.

32 Ibid, p. 8.

33 NER, clause 4.1.1(a)(1).

34 NER, clause 4.1.1(a)(3).

Overall, AEMO must use reasonable endeavours to achieve the AEMO power system security responsibilities in Chapter 4.[35] Some of these responsibilities include:[36]

- maintaining power system security
- monitoring the operating status of the power system
- ensuring that the power system is operated within the limits of the technical envelope
- assessing the impacts of technical and any operational plant on the operation of the power system
- determining any potential constraint on dispatch and assessing the effect of this constraint on the maintenance of power system security, and
- issuing a direction or clause 4.8.9 instruction (as necessary) to any Registered Participant.

For more information about AEMO's power to issue directions and clause 4.8.9 instructions, please refer to section 5.3.2 of the Market Suspension Chapter.

2.3.2 What is power system security?

The NER define "power system security" as "the safe scheduling, operation and control of the power system on a continuous basis in accordance with the power system security principles set out in clause 4.2.6".[37]

Clause 4.2.6 relevantly provides that:

- to the extent practicable, the power system should be operated such that it is, and will remain, in a secure operating state, and
- following the occurrence of any [credible or non-credible] contingency event or a significant change in power system conditions, AEMO should take all reasonable actions to adjust, wherever possible, the operating conditions with a view to returning the power system to a secure operating state as soon as it is practical to do so, and, in any event, within 30 minutes.

The AER considers that "all reasonable actions" imports an obligation to do all that is reasonably required to be done in the circumstances, having regard to AEMO's roles, powers and capacity.

Clause 4.2.4 provides that the power system is in a secure operating state if, in AEMO's reasonable opinion, taking into consideration the appropriate power system security principles described in clause 4.2.6:

- the power system is in a satisfactory operating state, and
- the power system will return to a satisfactory operating state following the occurrence of any credible contingency event in accordance with the power system security standards.

Without limitation, in forming this opinion, AEMO must:

- consider the impact of each of the potentially constrained interconnectors, and
- use the technical envelope as the basis of determining events considered to be credible contingency events at that time.[38]

The NER provides that the power system is in a satisfactory operating state if, among other things, various technical requirements are met in relation to frequency, voltage and transmission line flows.[39] The term "transmission line flows" includes interconnector flows.

As outlined above, power system security depends on AEMO holding the reasonable opinion that the power system will remain secure after a credible contingency event occurs.

As defined in the NER:

- A "contingency event" is an event affecting the power system which AEMO expects would likely involve the failure or removal from operational service of one or more generating units and/or transmission elements.[40]
- A "credible contingency event" is a contingency event that AEMO considers to be reasonably possible in the surrounding circumstances including the technical envelope.[41]
- "Technical envelope" means the limits of the technical boundary of the power system for achieving and maintaining the secure operating state of the power system for a given demand and power system scenario.[42]

The technical envelope is relevant to power system security because it describes the physical aspects of a power system and is relevant to the effect a credible contingency event may have on the power system.

AEMO is generally obliged to operate the power system so that it maintains a secure operating state following a credible contingency event; however, AEMO is expressly not obliged to operate the power system for the potential effects of any non-credible contingency event.

35 NER, clause 4.3.2(a).
36 NER, clause 4.3.1.
37 NER, Chapter 10.
38 NER, clause 4.2.4(b).
39 NER, clause 4.2.2.
40 NER, clause 4.2.3(a).
41 NER, clause 4.2.3(b).
42 NER, clause 4.2.5(a).

Generally, AEMO operates under the assumption that the unexpected loss of a generator, or of a single circuit transmission line, are credible contingency events.[43] This is consistent with clause 4.2.3(b) of the NER, which lists these events as likely examples of credible contingency events. However, AEMO does not consider it reasonably possible that multiple generators or transmission elements will be lost simultaneously during normal operating conditions. As such, these are considered by AEMO to be non-credible contingency events during normal operating conditions. This is also consistent with clause 4.2.3(e) of the NER, which lists these events as likely examples of non-credible contingency events.[44]

2.3.3 Relevance of interconnectors when managing power system security

In managing the NEM, AEMO treats the power system as a collection of different regions, although interconnections between regions are also essential elements. Generally speaking, each state in the NEM constitutes a region.

A fundamental principle with respect to maintaining the security of the NEM is that the supply of electricity must equal the demand for electricity within the frequency limits specified by the frequency operating standards. Interconnectors electrically connect two adjacent regions, allowing energy to flow from one region to another (i.e. from Victoria to SA). If an interconnector trips (or "shuts down") while energy is flowing between the adjacent regions, then the regions on either side of that interconnector will immediately experience a supply and demand imbalance and, as a consequence, the power system frequency will vary. Temporary frequency changes due to credible contingency events can be dealt with through contingency FCAS. Maintaining power system security overall depends on managing the dispatch of generation in all regions to within the technical envelope so that the physical capability of the transmission network is not exceeded. The operational capability, or limits, for each transmission element is determined such that the power system can withstand the loss of the largest appropriate credible contingency. Regional system security is particularly dependent on appropriately managing the load on interconnectors within secure limits. Interconnectors often include control schemes that separate the neighbouring regions when unusual events occur. If relevant contingency events occur and these elements are operating beyond their secure limits, then these control schemes may operate. These network limits can constrain flows across the network, and in the case of interconnectors lead to the dispatch of higher-priced generation in the importing region to manage that limit, up to the market price cap.

The satisfactory operating limit for a transmission element is the maximum flow on that element consistent with maintaining the power system in a satisfactory operating state pursuant to clause 4.2.2.[45] The secure limit is a lower limit than the satisfactory limit, set at a level to ensure the satisfactory limit is not exceeded as a result of an increase in flow following a credible contingency event.

Our consideration of the events leading up to the Event recognises the complexities needed to manage the power system but is focused on the interconnectors because:

- flows across the Heywood Interconnector from Victoria to SA on the day were highly variable and often exceeded the target flow and the secure limit for Victoria to SA flows, and
- AEMO found that the trip of the Heywood Interconnector, while caused by non-credible contingency events, ultimately contributed to the Event.[46]

Figure 1 illustrates the AER's interpretation of how AEMO is required to manage flows across network elements, including interconnectors, to maintain power system security in practice.

43 NER, clause 4.2.3(b).

44 NER, clause 4.2.3(e).

45 NER, clause 4.2.2. Section 2.3.2 above considers the NER definition of "satisfactory operating state" in more detail.

46 AEMO, Final Report, pp. 6, 24 and 42.

Figure 1: How AEMO is obliged to operate interconnectors to maintain power system security

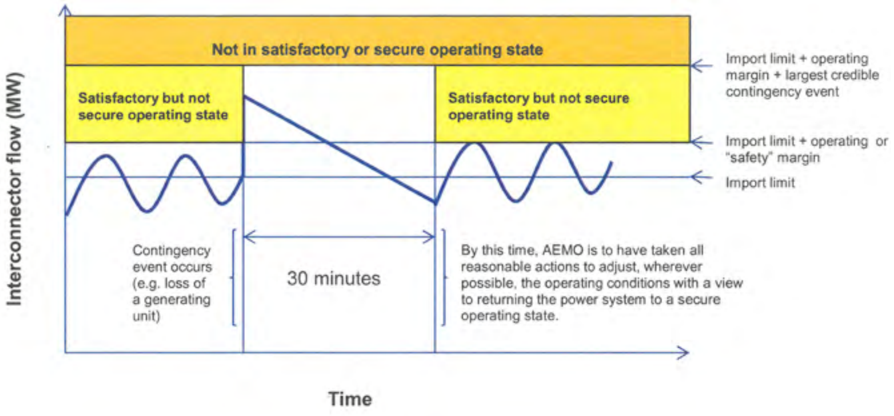


Figure 1 provides an example of how AEMO is required to manage interconnector flows when constrained at the maximum import limit following a credible contingency event (in this case, the loss of a generating unit), which will cause imports to increase in the importing region:

- Before the credible contingency event occurs, actual metered interconnector flows vary from the target in the unshaded area around the target (which is also the import limit given the interconnector is importing at its maximum) while remaining lower than the operating or "safety" margin designed to allow for such variance in flows (indicated by the "Import limit + operating or "safety" margin" line). The import limit adjusts with overall system conditions including demand and network configuration (that is, it takes into account any network outage conditions).

  The NER requires AEMO to be of the reasonable opinion that the power system will return to a satisfactory operating state following the occurrence of a credible contingency event. Put another way, the import limit plus the operating margin plus the amount of generation lost in the largest credible contingency event should not cross into the orange shaded area, since flows in this area indicate the power system is not in a satisfactory operating state.

  Overall, in this example, since flows vary from the import limit by no more than the safety margin, the power system is in a secure operating state in accordance with the power system security principles. Were a credible contingency event to occur, flows on the power system would remain in a satisfactory but not secure operating state, as shown by the yellow shaded area. To the extent practicable, AEMO should not allow actual metered flows to move out of the unshaded area unless a credible contingency event occurs.

- When a contingency event occurs actual metered flows over the interconnector instantaneously jump by the amount of power output that is no longer supplied (plus any losses that may occur because of the increased distance between generation in a remote region that has increased its output to meet the local regional load). At this time, according to the power system security principles, AEMO must take all reasonable actions to adjust, wherever possible, the operating conditions with a view to returning the power system to within the secure limit as soon as it is practical to do so, and, in any event, within 30 minutes.

  This 30-minute period is illustrated by the two-way arrow labelled "30 minutes". In this scenario, AEMO manages the interconnector flow such that it gradually decreases until it has returned to a secure operating state within 30 minutes of the credible contingency event occurring. In this way, the power system can again withstand the loss of a further credible contingency event.

2.3.4 AEMO's practices and procedures

Pursuant to the NER, AEMO has a crucial role in monitoring power system conditions and taking proactive steps to maintain power system security. This section considers how AEMO structures its control room operations, monitoring tools and procedures to fulfil this role at a high level.

Summary of AEMO control room operations

AEMO has two physical control rooms for the NEM in different states. The control room is supported by other areas of AEMO, which can provide offline advice, expertise or assistance. AEMO has processes in place to escalate issues to senior management when a significant power system event occurs.

AEMO is responsible for monitoring real-time and short-term power system operations using available control room systems. Among other things, this involves:

- monitoring and managing the effects of power system conditions and events on power system security, including by:
  – liaising with Registered Participants (both generators

and TNSPs) where there are asset issues or known threats to power system security
  - performing offline simulations to assess particular risks to power system security, and
  - implementing constraints and reclassification decisions
- monitoring critical network flows compared to target flows and operating limits
- monitoring and managing demand and dispatch accuracy
- planning, assessing and authorising the impact of network outages, and
- building network constraints in response to these outages.

To carry out its control room responsibilities, AEMO uses various monitoring tools and information sources that provide real-time and forecast information on a range of environmental, equipment and power system conditions. When there are abnormal conditions, these systems become more important. As set out in section 2.6.1 and appendix A, AEMO must monitor abnormal conditions including how they relate to possible contingency events and affect the likelihood of a non-credible contingency event occurring. Lightning, bushfires and unplanned outages are the most common abnormal environmental conditions that arise.

Our investigation has obtained details from AEMO about these tools and sources where relevant to assessing compliance with the NER. Among other things, AEMO's systems are equipped to provide information on:

- voltage and small signal stability, including whether voltage will remain within limits following the occurrence of a contingency
- the effect of actual and planned transmission network outages
- any issues regarding binding network constraints
- weather forecasts and warnings
- real-time weather and environmental conditions (including lightning, wind speeds, geomagnetic disturbances, bushfires and weather conditions generally) and their relationship to electricity assets
- real-time alerts, especially for lightning, and warnings for weather events occurring within reclassified zones
- wind farm data, including:
  - real-time data in relation to wind speed, output and the number of operating turbines
  - trend data in relation to output and the number of operating turbines, and
  - forecast data in relation to MW generation, and
- whether dispatch might become inaccurate at a wind farm due to overspeed protection. Overspeed protection is considered further in section 2.4.3 below.

At the time of the pre-event, AEMO relied on Weatherzone and Telvent (which utilise BOM data) rather than BOM for weather forecasts. However, AEMO states that its general practice was to "review the publicly available BOM weather forecasts and warnings in addition to the detailed weather forecasts and information from the weather service providers".

AEMO's Power System Security Guidelines

AEMO has produced a guideline in relation to power system security, the PSSG, which is a power system operating procedure as defined under clause 4.10.1 (and therefore binding) and applies to AEMO and all Registered Participants. AEMO's main reclassification procedures are found in Part 11 of its PSSG, which sets out, among other things:[47]

- AEMO's general approach to reclassifying contingency events
- AEMO's interpretation of its responsibilities with respect to reclassification, and
- its interpretation of the responsibilities of Registered Participants and System Operators.

The PSSG also discuss AEMO's interpretation of its responsibilities under the NER, including:[48]

- determining and declaring a non-credible contingency event to be a credible contingency event in accordance with the NER
- notifying all Market Participants of such a reclassification as soon as practicable
- following the reclassification of a non-credible contingency, ensuring it fulfils its power system security obligations to achieve and maintain the secure operating state of the power system for the revised technical envelope, and
- issuing a report every six months setting out its reasons for all decisions to reclassify non-credible contingency events to be credible contingency events.[49]

2.3.5 Registered Participants' power system security responsibilities

All Registered Participants (including generators and NSPs) have an overarching obligation under the NER to notify AEMO of any circumstances which could pose a risk to

47 "PSSG" refers to Version 78 of the PSSG (published 29 August 2016) unless otherwise specified. This was the applicable version at the time of the Black System Event.

48 AEMO, *Power System Security Guidelines*, Version 78, 29 August 2016, p. 21.

49 AEMO, *Power System Security Guidelines*, Version 90, 1 March 2018, p. 22 (change introduced in Version 79, 26 September 2016).

power system security or any equipment owned or under the control of the participant.[50] AEMO considers that Registered Participants must proactively inform AEMO of risks to their own equipment or of any circumstance which could be expected to adversely affect the secure operation of the power system or any equipment owned or under the control of the Registered Participant. In addition to using its own monitoring tools and information sources, AEMO relies on advice from participants in terms of risks posed by environmental changes and unplanned changes to manage power system security. We note, however, that while AEMO's view of how Registered Participants are to fulfil their responsibilities in relation to power system security appears to be mostly aligned with ElectraNet's view of its responsibilities, there are differences in understanding in some respects. An example of this is evident where AEMO states that, for the purpose of deciding whether to reclassify a non-credible contingency as credible due to high wind speed conditions, it relies on advice from the relevant TNSP in relation to whether the design rating of transmission lines in the path of the storm could be exceeded. However, whilst ElectraNet considers wind withstand ratings in designing, building and maintaining its assets, it indicates that its control room operators do not consider the wind forecasts in relation to the wind withstand ratings of specific assets to determine the "security classification" of those assets in the lead-up to a weather event.

AEMO states it does not explain all of its expectations explicitly in the PSSG because it considers participants' obligations are made clear in the NER. AEMO's position is that TNSPs need to know their own safe operating limits and advise AEMO, which then manages the technical envelope accordingly. More generally, AEMO considers that participants are the experts regarding their own equipment and are in the best position to identify potential risks to their equipment. The AER agrees with this view, noting however that AEMO as system operator is the only entity able to bring together disparate information from different participants across different regions to form a holistic view of what this means for power system security.

We consider that although the NER sets out Registered Participants' obligations, the obligations themselves are very broad, opening the possibility of misalignment between the views of AEMO and Registered Participants regarding their respective responsibilities, particularly in relation to information exchange and how that information will be used. To ensure a consistent expectation of the roles and responsibilities of each of the parties—in particular, what a Registered Participant should, at a minimum, provide AEMO—we consider it would be beneficial for the AER to conduct a compliance review of the relevant obligations. In this respect, we note the Pre-Event (ElectraNet) Chapter provides that:

> *The AER to conduct an industry-wide compliance review of clauses 4.3.3(e), 4.3.4(a) and 4.8.1 to verify that there is alignment between Registered Participants' and AEMO's expectations in relation to the extent and type of information to be communicated by Registered Participants to AEMO.*

We note that AEMO does not consider there is non-alignment between the expectations of AEMO and ElectraNet (or any TNSP) in respect of the provision of information and advice about risks to network assets. We address AEMO's arguments in detail in the Pre-Event (ElectraNet) Chapter.

2.3.6 Assessing whether a non-credible contingency event is more likely or reasonably possible

Part 11 of the PSSG contains detailed criteria for reclassifying the loss of transmission lines due to bushfires or lightning. However, there are no detailed procedures on reclassification stemming from other abnormal conditions such as high wind speeds or other weather events.

Prior to the Black System Event, it was uncommon for AEMO to reclassify the loss of transmission or generation assets due to "severe weather conditions" in SA, including storms (other than lightning), cyclones and strong winds. In particular, between May 2012 and the Black System Event, AEMO reclassified a non-credible contingency event as credible due to severe weather conditions on just one occasion in SA. Generally, AEMO states that it has only considered wind speed in the context of it exceeding the rating of TNSPs' transmission towers during cyclones—AEMO has made the decision to reclassify in such circumstances.

In relation to assessing whether a non-credible contingency event is "reasonably possible", the PSSG state in a general sense:[51]

> *Abnormal conditions may result in reclassification. The reclassification is based upon an assessed increase in the likelihood of a trip of equipment to occur, the occurrence of which is normally considered to be relatively low. If AEMO determines that the occurrence of the non-credible event is reasonably possible, based on established criteria, then AEMO must reclassify the event as credible.*

The PSSG do not explain how AEMO assesses whether a non-credible contingency event is "more likely" due to

50 NER, clause 4.8.1.

51 AEMO, *Power System Security Guidelines*, Version 78, 29 August 2016, p. 21.

abnormal conditions, except that in doing so AEMO consults with the relevant TNSP.[52] AEMO states that the involvement of other Registered Participants in this process will depend on the risk. The criteria in the PSSG for bushfires and lightning provide guidance on how AEMO assesses the likelihood of a contingency event occurring due to those abnormal conditions. However, they do not indicate what AEMO considers to be "more likely" for the purpose of notifying market participants under clause 4.2.3A(c).

According to AEMO, once the control room identifies an approaching storm it will start assessing the potential impacts of the storm and then plan to mitigate those impacts through various actions, including by potentially reclassifying transmission lines. If there is a severe weather warning, it is AEMO's standard practice to contact the relevant TNSP to see whether they are aware of the forecast weather event, make them aware if they are not, and then ask them whether there are any additional risks to assets.

According to AEMO, "Where a detailed assessment process does not exist AEMO generally relies on advice from a Registered Participant (under clause 4.8.1 of the NER) of the likelihood of any threat arising from environmental changes or unplanned outages, and then determines whether a reclassification is warranted."

In more general terms, if there is a potential material risk to the power system warranting the adjustment of the technical envelope, AEMO states that it acts on the assumption there is a risk until proven otherwise, and reclassifies until the relevant TNSP confirms, or AEMO's offline analytics outside the control room indicate, there is no risk. Control room staff make reclassification decisions and have a variety of mechanisms for determining appropriate constraints. The PSSG indicate that AEMO will inform Market Participants of reclassification decisions as soon as practicable through the issuing of a market notice.[53]

We note that each of the definitions of "contingency event", "credible contingency event" and "non-credible contingency event" in the NER require an opinion to be formed by AEMO, and that opinion will change with the circumstances. Other participants can only know the opinions of AEMO about these matters if that information is clearly notified to them. AEMO also has positive obligations to be informed about abnormal conditions, make assessments about the risks abnormal conditions might pose to power system security, identify if any events that it would normally consider to be non-credible are more likely because of the abnormal conditions and, if it does identify such an event, to notify market participants accordingly.

The NER were amended in 2008 to provide the market and system operator with this flexibility, including the flexibility to decide which contingency events are credible or non-credible, how it approaches reclassification and how it takes account of abnormal conditions. The historical context in which these changes to the NER occurred is important for understanding these requirements.

NER clauses 4.2.3A and 4.2.3B were inserted in response to a rule change proposal submitted by the AER in 2008. The rule change proposal followed an investigation by the AER into a load shedding event in Victoria on 16 January 2007. The investigation focussed on NEMMCO's decision not to reclassify the loss of the double circuit 330 kV transmission lines between Dederang and South Morang as a credible contingency—on the basis of regularly updated information provided by the network owner—notwithstanding there were bushfires burning in the vicinity of those lines that increased the probability of losing both lines. These lines subsequently concurrently tripped, which ultimately led to the NEM separating into three electrical islands and the loss of 2200 MW of load in Victoria.

While most aspects of the power system worked well on that day, the AER report identified shortcomings in the way in which risks had been assessed, and contingency events classified, by NEMMCO—the market and system operator at the time.[54] NEMMCO's functions are now undertaken by AEMO.[55] The processes adopted by the market and system operator at that time were not considered sufficiently transparent for all stakeholders to understand the nature of the risks posed by abnormal conditions.[56] The AER also noted that there appeared to be an undue reliance by NEMMCO on advice from network operators when making reclassification decisions on 16 January 2007.[57] In light of this, the AER proposed amending the NER.

The AEMC accepted the need for amendments to the scheme. There were four main goals for the new rules, which the AEMC explained as follows:[58]

- Requiring NEMMCO to develop and apply criteria for assessing whether abnormal conditions necessitate the reclassification of contingency events would promote

52 The NER require AEMO to consider whether the existence of abnormal conditions makes a contingency event "more likely". The PSSG note (see p. 21) that if abnormal conditions exist near a regional boundary, all relevant TNSPs will be consulted.

53 AEMO, *Power System Security Guidelines*, Version 78, 29 August 2016, p. 21.

54 AER, *Report into the events of 16 January 2007*, published September 2007 ("AER, 2007 report"), pp. 1 and 21-22.

55 From 1 July 2009, *NEMMCO* ceased operations and its roles and responsibilities transitioned to AEMO.

56 AER, 2007 report, pp. 1 and 27.

57 Ibid, p. 2.

58 AEMC, *Rule Determination: National Electricity Amendment (Reclassification of Contingency Events) Rule 2008* (AEMC, Rule Determination), pp. 6-7.

more robust and reliable reclassification decisions that better reflect the risk posed to the power system and the NEM. This requirement would also improve the consistency of NEMMCO's reclassification decisions enabling Market Participants to more reliably predict and plan for when NEMMCO will reclassify a contingency event. The requirement to consult on the development of the criteria would improve the transparency of NEMMCO's reclassification processes and would help to create robust criteria.

- Placing a positive obligation on NEMMCO to make reclassification decisions would require NEMMCO to take direct responsibility for reclassification decisions. To comply with this Rule obligation, the Commission would expect NEMMCO to apply more rigour in the collection and analysis of information about abnormal conditions and would be more accountable for the reclassification decisions it makes. More rigorous and accountable decision making would produce better reclassification decisions.
- Requiring NEMMCO to notify the market when it is considering whether abnormal conditions necessitate the reclassification of contingency events would give Market Participants more information on which to respond to abnormal conditions. This would enable Market Participants to make more informed decisions in response to the possibility of a contingency event occurring or the possibility of new constraints being invoked in dispatch. Market Participants would be able to manage their risk exposure more effectively thus advancing the efficient operation of the NEM. Market Participants could also be better placed to respond physically to a contingency event, thus reducing the impact of the contingency event and enhancing the reliability and security of the national power system.
- Requiring NEMMCO to report every six months on all reclassification decisions would assist Market Participants to understand NEMMCO's decisions, place greater discipline on NEMMCO's decision making process, and would open NEMMCO's decisions to public debate and constructive criticism. This would promote transparency and confidence in NEMMCO's reclassification decisions and would promote ongoing improvement in the reclassification process.

This history establishes important context for interpreting the obligations that have been placed on AEMO under the NER. Some key issues highlighted in these reasons for amending the NER are:

- The market and system operator is best placed to make assessments about risks and the criteria for classifying events.
- The market and system operator should take responsibility for gathering information about abnormal conditions and analysing any associated risks, rather than effectively deferring to other stakeholders.
- Information should be actively shared with market participants to help manage risk better.
- Transparency in processes and decisions, and regular reviews of processes and decisions, are important for ongoing improvement of risk management. To this end, what should be seen as constituting a credible contingency event and how best to manage the power system for those events in any given circumstances should be open to ongoing, and actively considered, improvement and refinement.

2.4 Power system conditions on 28 September 2016

2.4.1 Overview of power system conditions

Box 1 below provides an overview of power system conditions and events in relation to 28 September 2016 before the Event occurred. In sections 2.4.2 to 2.4.5, we further analyse particular power system conditions and events on the day, including:

- weather forecasts, warnings and conditions
- aggregate and individual wind farm output variation
- Heywood Interconnector flows, target flows and import limits, and
- transmission line faults.

Box 1: Chronological overview of power system conditions during the pre-event period

On 28 September, and during the days leading up to it, weather forecasting services were forecasting a severe storm heading towards SA.

At 16:55 hrs on 26 September, BOM issued various forecasts, stating “A vigorous front and intense low-pressure system is expected to move across the State on Wednesday and Thursday [28 and 29 September].” Subsequent forecasts on 27 September repeated this statement.

At 17:16 hrs on 27 September, BOM issued its first severe weather warning for damaging winds on 28 September. The warning stated:

… [A]n intense low-pressure system will move across the Bight towards the SA coast with strong to gale force winds impacting western parts. Wind speeds may increase later on Wednesday to 50-75 km/h with gusts around 90-120 km/h, most likely near coasts and with squally showers and thunderstorms. These conditions are expected to extend further eastwards during Wednesday night and Thursday.

BOM issued several subsequent severe weather warnings for damaging winds on 28 September between 20:14 hrs on 27 September and 07:30 hrs on 28 September.

On 28 September leading up to the Event, wind generation as a proportion of total SA generation exceeded 50% most of the time.

At 06:10 hrs on 28 September, BOM’s forecasts stated “A vigorous front associated with a deep low-pressure system will move across SA today. The deep low southwest of the Bight will gradually move eastwards over the next couple of days to be over Victoria by Thursday night.”

At 09:46 hrs on the day of the Event, BOM issued a severe weather warning for damaging winds, stating that “[W]ind speeds will increase later today to 50-75 km/h with gusts around 90-120 km/h, most likely near coasts and with squally showers and thunderstorms. These conditions are expected to extend further eastwards during Wednesday night [28 September] and Thursday [29 September].”

From the 10:25 hrs dispatch interval until the Event, five-minute Heywood Interconnector actual metered flows exceeded the target flow and the import limit for 46 and 29 out of 71 dispatch intervals, respectively. In one case, the import limit exceedance reached 156 MW. Most (but not all) of these discrepancies were not large or sustained. Specific instances are discussed below. Between 10:35-10:53 hrs, the Hummocks-Snowtown-Bungama 132 kV transmission line tripped once and the Blyth West-Bungama 275 kV transmission line tripped three times. The Snowtown WF was consequently disconnected from the system.[59] The normal protection systems all operated correctly following the faults and the transmission lines successfully auto-reclosed. The faults did not affect the normal operation of the transmission lines.[60]

At 10:40 hrs, BOM issued a warning stating that “[s]evere thunderstorms are likely to produce damaging wind gusts in excess of 90 km/h in the warning area over the next several hours”. The warning area essentially covered the western half of SA.

Five-minute actual metered Heywood Interconnector flows exceeded the import limit and target flow for six dispatch intervals in a row between 12:05-12:30 hrs.

At 12:56 hrs, BOM issued an upgraded severe thunderstorm warning for destructive wind, heavy rainfall and large hailstones, with wind gusts forecast to reach up to 140 km/h. The Mid North region, containing nearly 1000 MW of wind farm generation capacity, became the subject of a BOM warning for the first time, as well as the Flinders and Yorke Peninsula regions.

Between 14:28-14:35 hrs, SA wind generation decreased from 1055 MW to 890 MW (165 MW or 16% decrease) with Cathedral Rocks WF decreasing output to 0 MW and Hallett 1 WF and North Brown Hill WF both reducing output significantly. During this time, 4-second Heywood Interconnector flows increased from 346 MW to 490 MW (144 MW or 42% increase). Furthermore, 4-second flows exceeded the target flow of 329-429 MW and the import limit of 417-

59 This is because Snowtown WF is connected to the Hummocks-Snowtown-Bungama 132 kV line in a simple “T” connection. Please see section 2.4.5 below for more details.

60 AEMO, Final Report, p. 30.

441 MW from 14:31-14:38 hrs.[61] Four-second flows returned to 1055 MW by 14:56 hrs.

At 14:40 hrs, BOM issued a similar warning to that issued at 12:56 hrs, noting also that "[a] thunderstorm produced large hailstones at Cleve, a gust to 87 km/h and 14 mm [of rainfall] in 15 minutes earlier this afternoon".

Between 15:42-15:51 hrs, SA wind generation decreased from 1165 MW to 916 MW (249 MW or 21% decrease) with Snowtown North WF and Snowtown WF decreasing output to 0 MW and Snowtown South WF and Clements Gap WF both reducing output significantly. During this time, 4-second actual metered Heywood Interconnector flows increased from 323 MW to 591 MW (268 MW or 83% increase). Furthermore, from 15:46 hrs to 16:04 hrs, 4-second flows exceeded the import limit of 426-432 MW and the target flow of 317-432 MW, with a maximum import limit exceedance of 183 MW.

At 15:53 hrs, BOM issued a severe thunderstorm warning for destructive wind, heavy rainfall and large hailstones in the Adelaide Metropolitan, Mount Lofty Ranges, Yorke Peninsula, Flinders and Mid North districts, as well as parts of the Eastern Eyre Peninsula, Murraylands, North West Pastoral and North East Pastoral districts.

At 16:16:46 hrs, the first of the transmission faults leading to the Event occurred.

The damage to transmission assets on the day of the Event was subsequently found to be caused by storm supercells and tornadoes, which were not forecast to occur.[62]

2.4.2 Weather forecasts and conditions

In the lead up to the Event, AEMO received multiple BOM severe weather warnings for damaging winds. Over the course of 28 September, the weather front was moving across the State from the Eyre Peninsula to the Mid North. For most of the morning, the forecast was for damaging wind gusts with maximum wind gusts forecast between 90-120 km/h. From 12:56 hrs onwards, the forecast was upgraded to destructive wind gusts with maximum wind gusts forecast to be around 140 km/h.

The actual conditions on the day were different from forecast. During the pre-event, the recorded maximum wind gust was 104 km/h at Snowtown AWS at 15:28 hrs, while the storm supercells and tornadoes that led to the Event were not forecast to occur.

More detailed information on the weather forecasts provided throughout the day is set out in appendix B.

2.4.3 Aggregate and individual wind farm output variation

High wind speeds on 28 September led to several wind farms reducing output rapidly during the pre-event period. According to AEMO, when an individual wind turbine experiences the following wind speed events, output is reduced to zero to prevent equipment damage:

- if the wind speed measured at the turbine averages more than 90km/h (25m/s) over a 10-minute period
- if the wind speed measured at the turbine exceeds 108km/h (30m/s) for at least 30 seconds sustained, or
- if the wind speed measured at the turbine exceeds 126 km/h (35m/s) for at least 3 seconds sustained.

Known as "overspeed" or "feathering", the wind turbine's control system detects the high wind speed and adjusts the angle at which the wind turbine blades meet the wind to reduce the aerodynamic load on the machine. This is a known turbine safety mechanism that affects each turbine according to its local meteorological conditions. It is unlikely to uniformly or simultaneously affect all machines in a wind farm as the machines are geographically dispersed, but the aggregate output from the wind farm will vary as individual machines stop and restart. Under conditions where average wind speed is consistently high or there are high intensity gusts, numerous machines may stop operating and wind farm output may drop quite quickly and significantly affect overall output at a wind farm. We note that this appeared to occur during at least one period at different wind farms in SA in the pre-event period.

AEMO uses the Australian Wind Energy Forecasting System (AWEFS) to forecast wind farm output, including for use as an input in the dispatch engine. AEMO has advised that AWEFS does take into account feathering. AEMO has also informed us that, when wind speeds exceed one of the feathering thresholds listed above, it generally "overrides" individual wind farm output forecasts from AWEFS, such that the forecast wind farm generation for the relevant

61 This paper refers to both 4-second and 5-minute actual metered interconnector flows. Interconnector flows are measured every 4 seconds—hence, all interconnector flows are "4-second interconnector flows". The "5-minute flow" for a dispatch interval is just the final 4-second interconnector flow observation before the beginning of that dispatch interval. That is, the 5-minute figure is not an average of the 4-second flows in a dispatch interval. The 5-minute figures are generally used to identify whether interconnector flows are significantly different from the target for that 5-minute dispatch interval, whereas the 4-second data is more detailed and shows the exact interconnector flows within a dispatch interval. The 4-second data is sourced from AEMO's publicly available "FCAS causer pays" data.

62 BOM, *BOM Report: Severe thunderstorm and tornado outbreak South Australia 28 September 2016*, p. 1.

five-minute dispatch interval simply becomes the output of that wind farm in the previous five-minute interval. It is our understanding that AWEFS output forecasts are based on a curve fitting wind speed to electrical power, which includes the shutdown threshold. As AWEFS utilises average wind speed as an input, the ability of AWEFS to accurately forecast reductions in output due to gusts is reduced.

In the pre-event period, there were multiple occasions where actual wind farm output was variable and lower than target, which correlated with increases in flows over the Heywood Interconnector. Some variations in wind farm generation occurred relatively quickly, resulting in metered output for some wind farms reducing from near maximum output to a significantly lower level than that targeted by the dispatch. We consider two periods specifically as examples:

Between 14:28 hrs and 14:35 hrs:

- SA wind farm generation decreased from 1055 MW to 890 MW (165 MW or 16% decrease). Four-second data shows that:
  - North Brown Hill WF reduced output by 93 MW from 127 MW to 34 MW (73% decrease) over the period from about 14:29 hrs to 14:32 hrs
  - Hallett 1 WF reduced output by 79 MW from 87 MW to 8 MW (91% decrease) over the period from about 14:30 hrs to 14:33 hrs, and
  - Cathedral Rocks WF reduced from 22 MW to 0 MW over about 40 seconds from 14:33:23 hrs.
- Heywood Interconnector actual metered flows increased from 346 MW to 490 MW (144 MW or 42% increase).

Between 15:42 hrs and 15:51 hrs:

- SA wind farm generation decreased from 1165 MW to 916 MW (249 MW or 21% decrease). Four-second data from this period shows:
  - Snowtown North WF reduced output from 142 MW to 0 MW from 15:44 hrs to 15:51 hrs
  - Snowtown South WF reduced output by 41 MW from 108 MW to 67 MW (38% decrease) from 15:42 hrs to 15:51 hrs
  - Snowtown WF reduced output by 39 MW to 0 MW from 15:43 hrs to 15:49 hrs (with a particularly rapid drop of around 20 MW over approximately 30 seconds at 15:45 hrs), and
  - Clements Gap WF reduced output by 20 MW from 38 MW to 18 MW (53% decrease) from 15:47 hrs to 15:51 hrs.
- Heywood Interconnector actual metered flows increased from 323 MW to 591 MW (268 MW or 83% increase).

More detail regarding these periods is provided in appendix C.

AEMO analysed these instances of wind farm output reductions post-event using 4-second SCADA data on wind speed, active power output, local set point, turbines available and turbines online. In relation to the reductions between 14:28 hrs and 14:35 hrs, AEMO indicates that the reduction in output at:

- North Brown Hill WF was due to the operator changing its set point from 130 MW to 35 MW just after 14:29 hrs, with the NEMDE dispatch target remaining around 120 MW
- Hallett 1 WF was also due to the operator changing its set point from 90 MW to 10 MW just after 14:29 hrs, with the NEMDE dispatch target remaining around 90 MW. Based on data AEMO provided, we note that the SCADA wind speed measurement for this wind farm reached 23 m/s (83 km/h) around 14:33 hrs, and
- Cathedral Rocks WF did not coincide with wind speeds exceeding 90 km/h.

In relation to the reductions between 15:42 hrs and 15:51 hrs, AEMO indicates that there was no obvious cause of the output reductions, noting:

- feathering may have been a factor for output reductions at Snowtown North WF based on wind speed but is unlikely to have been the only one. According to AEMO, the reduction in output began two minutes before wind speed started increasing
- feathering may have been a factor for output reductions at Snowtown WF based on wind speed, but is unlikely to have been the only one, and
- feathering is unlikely to be the cause of the output reductions at Snowtown South WF and Clements Gap because wind speed remained below 90 km/h.

We note that the 4-second SCADA wind speed data is based on the recorded wind speed at a single point in a wind farm. Not all wind turbines in a wind farm will necessarily experience this recorded wind speed, since some turbines may be located several hundred metres from the measurement point. A measurement of below 90km/h (25m/s) does not categorically mean that the wind speed could not have exceeded one of the feathering thresholds at one or more turbines in the wind farm.

We asked the operator of the North Brown Hill and Hallett 1 WFs for more information about the respective set point reductions. The operator responded that the output reductions at these wind farms were likely due to the dynamic volt-ampere reactor (DVAR) shutting down due to the application of an automated protection system. The operator stated that a network fault was the likely trigger of this protection system.

Regardless of whether any of the above output reductions were caused by feathering or other causes, we consider it is clear that during the pre-event AEMO anticipated there was an increased risk of wind farms reducing output given the forecast weather conditions (see sections 2.5.2 and 2.6.1 below). Further, on the day, AEMO could only observe that wind farm output was decreasing rapidly in a manner similar to feathering but could not determine why it was happening. Hence, for the purpose of assessing how AEMO responded to the increased risk, and eventual occurrence, of wind farms rapidly reducing output, it is irrelevant whether feathering actually caused these reductions.

2.4.4 Heywood Interconnector flows, target flows and limits

As discussed in section 2.3.3, to ensure secure operating conditions, second-by-second flows on network elements, including interconnectors, should not materially exceed the secure operating limit. However, it is normal for metered 4-second interconnector flows to vary somewhat from the target calculated for each 5-minute dispatch interval as demand and supply conditions change.

Network limits are determined according to the capability of all relevant elements and the impact on modelled increases in flows across the elements resulting from credible contingencies. Generally, network limits are related to overheating, voltage collapse or loss of power system stability. The limit is set lower than the capability to account for the increase in network flows that will occur after a credible contingency event occurs, such as the loss of a network element or a large generator. The limit restricts pre-contingent flows so that actual post-contingent flows will not cause overheating, voltage collapse or loss of stability. If pre-contingent flows exceed the limit, then the power system security impact differs according to the type of limit.

Overheating limits tend to have longer time periods before damage occurs to the relevant equipment so that AEMO has some time to act post-contingency before any adverse outcomes occur. However, voltage and transient instability issues occur much more rapidly so that operator action may not be able to address the post-contingency consequences quickly enough. The Event occurred when the Heywood Interconnector tripped automatically to avoid transient instability between Victoria and SA.

Five-minute targets, limits and actual flows are published in AEMO's Electricity Market Management Systems. The SCADA system measures data across the entire network approximately every 4 seconds.

On the day of the Event, 5-minute actual measured flows on the Heywood Interconnector into SA exceeded the target flow and the import limit for 46 and 29 out of 71 dispatch intervals, respectively, between the 10:25 hrs dispatch interval and the time of the Event. In one case, the import limit exceedance reached 156 MW. Most (but not all) of these discrepancies were not large or sustained. The most significant instances occurred during the 12:05-12:40 hrs, 14:35 hrs and 15:50-16:00 hrs dispatch intervals.

Appendix D provides details regarding the main periods during the pre-event period in which 4-second data shows that actual metered interconnector flows significantly exceeded the 5-minute limit and target flow.

- Overall, during the 12:05-12:45 hrs dispatch intervals, 4-second actual metered flows on the Heywood Interconnector exceeded the 5-minute import limit and target flow 81% of the time. During the 12:10-12:30 hrs dispatch intervals, 4-second actual metered Heywood Interconnector flows into SA exceeded the target and the import limit continuously. During the 12:45 hrs dispatch interval, the 4-second actual metered interconnector flow exceeded the 5-minute import limit and target flow by up to 111 MW.
- Between 14:31 hrs and 14:38 hrs, 4-second actual metered interconnector flows continuously exceeded the 5-minute import limit and target flow, with a maximum exceedance of 85 MW and 174 MW, respectively.
- Between 15:46 hrs and 16:04 hrs, 4-second actual metered interconnector flows continuously exceeded the 5-minute import limit and target flow, with a maximum exceedance of 183 MW and 252 MW, respectively.

2.4.5 Transmission line faults

A total of six transient transmission line faults[63] occurred prior to the transmission faults that triggered the events leading to the Black System:

- three on the Hummocks-Snowtown-Bungama 132 kV line at 10:31 hrs, 11:28 hrs and 15:49 hrs, and
- three on the Blyth West-Bungama 275 kV line between 10:35-10:53 hrs.[64]

Normal protection systems operated correctly following the faults and the transmission lines successfully auto-reclosed. Hence, the faults did not materially affect the normal operation of the transmission lines.[65] Table 2 lists these transmission faults.

These transmission lines are both located in the Mid North, in respect of which severe weather warnings were only issued on 28 September after 12:56 hrs. Only the 15:49 hrs fault on the Hummocks-Snowtown-Bungama 132 kV line occurred

63 A transient transmission line fault is a fault that lasts for a very short period of time. The line will trip and then auto-reclose (depending on the type of the fault) after a short duration. If the fault is transient, the auto-reclose will be successful.

64 AEMO, Final Report, p. 30.

65 Ibid.

in an area that had been subject to a weather warning prior to the fault.

Snowtown WF is connected to the Hummocks-Snowtown-Bungama 132 kV line in a simple "T" connection. If there is a fault on this line, the wind farm shuts down and the wind farm operator can only restart once ElectraNet provides clearance. The Snowtown WF tripped at 10:32 hrs after the Hummocks-Snowtown-Bungama 132 kV line fault and auto-reclose at 10:31 hrs. Snowtown WF remained out of service until ElectraNet advised that it could return to service at approximately 13:44 hrs. It began to generate again at 15:32 hrs but shut down again at 15:49 hrs due to the third line fault on the Hummocks-Snowtown-Bungama 132 kV line.

In relation to the transmission line faults which occurred from 16:16:46 hrs onwards leading up to the Event:

- The Northfield–Harrow 66 kV line situated in the Mount Lofty forecast district did not have a severe weather warning or thunderstorm forecast until 15:53 hrs.
- The Brinkworth-Templers West 275 kV line is situated in the Mid North forecast district. Parts of the Mid North forecast district were subject to a severe thunderstorm warning from 12:56 hrs, and the entire district was subject to such a warning from 15:53 hrs onwards.
- The Davenport-Belalie and Davenport-Mt Lock 275 kV lines situated in the Flinders forecast district were subject to a severe thunderstorm warning from 12:56 hrs.
- None of the above four lines, however, were forecast to be affected by tornadoes or storm supercells, which ultimately caused the faults from 16:16:46 hrs onwards.

Table 2 Transient transmission faults on 28 September prior to 16:16:46 hrs

Time	Transmission line
10:31 hrs	Hummocks-Snowtown-Bungama 132 kV
10:35 hrs	Blyth West-Bungama 275 kV
10:35 hrs	Blyth West-Bungama 275 kV
10:53 hrs	Blyth West-Bungama 275 kV
11:28 hrs	Hummocks-Snowtown-Bungama 132 kV
15:49 hrs	Hummocks-Snowtown-Bungama 132 kV

Source: AEMO, Final Report, p. 30.

2.5 AEMO considerations on 28 September

2.5.1 Overview

In section 2.5, we draw on a number of information sources to summarise how AEMO was monitoring and managing the risks that it identified during the pre-event, including but not limited to:

- control room recordings
- operator logs, and
- AEMO's responses to our information requests.

We focus only on the substantive considerations and decisions we have identified that are relevant to AEMO's compliance with the NER during the pre-event. For confidentiality and privacy reasons, we do not refer to the names or positions of any employees or the exact times of any discussions that took place on the day.

AEMO's Final Report notes AEMO was operating the power system in accordance with the NER and procedures under the NER, and was covering the loss of the largest generation contingency, which during the pre-event period was the group of Lake Bonney WFs.[66] The Lake Bonney WFs are connected to one transmission line and therefore AEMO considers the instantaneous loss of the single line that connects them to the rest of the network a credible contingency event at all times.

AEMO's Final Report states that the Heywood Interconnector would have remained stable for the loss of 260 MW of generation within SA (the full output from the Lake Bonney WFs) and action would then be required by AEMO following such a loss to bring the flow on the interconnector back to the secure limit within half an hour. AEMO considered there was sufficient reserve generating capacity within SA to return the power system to a secure operating state if this situation had eventuated.[67]

Early in the morning on 28 September 2016, AEMO staff discussed the power system conditions that occurred during the previous night. The following issues, their associated risks and the plan for dealing with those issues were also discussed:

- extreme weather conditions
- recent unplanned network outages
- potential for wind farm output variability, and
- the risk of losing transmission lines due to lightning.

According to AEMO, it acknowledged the heightened risk to the power system associated with the abnormal conditions, including the potential for wind farms to reduce output at wind speed exceeding 90 km/h (120 km/h winds were forecast) and the added risks to the power system posed by lightning strikes. As a result, AEMO states it:[68]

- implemented increased monitoring of wind farm performance

66 Ibid, p. 23.

67 Ibid.

68 Ibid, pp. 23-24.

- assessed the potential impact on the transmission network due to expected thunderstorms
- assessed how to deal with the loss of multiple generating units
- assessed conditions that could impact on the Heywood Interconnector
- discussed the approaching weather with ElectraNet, which had cancelled several planned outages, returned several outages earlier than planned and had emergency response field crew on standby, and
- concluded there was insufficient justification to reclassify the loss of multiple transmission circuits, including the two circuits that constitute the Heywood Interconnector, or multiple generating units as a credible contingency event (which we refer to subsequently as the "early morning decision not to reclassify").

Knowing that there were abnormal conditions, AEMO considered the risks that those conditions might have for the security of the power system. It identified that the occurrence of a non-credible contingency event (the loss of multiple transmission circuits or generating units) was more likely as a result of the abnormal conditions but that it was still not, in AEMO's view based on the information then available, sufficiently possible to warrant reclassifying the loss of multiple transmission circuits or generating units beyond the level already covered as a credible contingency event. AEMO discussed relevant matters with key market participants at various stages through the afternoon with a view to keeping itself promptly informed about the risks posed by the abnormal conditions and whether it was necessary to reclassify any contingency event. We note that AEMO did not issue any notifications to market participants in relation to these assessments.

As noted in section 2.4.4, actual metered flows on the Heywood Interconnector were materially higher than the target and import limit for much of the period between the 10:25 hrs dispatch interval and the Event occurring. As discussed in section 2.3.3, these limits, which manage power system security by using constraint equations, impact on market outcomes when the limit is reached by dispatching higher-priced generation to manage the flow within the network limit.

According to AEMO, no constraint equation violations occurred during the pre-event period, and therefore the power system was in a secure operating state. In other words, "enough generation could be dispatched to adjust the flow [on the Heywood Interconnector] back within limits (back to a secure level) in the next possible DI [dispatch interval]". Therefore, AEMO considers it did not need to manually intervene to adjust these flows.

AEMO initially stated that it did not identify "any instances where the power system wasn't returned to a secure operating state within 30 minutes". AEMO subsequently refined its response as follows:

> *While this reflects AEMO's response, we need to correct this and explain an important subtlety that we did not express before: While the limits are set at a level that is designed to achieve and maintain a secure operating state, it will not always follow that a breach of the secure operating limits results in the system being insecure. The limits are in fact set at a 95% confidence level of not being exceeded. That is, it is accepted that in practice the limits will occasionally be exceeded, and that is consistent with the power system security principles… In fact, based on power system studies run by AEMO for periods from 13:00 on 28 September, Heywood import limit breaches did not in fact cause the power system to become insecure…*

AEMO elaborates on these power system studies as follows:

> *…On 28 September the V-SA interconnector tripped (due to loss of synchronism) when the flow was above 890 MW. For the flows prior in the day the trip of Lake Bonney would not have caused the interconnector flow to reach a level that would have tripped the interconnector due to loss of synchronism (highest cases would have been 870/880 MW—and most were well below this). As such none of the cases prior represent a breach of power system security.*

AEMO expected to see larger fluctuations in wind output and consequently larger interconnector flows on 28 September 2016 than on a "normal" windy day. However, it states it did not see any variations on the day which would have caused it to change the operating strategy set out in the six dot points above. It notes that had AEMO systems indicated that the system may not return to a secure operating state (e.g. due to insufficient generator availability or non-conformance with dispatch instructions) it would have taken action to remedy this issue in accordance with section 5 of the PSSG.[69]

Network limits, particularly those that limit interconnector flows, have a material impact on market dispatch and pricing. It is therefore critical to set the limit at a level that provides confidence in ensuring system security is maintained, but not so low that there are disproportionate impacts on dispatch and pricing.

69 Section 5 of the PSSG sets out AEMO's policy on the management of secure and satisfactory limits. The policy indicates that AEMO ordinarily manages these limits through the use of network constraints. In circumstances where this approach is ineffective, AEMO will pursue other options, including (but not limited to) revision to plant thermal ratings and power system limits.

AEMO's general approach is to manage the network limit by dispatching generation to ensure that the flow across the network element (or elements) is less than the modelled limit, with a 95% confidence level. AEMO states that, because of variations in actual metered flows, "… it is accepted that in practice the limits will occasionally be exceeded, and that is consistent with the power system security principles." AEMO indicates that it has designed "market systems to respond automatically to changes in power system circumstances" and that "[t]he practicability of action may be constrained by those systems". See section 2.5.3 for further discussion of AEMO's considerations in respect of Heywood Interconnector flows and power system security.

AEMO's Final Report ultimately states, "AEMO's assessment was that under the NER, in the absence of advice as to specific threats to power system security, it had no obligation or authority to take further action to maintain the secure operation of the power system."[70]

Weather forecasts and overall conditions

AEMO states it was aware of the developing weather situation in SA from 27 September. According to AEMO, from about 06:00 hrs on 28 September, the control room was monitoring the real-time storm conditions across two systems—Weatherzone and Indji (Global Position and Tracking Systems Pty Ltd (GPATS)).[71]

AEMO's Final Report indicates that it undertook a risk assessment early in the morning ("early morning risk assessment") based on forecasts of maximum wind speeds of 120 km/h.[72] Having reviewed material documenting this assessment, we note that:

- it was anticipated that the storm was going to be severe, and
- it was estimated that the storm was about one and a half hours away from affecting the SA power system at the time of the assessment.

As a consequence of the assessment, AEMO decided to maintain a heightened control room focus on power system conditions in SA. However, it was decided that, having regard to the criteria in its emergency management plans, the situation was not severe enough to be escalated internally.

AEMO and ElectraNet discussed the general impacts of the storm during the morning. ElectraNet noted it would be managing outages differently because of the forecast storm. It had cancelled several planned outages, expected to return several more planned outages to service earlier than scheduled, and had field crews on standby if required for emergency response. AEMO and ElectraNet also discussed the storm more generally. AEMO asked whether ElectraNet had seen the storm coming, to which ElectraNet replied that it had been monitoring the storm all morning, including lightning strikes. Further details of this communication as it relates to the transmission system is covered in section 2.5.4 below.

Around mid-morning, AEMO staff again discussed the severity of the storm internally. While it was reconfirmed that the situation was not severe enough to be escalated internally, resources were reallocated to enable AEMO to focus on the SA region. AEMO staff also discussed further reallocation plans should the situation warrant it.

According to AEMO, it continued to monitor the storm for the rest of the day and prepared for the effects that lightning might have on the SA power system.

Although AEMO did consider real-time wind speed and lightning data through Indji, it did not consider updated weather warnings issued after the early morning decision not to reclassify. Updated weather forecasts and warnings issued by BOM from 12:56 hrs after this initial assessment had been made indicated forecast wind speed gusts of up to 140 km/h; however, AEMO did not utilise this information when constantly reviewing the early morning decision not to reclassify.[73] AEMO did not change its strategy, and subsequently advised that the updated weather warnings would not have caused it to do so on the day. AEMO further states it did not receive any other advice from SA Market Participants regarding potential risks posed by forecast weather conditions.

2.5.2 Changes in wind output

In its Final Report, AEMO states it noted that "forecast wind conditions could reduce wind farm output where the wind speed exceeded 90 km/h and implemented increased monitoring of wind farm performance [on 28 September during the pre-event]".[74] AEMO advises that the increased monitoring of wind farm output to observe possible sudden reductions involved checking:

- differences between actual and pre-dispatch output at wind farms
- binding or violated constraints, and
- contingency analysis tools.

AEMO states that:

70 AEMO, Final Report, p .24.

71 Ibid, p. 23.

72 Ibid, p. 31.

73 Ibid.

74 Ibid, p. 23.

"[its] normal practice is to focus on regional wind farm generation/forecast generation as wind farm generation is intermittent and diverse, meaning that the fluctuations in regional aggregate wind farm generation is the more important consideration with respect to power system security".

Nevertheless, AEMO has an application that allows control room operators to observe outputs and wind speeds at individual wind farms. AEMO states that where wind speeds reach the 90km/h feathering level the control room generally "overrides" individual wind farm output forecasts from AWEFS, which forecasts output based on forecast wind speed. As set out in section 2.4.3, it is our understanding that, because AWEFS utilises average wind speed as an input, the ability of AWEFS to accurately forecast reductions in output due to gusts is reduced. If there are consequential forecast errors, this will likely result in higher than expected imports across the interconnector for the relevant period.

According to AEMO, the override by the control room is to use the current output (which is lower than AWEFS) as the forecast output for the next dispatch interval. When the difference between the AWEFS forecast and actual wind farm output reduces, then the forecast override decision is manually reversed. If AEMO does not override the AWEFS forecast, then NEMDE assumes higher generation and the discrepancy is usually taken up by increased imports across the interconnector.

AEMO's usual practice is to monitor feathering and turn the "DS forecast"[75] off in the ANEMOS DS Feed for any wind farms that experience feathering reductions in output, which reduces any error between dispatch and forecast. Shortly after the early morning risk assessment, AEMO staff discussed the storm in SA and the effect it might have on SA wind farms in relation to feathering reductions in output. It was confirmed that AEMO would follow its usual practice in relation to feathering.

AEMO confirmed it was aware of the following reductions in wind farm output on 28 September:

- Snowtown WF's reduction in output around 10:31 hrs
- the reduction in output between 14:28 hrs-14:35 hrs at Cathedral Rocks, Hallett and North Brown Hill WFs (as discussed in appendix C), and
- the reduction in output between 15:42 hrs-15:51 hrs at Snowtown North, Snowtown South and Snowtown WFs (as discussed in appendix C).

AEMO did not "override" or adjust the AWEFS forecast in response to the 165 MW reduction in aggregate wind farm output between 14:28 hrs-14:35 hrs across the three wind farms listed.

At 15:57 hrs, AEMO did "override" AWEFS and turn off the "DS forecast" for Snowtown North WF, Snowtown South WF, Snowtown WF and North Brown Hill WF due to the dispatch forecast produced by AWEFS being significantly in error and security concerns with the Heywood Interconnector metered flow exceeding the import limit into SA. AEMO reversed the "override" and turned the "DS forecast" on again for North Brown Hill WF at 16:01 hrs.

According to AEMO, it "continually assessed the impact [of reduced wind farm output] on power system security through AEMO's suite of monitoring/diagnostic tools". Further, AEMO expected to see larger fluctuations in wind farm output and interconnector flows than a "normal" windy day. It states it did not see any variations on the day which would have caused it to change its operating strategy.

In other words, using the language of the clauses in the NER, despite noticing near simultaneous reductions in output at multiple wind farms on a number of occasions, and observing the resulting increased actual metered flows on the Heywood Interconnector above the import limit, AEMO did not expect that the existence of high wind speeds would make the failure or removal from operational service of one or more generating units or transmission elements reasonably possible in all the circumstances (including the technical envelope). It did not reclassify the near simultaneous reduction in the output at multiple wind farms due to feathering, or any other related event, as a credible contingency event. We understand this was because AEMO considers this reduction typically occurs slowly and hence any reduction in output is not the same as an instantaneous generator or network failure.

AEMO states that the Heywood Interconnector could manage the loss of the largest generator (the equivalent of the loss of the Lake Bonney WFs) in addition to feathering reductions within a five-minute interval as the dispatch engine would adjust generator output to match the feathering reductions in the next dispatch interval. In other words, AEMO assumed that the reduction in wind farm generation due to high wind speed within a five-minute interval was not a credible contingency event. AEMO states that its approach to dealing with wind farm output variations on the day was consistent with standard practice.

2.5.3 Heywood Interconnector flows

During AEMO's early morning risk assessment (referred to in section 2.5.1 above) the issue of reclassifying the failure or removal of the Heywood Interconnector as a credible contingency event due to lightning strikes in SA was raised. However, AEMO concluded that there was no cause to reclassify as the interconnector was not classed as vulnerable to lightning and AEMO had not received advice

75 We understand "DS forecast" to be the dispatch forecast.

from ElectraNet that both Heywood Interconnector lines would trip at once.

Nevertheless, around mid to late morning, AEMO identified that:

- there were restrictions on the Heywood Interconnector due to the Rowville line constraints in place at the time
- if wind farms stopped generating or generated less due to overspeed feathering, SA would need to get imports quickly across the Heywood Interconnector, and
- it could increase network and interconnector capability by restoring network plant to service (and to avoid load shedding in the event of significant wind farm output reductions), as this would improve import capability into SA.

In relation to restoring network plant to service, AEMO states:

> *The intent of seeking to relieve some of those constraints was to free up additional capacity to transfer cheaper generation into SA as needed to supplement the variable wind generation. It did not indicate any concern about the interconnector tripping due to a contingency event in SA. The binding constraints were for power system security within the Vic region.*

AEMO subsequently contacted AusNet Services (AusNet), the Victorian TNSP, on a number of occasions. According to AusNet, at some time prior to 1 pm, it received a call from AEMO regarding AusNet's outages of the No 1 and No 2 Rowville Terminal Station static VAR compensators.[76] AEMO outlined the severity of the storm in SA and was concerned that wind farms in SA were going to "trip" due to the storm because of high wind overload protection. AEMO was also concerned that AusNet's planned outages at Rowville Terminal Station were restricting the Heywood Interconnector.

AusNet and AEMO discussed the possibility of AusNet cancelling the following outages with the aim of providing additional capacity on the interconnector in case the wind farms in SA tripped:

- Horsham Terminal Station to Red Cliffs Terminal Station line
- No 1 Rowville Terminal Station static VAR compensator, and
- No 2 Rowville Terminal Station static VAR compensator.

Early in the afternoon, AusNet returned the Horsham Terminal Station-Red Cliffs Terminal Station and No 1 Rowville Terminal Station static VAR compensator outages. This was earlier than scheduled and the related constraints were removed. AusNet states that around early to mid-afternoon it subsequently advised AEMO the Horsham Terminal Station-Red Cliffs Terminal Station outage had been cancelled independently due to high winds. It also advised that it had cancelled the No 1 Rowville Terminal Station static VAR compensator outage and that the No 2 Rowville Terminal Station static VAR compensator was on a long-term outage and could not be recalled.

Around midday, AEMO agreed to ElectraNet putting a capacitor bank in service at Tailem Bend and Cherry Gardens because voltage was low due to increasing interconnector limits and flows, and also because the storm was approaching. AEMO indicated that scheduled interconnector flows were at the import limit (from Victoria to SA) and were forecast to be at the import limit for the majority of the day. Hence, AEMO was aware of SA's high dependence on the interconnector between 12:00 hrs and 12:40 hrs (the 12:05-12:40 hrs dispatch intervals).

In response to high winds reducing wind farm generation between 15:42 hrs-15:51 hrs, AEMO was considering putting a capacitor bank in service on the Heywood Interconnector, which would have increased imports from Victoria to SA. However, AEMO decided against this shortly afterwards because interconnector flows were already significantly higher than the import limit.

All these actions indicate that AEMO had assessed that the threat posed to the power system by the abnormal conditions made the loss of more than one generating unit (or partial but significant near simultaneous output reduction from multiple wind farms) or transmission element more likely, even if AEMO still considered that it was not necessary to reclassify any non-credible contingency event as credible.

As noted in section 2.5.1 above, according to AEMO, the increase in actual metered interconnector flows on the day was the expected immediate response to reductions in wind farm output from feathering, but these reductions would be compensated by the dispatch of additional generation in the next five-minute dispatch interval. It further notes that no constraint equations were violated and therefore the power system was in a secure operating state.

2.5.4 Risk of loss of transmission elements or generating units

As mentioned in section 2.5.3 above, during the early morning risk assessment, AEMO raised internally the issue of reclassifying the loss of the double circuit Heywood Interconnector as credible due to lightning strikes in SA. Heywood was not listed as vulnerable to lightning in the PSSG. Accordingly, AEMO concluded there was no basis to automatically reclassify on the basis of lightning per the PSSG. Hence, in the absence of advice regarding "abnormal

76 A static VAR compensator is a set of power electronics devices that provide fast-acting reactive power to manage the safe operation of the high-voltage electricity transmission networks.

risks to the transmission network due to the forecast weather conditions", [77] AEMO did not reclassify this multiple circuit loss as a credible contingency event. It did not reclassify the loss of any transmission lines in SA on the day.

Around early to mid-morning, AEMO and ElectraNet discussed various power system issues. AEMO inquired whether ElectraNet was planning to do anything differently in light of the storm approaching SA at the time. ElectraNet advised that while it was not taking any "super special" precautions, it had cancelled several planned outages and was expecting to return several more planned outages to service earlier than scheduled, and emergency response field crews were on standby if required. AEMO did not inquire in particular about abnormal risks to the transmission network (AEMO does not consider it needed to explicitly do so given the practice and custom in its dealings with ElectraNet as a TNSP) and ElectraNet did not raise any such risks with AEMO. AEMO considers that "[t]he lack of any advice from ElectraNet of additional risks to its transmission network under these forecast conditions was consistent with its [ElectraNet's] historical approach of only reporting security threats to the grid where there is actual evidence of damage to its transmission assets".[78]

Shortly after this discussion with ElectraNet, AEMO staff familiarised themselves with procedures on how to manage multiple outages in SA when the relevant lines are close to each other in the context of the power system. AEMO considers that while on the day several transmission lines tripped and reclosed successfully (that is, there was a short-term transient fault), if not all recloses had been successful (i.e. a permanent fault had occurred) it might have had to consider managing multiple separate network outages in accordance with the procedures outlined above. AEMO ultimately adhered to the early morning decision not to reclassify the loss of multiple generating units or transmission lines as credible because there were no "probable" or "proven" transmission line pairs in SA susceptible to lightning, and although the whole network was at greater risk, it did not know which particular assets might trip. As explained in section 2.5.1, AEMO decided not to escalate the storm issue internally.

Around mid-morning, AEMO and ElectraNet discussed:

- the transient fault on the Hummocks-Snowtown-Bungama line (and Snowtown WF shutting down as a result)
- the two transient faults on the Bungama-Blyth West line, and
- the storm in general.

In this discussion, ElectraNet confirmed that the lines were in service and the faults were all transient. ElectraNet also noted that it had been monitoring the storm all morning. Shortly after this discussion, AEMO staff ensured that the relevant internal staff were aware of the trips and recloses on the Hummocks-Snowtown-Bungama and Bungama-Blyth West lines, and of Snowtown WF being disconnected as a result.

Shortly before the Event, ElectraNet informed AEMO that there had been a transient fault on the Hummocks-Bungama 132 kV line at 15:49 hrs due to lightning. ElectraNet indicated that, in accordance with its usual practice, it had someone patrolling the line to make sure it was still completely intact and there was no major damage.

AEMO placed no additional constraints on the operation of the Victorian and SA transmission network during the pre-event period.[79] AEMO states that participants did not notify it of any concerns on the day, noting that participants are obliged to advise AEMO of circumstances that could adversely affect equipment or the power system. AEMO did not contact participants in respect of any specific risks, other than calling ElectraNet. AEMO indicates that it is required under the NER to assume compliance by generators with their registered performance standards, unless it is aware of actual or potential non-compliance or advised otherwise.

2.6 Relevant NER provisions and assessment

A summary of AEMO's key obligations and responsibilities under the NER can be found in table 3 below. All the obligations set out in table 3 relate directly or indirectly to AEMO's obligation to maintain power system security.

2.6.1 Abnormal conditions

Relevant NER provisions and assessment against provisions

AEMO must take all reasonable steps to ensure that it is promptly informed of abnormal conditions, and when abnormal conditions are known to exist AEMO must:[80]

1. on a regular basis, make reasonable attempts to obtain all information relating to how the abnormal conditions may affect a contingency event, and
2. identify any non-credible contingency event which is more likely to occur because of the existence of the abnormal conditions.

77 AEMO, Final Report, p. 23.

78 Ibid, p. 24.

79 Ibid.

80 NER, clause 4.2.3A(b).

Table 3: Summary of AEMO's relevant obligations and responsibilities

Obligation/responsibility	Comments
Clause 4.2.3A	Requirements on AEMO regarding: • how it gathers and considers information about abnormal conditions • notifying market participants when non-credible contingency events are more likely to occur, and • the reclassification of non-credible contingency events as credible.
Clause 4.2.3B	Obligations on AEMO regarding the criteria it applies when reclassifying.
Clause 4.2.6(a)	Principle that AEMO should, to the extent practicable, operate the power system such that it is and will remain in a secure operating state.
Clause 4.3.2(a)	Overarching responsibility for AEMO to use reasonable endeavours to achieve the AEMO power system security responsibilities in accordance with the power system security principles. Clause 4.3.1(a) provides that one of the power system security responsibilities is to maintain power system security.

If AEMO identifies that a non-credible contingency event is more likely because of abnormal conditions, it must provide market participants with a notification that specifies, among other things, what the abnormal conditions are and whether or not AEMO has reclassified the contingency event.[81] We consider the purpose of this notification process is to keep all market participants aware of information relevant to power system security while the abnormal conditions continue and allow them to respond appropriately.

AEMO must update its market notifications with relevant new information that becomes available while the abnormal conditions continue. AEMO must also notify the market when abnormal conditions have ceased to have a material effect on the likely occurrence of the non-credible contingency.[82]

In addition, AEMO must regularly reconsider whether, having regard to all the facts and circumstances, a non-credible contingency event should be reclassified.[83] If at any time a non-credible contingency event becomes, in AEMO's view, reasonably possible, AEMO must reclassify.[84]

Clause 4.2.3A(a) defines "abnormal conditions" as "conditions posing added risks to the power system including, without limitation, severe weather conditions, lightning, storms and bush fires".

We consider that abnormal conditions existed on 28 September. As early as 27 September, BOM had published a severe weather warning for damaging winds on the day of the Event. On 28 September, BOM subsequently published a severe thunderstorm warning for destructive wind, heavy rainfall and large hailstones. "Severe weather conditions" are one type of abnormal condition specifically contemplated in the above definition of "abnormal conditions", as are "storms". AEMO was aware there were abnormal conditions during the pre-event period and it took certain steps to inform itself about those conditions.

Although AEMO did consider real-time wind speed and lightning data through Indji and direct wind farm monitoring, and weather forecasts from Weatherzone and Telvent, it did not review its early morning decision not to reclassify specifically in light of the updated weather warnings issued after 08:30 hrs.[85] Updated warnings issued by BOM from 12:56 hrs after this assessment had been made indicated forecast wind speed gusts of up to 140 km/h; however, AEMO did not utilise this information when constantly reviewing its early morning decision not to reclassify.[86] AEMO did not change its strategy, and subsequently advised that the updated weather warnings would not have caused it to do so on the day.

"All reasonable steps" and "reasonable attempts"

The term "all reasonable steps" imports an obligation to do all that was reasonably required to be done in the circumstances, having regard to AEMO's role, including its powers under the NEL and NER, its capacity and its responsibilities and obligations.

We consider that this provision, in referring to AEMO, means that the AEMO staff (or agents) responsible for carrying out the actions contemplated by the provisions are promptly informed. In this case, the responsible staff are the control room operators that manage the real-time operation of the power system, including the reclassification process under clause 4.2.3A. Hence, for "AEMO" to be "promptly informed" of abnormal conditions, AEMO must not only have the relevant information about abnormal conditions (e.g. weather

81 NER, clause 4.2.3A(c).

82 NER, clause 4.2.3A(d).

83 NER, clause 4.2.3A(e).

84 NER, clause 4.2.3A(g).

85 AEMO, Final Report, p. 31.

86 Ibid.

warnings) in its systems but also take all reasonable steps to ensure that the relevant control room operators are aware of and actively consider this information in a timely manner.

The AER considers that the term "reasonable attempts", on the other hand, imports a similar obligation to that imposed by "reasonable endeavours". AEMO must make attempts to obtain all information relating to how abnormal conditions may affect a contingency event in the way that a reasonable market and system operator, having AEMO's statutory functions and powers, would do in the particular circumstances that confronted AEMO at the relevant time. The term stipulates what was reasonably required to be done in the circumstances, having regard to AEMO's role, including its powers under the NEL and NER, its capacity and its responsibilities and obligations.

"Promptly informed of abnormal conditions"

We find that, by failing to utilise the updated weather warnings issued by BOM from 12:56 hrs when constantly reviewing the early morning decision not to reclassify, AEMO did not take all reasonable steps to ensure that it was promptly informed on a continual basis of how the abnormal conditions were evolving. AEMO, on receipt of the updated warnings, should have taken the reasonable step of reviewing and taking into account that information for the purpose of identifying whether a contingency event was more likely to occur, consistent with clause 4.2.3A(b)(2).

We note that AEMO disagrees that it did not take all reasonable steps, since "it was regularly assessing information about the conditions and monitoring their impact". Among other things, AEMO states it "had received weather warnings alerting it to abnormal conditions, and was actively monitoring live weather feeds and forecasts from its commercial weather service providers (who use BOM data)". AEMO notes that if it had assessed the updated warnings, this would not have changed any of the decisions it made on the day.

AEMO's argument does not change our view that AEMO failed to take all reasonable steps to keep itself promptly informed of abnormal conditions given that we have identified a reasonable step it did not take. We consider that BOM forecasts and warnings are an important source of reasonably available information about future conditions, in particular whether current abnormal conditions are likely to intensify or abate. However, we consider that AEMO's failure to utilise the updated weather warnings did not contribute to the Event, since BOM did not forecast the storm supercells and tornadoes that ultimately caused the damage to transmission assets leading to the Event.

AEMO also notes that:

> *In relation to information about the impact of the forecast conditions on transmission assets, it was entirely reasonable for AEMO to rely on ElectraNet's advice. In the conditions that were forecast, there were no contingency events that could reasonably have been reclassified.*

The AER agrees with this position but notes that it is not directly relevant to an assessment of whether AEMO took all reasonable steps to keep itself promptly informed of abnormal conditions.

"Contingency event"

Clause 4.2.3(a) defines "contingency event" as an event affecting the power system which AEMO expects would be likely to involve the failure or removal from operational service of one or more generating units and/or transmission elements. This definition covers both credible and non-credible contingency events. An event that is a contingency event falls within the reclassification framework in clause 4.2.3A. Hence, it is important to ascertain whether an event that could affect power system security, such as feathering reductions in wind farm output, is a contingency event.

High wind speeds can potentially cause a loss (including feathering reductions) in wind farm output or the failure of transmission assets. This in turn can have potential consequential impacts on other elements of the generation and transmission system. That is, high wind speeds can result in the failure or removal from operational service of one or more generating units or transmission elements. If more than one wind farm in a similar geographical area rapidly reduces output, the loss of output could even exceed that stemming from the complete loss of a single large generating unit or transmission element. We therefore consider that it would be open for AEMO to form the view that high wind speeds can affect the power system as a contingency event. That contingency event may be deemed more or less credible in different circumstances.

It is ultimately a decision for AEMO as to whether something is a contingency event, based on a reasonable analysis of the information before it, and having regard to its overarching responsibility to maintain power system security. Given the definitions in the NER rely upon AEMO forming views about what is a contingency event and whether it is credible in different conditions, it is essential that those views are developed in consultation with, and communicated to, market participants in a transparent manner.

"Generating unit" is defined as "the plant used in the production of electricity and all related equipment essential to its functioning as a single entity".[87] There can be one or more

87 NER, Chapter 10.

generating units at a given power station. For example, there are eight generating units at Torrens Island Power Station.

The capacity of generating units can differ from one power station to another, and hence have different potential impacts on power system security. The largest thermal generating units in SA can generate up to 230 MW. The generating capacity of individual wind turbines may also vary, but is usually around 2-3 MW; however, in aggregate, some wind farms in SA are over 200 MW. The instantaneous loss of a 230 MW thermal generating unit will affect interconnector flows and power system security more than the loss of an individual 3 MW wind turbine. To produce the equivalent of a simultaneous 230 MW thermal generator unit failure would require 70 to 100 individual wind turbines to feather at the same time. It could take several minutes for this number of wind turbines to feather, depending on the rate at which the extreme wind speed condition traverses the turbines that are distributed across affected wind farms. Outcomes during the pre-event period appear to suggest that around 180 MW of wind turbines feathered and were temporarily removed from service in around 10 minutes.

AEMO did not have access to real-time individual wind turbine output on the day of the Event but did consider real-time 4-second data for individual wind farms and total SA wind farm output. We consider this level of observation appropriate, given feathering reductions in individual wind turbine output due to high wind speeds can take several minutes. However, if the wind event is sufficiently large, a number of wind turbines at a wind farm, or at a number of wind farms, may be feathering or be feathered near simultaneously.

AEMO does not currently treat the loss of a single wind turbine as a contingency event, whether due to overspeed output reduction or some other cause, and does not consider it is open for AEMO under the NER to form a contrary view. AEMO considers that variations in intermittent generation are common in the NEM—they can be forecast to some extent in the dispatch timeframe and the associated variations are managed by optimising the dispatch of energy and ancillary services. It notes that during high wind conditions, several wind turbines across a region may be in the process of feathering or recovering from feathering as local wind speeds change. According to AEMO, feathering is "one of a number of factors that will change total wind farm output, and in power system terms [feathering is] neither major nor instantaneous".

Overall, we conclude that AEMO did not breach the NER by not treating the loss of a single wind turbine from feathering as a contingency event. We also note that wind turbines are aggregated to a wind farm. The loss of a wind farm is treated by AEMO as a credible contingency event for the purpose of managing power system security.

AEMO's approach means that there is a higher probability that the security of the power system is impacted. The critical voltage collapse constraint on Heywood was managing the largest contingent loss of generation (260 MW), but to cater for small variations in demand and generator non-conformance there is a small safety margin built in. However, the actual metered flows were well above the target flow and voltage collapse limit for long periods. If under these conditions the 260 MW contingency occurs, then flows will increase above that anticipated and managed by the safety margin. This situation is similar to two generator contingencies occurring at the same time—the material reduction in output from a wind farm and the 260 MW generation loss—which is normally a non-credible contingency. This suggests AEMO could have either reclassified to credible the loss of multiple generators in SA, which could have been managed by reducing the Heywood limit, or concluded that because the limit was not being effectively managed it should intervene to artificially lower that limit. This is similar to the approach AEMO uses to manage generator non-conformance (where the generator output differs from NEMDE's assumption, so NEMDE takes the output as a given to reduce the power system security impacts of this non-conformance). As AEMO notes, there are network constraints that do reduce the limit in the next dispatch interval if the actual metered flow is above the network limit. However, during the pre-event period, this form of constraint did not apply to the constraint that was managing voltage collapse.

AEMO must identify any non-credible contingency event more likely to occur because of abnormal conditions

A "non-credible contingency event" is defined as "a contingency event other than a credible contingency event".[88] Without limitation, examples of non-credible contingency events are likely to include:[89]

- 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).

AEMO was aware of the heightened risk on the day that a non-credible contingency event was more likely, although still not, in AEMO's view, reasonably possible. AEMO considered whether to reclassify an event affecting the Heywood

88 NER, clause 4.2.3(e).

89 NER, clause 4.2.3(e)(1)-(2).

Interconnector due to lightning. It is evident that AEMO considered the potential for high wind speeds to affect wind farm output and potentially adversely affect power system security as discussed in section 2.5. It took various steps to inform itself about the risks posed by the storm and to prepare for contingencies that it considered during the day that could affect the security of the power system. This is also discussed in more detail in section 2.5. It included matters such as:

- considering procedures on how to manage multiple outages in SA when the relevant lines are close to each other in the context of the power system
- implementing increased monitoring of wind farm performance
- assessing the potential impact on the transmission network due to lightning
- discussing the approaching weather with ElectraNet (with ElectraNet noting it would be managing planned outages differently because of the forecast storm) and AusNet, and
- raising the possibility of escalating the event internally at different times.

We consider that AEMO correctly identified that there was a heightened risk of a non-credible contingency event, such as the loss of multiple lines or generating units, but that the information they did take into account did not necessarily indicate that any specific assets were threatened or that a non-credible contingency event was reasonably possible and should therefore be reclassified. This was ultimately a judgement for AEMO to make in the circumstances. Given the unique circumstances confronting AEMO, we consider that it acted reasonably. However, while AEMO communicated some relevant information to some market participants about these matters, it did not give market participants a notification as contemplated under clause 4.2.3A(c).

We note that AEMO disagrees that it identified a non-credible contingency that was more likely due to the abnormal conditions during the pre-event—it considers that:

> *While generically there were greater risks of things going wrong on a day of very bad weather, AEMO did not identify any specific contingencies that were more likely. As explained in our detailed response, it is not appropriate to consider wind turbine overspeed/feathering as a contingency event—it is managed in dispatch with other energy ramping variations.*

According to AEMO, during the pre-event:

> *No incidents caused AEMO to believe that elements of the transmission system could not withstand the forecast weather conditions. This is corroborated by ElectraNet. ElectraNet stated that if it were to receive a warning of a tornado or severe downdraft event located near its network assets then it would consider that to be a risk to its network assets and take appropriate action, including notifying AEMO. There were no such warnings, and no such risk was identified by ElectraNet based on the information available to it before the event.*
>
> *There was no indication that multiple generating systems would simultaneously trip or disconnect in response to power system conditions that were, and were expected to remain, within prescribed operating ranges for generator performance standards.*
>
> *Accordingly, at no point did AEMO identify a specific event that was more likely to occur because of the forecast conditions. This corresponds with the position expressed by ElectraNet in the separate pre-event section, that the forecast weather conditions did not give rise to specific concerns, its practice is only to consider reclassification of a contingency event in relation to specific assets. Where it is not possible to establish a direct threat to a specific asset, reclassification is not considered.*

Clause 4.2.3A prescribes an administrative process that is ultimately intended to ensure AEMO is accountable for decisions to reclassify (or not reclassify) contingency events as credible. In this sense, deciding whether a specific asset is "more likely" to be at risk may be a logical step leading up to the ultimate decision whether or not to reclassify a contingency event. However, the key purpose of clause 4.2.3A(b)(2) and (c) appears to be to initiate information exchange and preparedness for an event, and in some cases to prompt appropriate market responses. If AEMO notifies the market that there is a heightened risk due to abnormal conditions that a non-credible contingency event is more likely (regardless of whether it considers it should reclassify at that stage or whether a direct threat to a specific asset is identified) this will indicate to market participants that a higher degree of vigilance is required and the potential issues associated with the abnormal conditions.

Findings

We conclude that, by failing to utilise the updated weather warnings issued by BOM from 12:56 hrs when constantly reviewing the early morning decision not to reclassify, AEMO did not fully comply with its obligations under clause 4.2.3A(b).

Our findings are fully discussed in Findings, recommendations and AER actions section (section 2.7) at the end of this chapter.

2.6.2 Providing notification to Market Participants

Relevant NER provisions and assessment against provisions

Under clause 4.2.3A(c), as soon as practicable after AEMO identifies a non-credible contingency event which is more likely to occur because of the existence of abnormal conditions, AEMO must provide Market Participants with a notification regarding the conditions and the event, as well as whether AEMO has reclassified it as a credible contingency event. The wording of this clause shows that "more likely" and "reasonably possible" constitute different thresholds and have different purposes—the former for notifying the market under clause 4.2.3A(c) and the latter for reclassifying a non-credible contingency event as credible under clause 4.2.3A(e) and (g) (see section 2.6.3 below).

In section 2.6.1 above, we have concluded that AEMO did consider a non-credible contingency event during the pre-event period was more likely to occur because of the existence of abnormal conditions. It was not necessary for AEMO to conclude that a reclassification was required at that point in time in order to trigger this obligation. However, AEMO did not provide Market Participants with a notification as required by clause 4.2.3A(c). Hence, our finding is that AEMO did not fully comply with clause 4.2.3A(c). Because AEMO did not issue a notification to participants under clause 4.2.3A(c), we conclude that AEMO's obligation under clause 4.2.3A(d) to update such a notification was not enlivened.

Findings

We find that AEMO did not fully comply with clause 4.2.3A(c).

Our findings in relation to notification of Market Participants are fully discussed in Findings, recommendations and AER actions section (section 2.7) at the end of this chapter.

2.6.3 Considering whether a more likely non-credible contingency event is reasonably possible

Relevant NER provisions and assessment against provisions

Under clauses 4.2.3A(e),(f) and (g), if AEMO identifies a non-credible contingency event which is more likely to occur because of the existence of abnormal conditions it must, on a regular basis, consider whether the occurrence of that non-credible contingency event is reasonably possible, having regard to all the facts and circumstances identified in accordance with clause 4.2.3A(b). If AEMO considers that a non-credible contingency event is reasonably possible, it must reclassify it.

AEMO is required to consider whether an event is reasonably possible having regard to criteria published under clause 4.2.3B, which it must review every two years.

Even though clause 4.2.3A(f) requires AEMO to have regard to the reclassification criteria established under clause 4.2.3B, we consider that clause 4.2.3A(e) also requires AEMO to consider other factors that are relevant to determining whether the occurrence of a more likely non-credible contingency event is reasonably possible. We consider that AEMO identified on the day that the instantaneous loss of multiple generating units or transmission lines (a non-credible contingency event) was more likely due to abnormal conditions, in particular lightning and the impact of a severe storm. Hence, the main question is whether AEMO considered, on a regular basis, whether the loss of multiple generating units or transmission lines was reasonably possible, taking into account the published criteria.

AEMO states it did not reclassify as there were no "probable" or "proven" lightning transmission line pairs in SA and although the whole network was at greater risk, it did not know which assets might trip. AEMO states that it did not receive advice from ElectraNet regarding "abnormal risks to the transmission network due to the forecast weather conditions".[90] Further, ElectraNet has independently indicated that it did not identify any risks to its transmission assets due to lightning, high wind speed or any other conditions on the day that could warrant reclassification (noting that the loss of a single circuit transmission line is considered credible at all times). We find that AEMO acted consistently with its obligations.

For completeness, we note that multiple wind farms reducing their output in extreme weather conditions as a result of feathering may pose a risk to system security because actual metered flows on interconnectors are higher than expected by dispatch (noting this is not a mechanical risk to the transmission towers). This is because a loss of synchronism between regions may occur if the magnitude of the flow on the interconnector that occurs with an unexpected generation loss—which increases imports into a region—exceeds the assumed flow level as a result of higher than anticipated pre-contingent flows when determining interconnector limits. We consider this could be a suitable issue for further consideration in reviews of the reclassification criteria. However, we note AEMO's position that wind feathering did not cause any system security

90 AEMO, Final Report, p. 23.

issues during the pre-event and has never caused such issues in the NEM to date.

We also note that AEMO held discussions with ElectraNet on a regular basis during the pre-event about power system conditions:

- In their morning conversations (outlined in section 2.5.4 above) AEMO and ElectraNet discussed the general impacts of the storm, planned outages and any special precautions ElectraNet was intending to take.
- In the early afternoon, AEMO agreed to ElectraNet putting a capacitor bank in service on Tailem Bend because voltage was low and the storm was also approaching.
- AEMO contacted ElectraNet shortly after the transient fault on the Hummocks-Bungama 132 kV line at 15:49 hrs to understand what had caused it.

Furthermore, in its internal early morning meeting, AEMO discussed the abnormal conditions including whether to reclassify the Heywood Interconnector due to lightning, although it decided not to do so. AEMO had discussions with both ElectraNet and AusNet during the day. It considered potential risks internally and took into account the information before it when making decisions about reclassification.

We conclude that AEMO complied with its obligations under clause 4.2.3A(e) during the pre-event as it was open to AEMO not to consider any non-credible contingency event as reasonably possible having regard to the information that it had available. Further, AEMO's reclassification decisions and its deliberations relevant to those decisions were adequate in the circumstances. We agree with AEMO that it was entitled to rely on ElectraNet's assessment of the risks to its own assets, as the discussions between AEMO and ElectraNet indicate that ElectraNet was closely monitoring the abnormal conditions on the day.

The relevant set of criteria for making decisions about whether a non-credible contingency event is reasonably possible is contained in the PSSG, which, among other things, set out AEMO's general approach to reclassification. As explained in section 2.3.6, the PSSG contain detailed procedures on reclassifying the loss of transmission lines due to bushfires or lightning. However, there are no detailed procedures on reclassification stemming from other abnormal conditions such as high wind speeds, other severe weather conditions or any other events that might pose an added risk to power system security. AEMO states that:

> *where a detailed assessment process does not exist AEMO generally relies on advice from a Registered Participant (under clause 4.8.1 of the NER) of the likelihood of any threat arising from environmental changes or unplanned outages, and then determines whether a reclassification is warranted.*

There is sufficient evidence that AEMO had regard to the reclassification criteria in the PSSG in considering whether the loss of multiple generators or transmission lines was reasonably possible on the day. The PSSG require AEMO to consider whether a double circuit transmission line is vulnerable due to a "probable" or "proven" risk of tripping due to lightning when reclassifying the loss of that transmission line due to lightning.[91] During AEMO's early morning risk assessment, it was concluded that there was no cause to reclassify the loss of the Heywood Interconnector as it was not classified as vulnerable to lightning in accordance with the PSSG and there was nothing to indicate to AEMO (for example, advice from ElectraNet) that both Heywood Interconnector lines would trip at once. There is also sufficient evidence that AEMO considered other relevant information, not expressly set out in the PSSG, when making its risk assessments on the day. The decision to reclassify involves judgement. We consider that AEMO had a reasonable basis for not reclassifying any non-credible contingency event as credible.

We therefore conclude that AEMO complied with its obligations under clauses 4.2.3A(f) and 4.2.3A(g). AEMO had information available to it from various sources that it considered when making decisions about possible reclassification. Based on the information before us, it appears that ElectraNet did not anticipate the loss of a double circuit tower and advised AEMO on the day that it was not taking extraordinary steps beyond its usual preparation for storm conditions. The super cells that destroyed transmission elements in quick succession could not have been reasonably predicted given the content of the relevant weather forecasts.

In respect of the loss of the wind farms, we also understand that AEMO claims not to have had any information about the multiple LVRT settings in the wind turbines operating in SA during the pre-event period. Although it observed "overspeed" reductions in wind farm output during the pre-event, AEMO did not consider such reductions to be a contingency event and hence did not contemplate these reductions within the reclassification framework in clause 4.2.3A. We find that AEMO's actions and decisions were compliant in the circumstances, however we have made separate recommendations about reviewing contingency events for which AEMO manages the system and the criteria it considers when making reclassification decisions.

91 AEMO, *Power System Security Guidelines*, Version 78, 29 August 2016, pp. 28-29.

Findings

We conclude that, within its existing reclassification framework, AEMO complied with clauses 4.2.3A(e), (f) and (g).

Our findings are fully discussed in the Findings, recommendations and AER actions section (section 2.7) at the end of this chapter.

2.6.4 Reclassification criteria

Relevant NER provisions and assessment against provisions

Clause 4.2.3B requires AEMO to:

- establish criteria that it must use when considering whether the existence of abnormal conditions makes the occurrence of a non-credible contingency event reasonably possible under clause 4.2.3A(e), and
- review the criteria at least every two years and in doing so:
  - first consult with relevant stakeholders, including Market Participants, TNSPs, Jurisdictional System Security Coordinators and relevant emergency services agencies
  - ensure that the criteria include a requirement to have regard to the particulars of any risk(s) to the power system associated with the various types of abnormal conditions that might arise, and
  - publish the criteria on its website as soon as practicable after the criteria have been established or amended.

The criteria have been published as part of the PSSG.

Various types of abnormal conditions that might arise

In terms of the review referred to in clause 4.2.3B, we consider the NER contemplate that each biannual review should relate to the criteria as a whole rather than specific criteria. In doing so, AEMO is required to first consult with "relevant stakeholders", which would be likely to include Market Participants, TNSPs and Jurisdictional System Security Coordinators. The object of the NER is to enable the development and ongoing improvement of the criteria used in risk assessments in an open and transparent manner. This is clear from the historical context in which this rule was made (which is discussed further in section 2.3.6).

We consider that, although clause 4.2.3B does not require AEMO to anticipate every type of abnormal condition or risk event that might conceivably arise, AEMO should ensure that the criteria include a requirement to have regard to the particulars of risks to the power system from severe weather conditions. Events associated with severe weather conditions, lightning, storms and bushfires are specifically contemplated as examples of "abnormal conditions".[92] We consider that the criteria should address other risks that become evident over time through investigation and experience. We also consider that the NER contemplate that the content of such criteria (as well as criteria associated with other types of abnormal conditions) will be developed and refined through the biannual review process outlined above.

In relation to assessing the criteria established under clause 4.2.3B(a), AEMO initially stated:

> *[t]here have been no consultations on the criteria established under clause 4.2.3B(a) in the last five years, however, AEMO has been investigating the issue at the [Power System Security Working Group] meetings in the context of cyclones affecting the Queensland transmission network.*

AEMO then refined its response, stating that:

- "[f]ormal reviews are conducted 2-yearly and publicly consulted on. Notices, consultation papers and submissions are published on AEMO's website, with alerts sent by AEMO communication." These formal reviews relate to specific criteria, namely bushfires and lightning, and
- the Power System Security Working Group (PSS Working Group), which involves AEMO and TNSPs, regularly reviews "[t]he specific reclassification conditions (bushfires and lightning)" and "[p]roposals for change may be developed through this process". AEMO also notes that all relevant stakeholders named in clause 4.2.3B(d)(1) are invited to the PSS Working Group.

AEMO subsequently further refined its response to clarify that while the formal reviews relate to specific criteria, namely bushfires and lightning, the reviews:

> *do not limit contingencies only to those. There is an "other risks" category which is regularly used; the criteria as a whole are open for review. However, before 28/9 neither AEMO nor [PSS Working Group] members had identified an additional specific risk which lends itself to the development of a common set of criteria.*

However, at the same time, while considering it complied with the provision, AEMO also accepted that:

> *previous reviews of the reclassification criteria have focused on the existing content of those criteria rather than specifically considering whether criteria for any additional conditions should be added. That said, prior to the black system event there had been no reason to consider developing criteria for any other specific weather or environmental event.*

92 NER, clause 4.2.3A(a).

The "other risks" category refers to sections 11.5 and 11.6 of the PSSG, which consider reclassification due to "other events" and reclassification following a non-credible contingency event.[93] However, the specific consultation documents we have reviewed are limited in scope to bushfires and lightning, and do not invite relevant stakeholders to comment on other criteria in the PSSG or criteria that could potentially be included.

AEMO has provided an example of a PSS Working Group meeting in 2015 in which an item for action was to "propose a way forward for a reclassification process" regarding cyclones and high winds. We note AEMO has not indicated whether the action item was advanced in subsequent meetings. This action item may establish that AEMO had considered reclassification criteria other than lightning and bushfires with certain stakeholders prior to the Black System Event. However, it does not refute our general conclusion that AEMO has not conducted formal reviews of the criteria as a whole every two years in which stakeholders are explicitly invited to consider whether the criteria should be expanded. Hence, we conclude AEMO has not reviewed the criteria in the manner required by the NER in the three years prior to the Black System Event.

Findings

We consider that the PSSG as they stand are too narrow in their operation and do not provide sufficient guidance to control room operators and Registered Participants on how AEMO intends to assess the risks associated with abnormal conditions that are not explicitly covered in the PSSG.

Our findings are fully discussed in the Findings, recommendations and AER actions section (section 2.7) at the end of this chapter.

2.6.5 Maintaining power system security

Relevant NER provisions and assessment against provisions

Under clause 4.3.2(a), AEMO has an overarching responsibility to use reasonable endeavours to achieve the AEMO power system security responsibilities in accordance with the power system security principles. Clause 4.3.1(a) provides that one of the power system security responsibilities is to maintain power system security. Further, according to the power system security principles, the power system must be operated so that it is in a secure operating state, to the extent practicable.[94] Hence, AEMO must use reasonable endeavours to maintain power system security in accordance with these principles.

Under the NER, the power system is in a secure operating state if, in AEMO's reasonable opinion, taking into consideration the appropriate power system security principles:[95]

- the power system is in a satisfactory operating state, and
- the power system will return to a satisfactory operating state following the occurrence of any credible contingency event … in accordance with the power system security standards.

Clause 4.2.4 specifically requires AEMO to consider the impact of each of the potentially constrained interconnectors in forming this opinion. As explained in section 2.3.3, if an interconnector trips (or 'shuts down') while energy is flowing between the adjacent regions, then the regions on either side of that interconnector will immediately experience a supply and demand imbalance. If this imbalance is too great, then this can compromise regional system security—for example by creating rates of change of frequency that the regional generators are unable to withstand. It is therefore particularly important to manage the actual loading compared to the limits on these interconnectors. Provided actual loading does not exceed the secure operating limit, if a credible contingency event occurs this will result in flows approaching, but not exceeding, the satisfactory operating limit.

For detailed background on the NER framework for power system security, refer to sections 2.3.1-2.3.3.

On the day of the Event, 5-minute measured flows on the Heywood Interconnector into SA exceeded both the target flow and the import limit into SA for 46 and 29 out of 71 dispatch intervals, respectively, between the 10:25 hrs dispatch interval and the time of the Event. In one case, the import limit exceedance reached 156 MW.

The flow was above the target flow and the import limit because wind farm output was consistently lower than expected by the dispatch engine. BOM issued several severe weather warnings for damaging winds. In the pre-event period, the weather front was moving across the State from the Eyre Peninsula to the Mid North. As it reached the Mid North, wind gusts in excess of 90 km/h (as contemplated by the warnings) contributed to "overspeed" reductions in wind farm output between 15:42-15:51 hrs and hence inconsistency with dispatch targets. AEMO states it did not revise the Heywood Interconnector import limit accordingly because at the time it did not consider "overspeed" output reduction to be a contingency event.

93 AEMO, *Power System Security Guidelines*, Version 78, 29 August 2016, pp. 34-35.

94 NER, clause 4.2.6(a).

95 NER, clause 4.2.4(a).

According to AEMO, on the day of the event, it was operating the power system so that it would be secure for the occurrence of the largest credible contingency event—the loss of the Lake Bonney WFs that are connected through one transmission line and were generating approximately 260 MW—in accordance with the NER.[96] In line with normal operating practice, it did not operate the power system to allow for the simultaneous occurrence of more than one contingency event, as it did not consider any non-credible contingency events, such as the simultaneous loss of the Lake Bonney WFs and another generator, or the simultaneous loss of multiple transmission lines, to be reasonably possible. This was an appropriate decision in the circumstances. However, as explained below, AEMO also needs to monitor actual flows to ensure they do not exceed the secure operating limit, including due to variability in intermittent generation.

NEMDE operates every five minutes—in the intervening period, variations in the power system occur leading to flows on the network that may differ compared with that expected by NEMDE. An operating (or "safety") margin is built into constraint equations to manage modelling approximations when determining the limits and limitations on control systems that manage generation output. AEMO has a policy that outlines its approach to setting this safety margin:[97]

> *The ability of the constraint equation in the AEMO dispatch engine (NEMDE) to maintain the flow on an interconnector or transmission element to within the true limit is dependent on a number of factors including:*
>
> - *Modelling approximations,*
> - *Control limitations, and*
> - *Short-term variations in loads and generator outputs.*

There is a trade-off when determining the operating margin to apply. If the operating margin is too large, the network capability is unnecessarily constrained so that less energy is able to be scheduled across the NEM, leading to higher costs to consumers. If the operating margin is too small, the risk to the power system is increased: modelling approximations may overstate the secure operating limit, or actual flows that occur across the network within the 5-minute dispatch interval may increase above the secure operating limit. As explained in section 2.4.4, the consequence of actual flows exceeding the secure operating limit—in the event of the contingency that the constraint is managing occurring at the same time—differs depending on the type of network limit the constraint is managing.

For thermal limits, post-contingent overheating of the affected equipment takes time, which means that operator action can often occur before permanent damage occurs to the equipment. In addition, AEMO has real-time modelling tools that can accurately assess pre- and post-contingent thermal loading conditions. These tools supplement NEMDE but can signal if the network limit is not being adequately managed by the network constraints. AEMO can then intervene to address the network constraint accuracy. As a result, thermal constraint equations are often created with only a small or no operating margin.[98]

For stability limits, however, there is little or no time for operator action and the consequences are severe. In addition, real-time modelling of these limits is not always possible. Hence, AEMO takes a "conservative approach" to setting the operating margin. AEMO states:[99]

> *Exceeding the transient stability limit can result in a partial or complete shutdown of the power system. The instability develops in a matter of seconds preventing any post-contingent action by the operator.*

This highlights the increased importance of maintaining flows on interconnectors at or below the secure operating limit, when the limit is set by a transient stability constraint.

During the pre-event period, power system imports into SA across the Heywood Interconnector were being limited at times by a transient stability limit. The limit varies in proportion to the size of the largest step change in generation if the associated largest generator trips. That is, the power system would have likely remained in a satisfactory operating state following the loss of generation from the Lake Bonney WFs (the largest group of generators connected to one transmission line during most of this period) even if the flow on the interconnector exceeded the limit but not by more than the safety margin of 30 MW plus 5% on each constraint.

At times, however, actual measured 4-second and 5-minute interconnector flows exceeded the import limit by up to 183 MW and 156 MW, respectively. We queried AEMO whether this meant the power system was not in a secure operating state at all times during the pre-event as defined by clause 4.2.4 of the NER.

AEMO has indicated that there were no Voltage Stability Assessment violations or violating constraints. In particular,

96 AEMO, Final Report, p. 23.

97 AEMO, *Confidence levels, offsets & operating margins—policy,* published July 2010, p. 5. http://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/Congestion-Information/2016/Confidence_Levels_Offsets_and_Operating_Margins.pdf.

98 Ibid, p. 7.

99 Ibid, p. 5.

AEMO did not have "any Voltage Stability Assessment (VSAT) violations or violating constraints, which would indicate enough generation could be dispatched to adjust the flow [on the Heywood Interconnector] back within limits (back to a secure level) in the next possible DI [dispatch interval]". Therefore, AEMO considers it did not need to manually intervene to adjust these flows.

However, these are two separate issues that are described below. We do not consider that the absence of violations in itself proves that the power system was in a secure operating state at all times on the day, particularly given that (as discussed below) a critical limit was related to transient stability. Confirming transient stability in real time is not possible, as stated by AEMO:[100]

> *Although AEMO has a transient stability analysis tool (Dynamic Stability Analysis tool, DSA) that is used in real time power system analysis, this tool was still in the development stages to make it suitable for outage assessment analysis. A transient stability analysis was not conducted during the outage assessment process, due to the unreliability of the assessment tool at the time [29 November 2016].*

For the period from 12:20 hrs to 16:20 hrs, the secure operating limit was being set by the transient stability limit for the loss of the largest generation block, or at a slightly lower limit (30-40 MW lower according to AEMO) to manage overloads on the Tailem Bend-Mobilong line. During this time for significant periods the actual metered 4-second Heywood Interconnector flow was significantly exceeding the secure operating limit (by up to 183 MW, which is much more than the 30 MW safety margin). If the limit is accurately determined then this suggests that, if the largest credible contingency occurred at a time when actual flows exceeded the limit by significantly more than the safety margin, then the power system could be at risk of not being managed for the potential transient stability event. In other words, the actual interconnector flows suggest that the Heywood Interconnector may have tripped due to loss of synchronism, severing the connection with Victoria (with flows reduced to zero). SA would therefore have been islanded. The alternative view is that AEMO considered that the actual limit was not accurate and in fact much higher than that considered by NEMDE, such that there was no need to intervene to ensure the interconnector was being managed securely. This conclusion is at odds with the role of AEMO in managing network security through network limits cognisant of the impact on the market and pricing outcomes.

In any case, transient instability is a near instantaneous power system risk, so it is irrelevant whether the flow could have been adjusted back within limits in the next possible dispatch interval, which is up to five minutes delayed from a contingency event.

In relation to whether actual flows materially above the limit reflected a secure operating state, AEMO stated:

> *The Heywood Interconnector limit set by the market systems has a number of built in margins:*
>
> - *The first is an operating margin which is set to allow for variations of plant output within dispatch intervals and measurement of SCADA—this covers 95% of operating cases.*
> - *Secondly, the stability limits are calculated to have the equation defining the limit to be below the limit 95% of the time. So it is quite possible that a limit could be conservative by 100-150 MW due to the nature of fitting a curve to the study results. On 28 September, the secure limit based on studies was between 650-760 MW; this was over 200 MW headroom on the limit from the constraint equation (this includes the operating margin).*

AEMO also stated:

> *…On 28 September the V-SA interconnector tripped (due to loss of synchronism) when the flow was above 890 MW. For the flows prior in the day the trip of Lake Bonney would not have caused the interconnector flow to reach a level that would have tripped the interconnector due to loss of synchronism (highest cases would have been 870/880 MW—and most were well below this). As such none of the cases prior represent a breach of power system security.*

This indicates that after the event, AEMO has undertaken power system studies that show the import limit was below the secure limit by a large margin and those studies indicate that the power system was secure. We have not assessed these studies, nor the cases selected, but note that some of the cases show the actual post-contingent flows were very close to the flows that led to the loss of synchronism and consequent Event. Further, as reported by AEMO on the events of 29 November 2016,[101] on 28 September the operators would have been unable to determine this fact.

No constraints were violated during the pre-event period because the target 5-minute interconnector flow did not exceed the import limit at any time. Assuming this import limit is set to allow for the loss of the largest credible contingency, the power system is not necessarily in a secure operating state merely because the 5-minute interconnector target and import limit align, although that is clearly a relevant

100 AEMO, *Power system in Victoria not in a secure operating state on 29 November 2016*, published July 2017, p. 5, https://www.aemo.com.au/-/media/Files/Electricity/NEM/Market_Notices_and_Events/Power_System_Incident_Reports/2016/Vic-not-secure-on-29-November.pdf.

101 Ibid.

factor. Rather, AEMO must be of the reasonable opinion that the power system is in a satisfactory operating state and will return to a satisfactory operating state following the occurrence of any credible contingency event.[102] Hence, we consider that the power system would not be in a secure operating state at a given time if a credible contingency event would result in actual interconnector flows exceeding and subsequently not returning to the satisfactory operating limit.

AEMO states that interconnector flows regularly exceed the import limit, and that the power system remains secure. According to AEMO, this is because the import limit is dynamic (effectively a target maximum flow) and adjusts with overall system conditions. For example, if the import limit is 600 MW and the flow is currently 620 MW, NEMDE “moves” the limit to 580 MW in the next dispatch interval. AEMO considers that exceedance of import limits “is not in fact an indicator of whether the power system is secure”.

We examined the constraints which were in effect on the day and found that there was such a constraint formulation utilised (a “feedback constraint”) to manage flows on the Heywood interconnector to avoid thermal overload on the Tailem Bend to Mobilong line. AEMO stated that “these normally undercut the stability limit for trip of the largest generator by 30-40 MW”. However, the transient stability limit constraint was managing a different power system security risk and this constraint limit did not take into account that actual metered flows on the Heywood Interconnector were significantly higher than the limit (it was not a “feedback constraint”).

In its Final Report, AEMO states that “[its] assessment was that under the NER, in the absence of advice as to specific threats to power system security, it had no obligation or authority to take further action to maintain the secure operation of the power system”.[103] However, we note that AEMO has broad powers to require a Registered Participant to do any act or thing if AEMO is satisfied that is necessary to do so to maintain or re-establish the power system to a secure operating state, a satisfactory operating state, or a reliable operating state.[104]

It is against this background that we have considered whether AEMO used reasonable endeavours to carry out its responsibilities and, in particular, maintain power system security during the pre-event.

Did AEMO exercise reasonable endeavours to maintain power system security?

As explained further in appendix A below, the AER considers that “reasonable endeavours” entails what was reasonably required to be done in the circumstances, having regard to AEMO’s role, including its powers under the NEL and NER, its capacity and its responsibilities and obligations.

We acknowledge that operational decisions generally require an element of judgment, and do not propose to second-guess the general quality of operational decisions. We also recognise that AEMO trains its operators extensively and uses complex systems to support operators in their decision-making. However, we must still be satisfied that AEMO’s decisions are transparent and reasonable in all the circumstances.

As noted above, when transient stability limits apply, it is important for AEMO to take more active steps to maintain flows on the interconnector at or below the secure operating limit. At times during the pre-event, however, actual measured 4-second and 5-minute interconnector flows significantly exceeded the import limit.

As stability limits cannot be determined in real time, we cannot conclusively state that the power system was known to be in a secure operating state during the pre-event period. However, AEMO stated that modelling it had undertaken after the event demonstrated that the power system did remain in a secure operating state throughout. We consider that there were further steps that AEMO did not take that would have been appropriate, including:

- reviewing the updated BOM forecasts from 12:56 hrs onwards and the impacts those changes in forecast may have for the power system
- notifying Market Participants about the matters listed in clause 4.2.3A(c)
- having in place more detailed reclassification criteria in the PSSG, and
- adjusting the AWEFS forecast for affected wind farms more promptly in response to the rapid reduction in aggregate output at these wind farms between 15:42-15:51 hrs. It did not adjust the forecast for Snowtown WF, Snowtown North WF, Snowtown South WF or North Brown Hill WF until 15:57 hrs, after the rapid reduction had already taken place.

On balance, however, we conclude that AEMO used reasonable endeavours to maintain power system security during the pre-event, in light of all the relevant facts and circumstances. These included:

- setting the secure operating limit of the Heywood Interconnector to cover the loss of the Lake Bonney WFs
- ensuring that target 5-minute interconnector flows did not exceed the secure operating limit for longer than half an hour

102 NER, clause 4.2.4(a).

103 AEMO, Final Report, p. 24.

104 NER, clause 4.8.9(a)(1).

- taking steps to increase its focus on power system events in SA by moving responsibility for Tasmania to the other control room and indicating that, if there were further issues, AEMO would devote the resources of an entire control room to the SA region
- monitoring all major trips and faults, including:
  - the six transient transmission line faults that occurred prior to the transmission faults that triggered the events leading to the Black System, and
  - the Snowtown WF tripping at 10:32 hrs after the Hummocks-Snowtown-Bungama 132 kV line fault and auto-reclose at 10:31 hrs
- discussing with AusNet the possibility of AusNet cancelling several outages (two of which were ultimately cancelled) with the aim of removing binding constraints and providing additional capacity on the interconnector
- implementing increased monitoring of wind farm performance, including by:
  - considering real-time wind speed and lightning data, and
  - being aware of significant wind farm output reductions
- considering requesting ElectraNet to put a capacitor bank in service on the Heywood Interconnector in response to high winds resulting in increased imports from Victoria to SA through the Heywood Interconnector (although ultimately deciding against doing so)
- identifying that a non-credible contingency event, namely the simultaneous loss of multiple transmission lines or generating units, was more likely due to the abnormal conditions on the day in accordance with clause 4.2.3A(b)(2), as evidenced by AEMO:
  - considering internal procedures for security management of unplanned multiple outages in SA
  - assessing the potential impact on the SA transmission network due to lightning
  - internally raising the possibility of escalating the event, and
  - discussing the approaching weather with ElectraNet. ElectraNet informed AEMO it would be managing outages differently because of the forecast storm, and
- considering on a regular basis whether the occurrence of a non-credible contingency event was reasonably possible in accordance with clause 4.2.3A(e) and having regard to the criteria in the PSSG in doing so, pursuant to clause 4.2.3A(f). This is evidenced by AEMO:
  - at the early morning risk assessment, concluding that there was no cause to reclassify the loss of the Heywood Interconnector as it was not classified as vulnerable to lightning in accordance with the PSSG and AEMO had not received advice from ElectraNet that both Heywood Interconnector lines would trip at once
  - regularly engaging with ElectraNet on the day about the general impacts of the storm, planned outages and any special precautions ElectraNet was intending to take
  - agreeing to ElectraNet putting a capacitor bank in service on Tailem Bend because voltage was low, and the storm was approaching, and
  - discussing with ElectraNet the transmission faults that occurred prior to the faults that contributed to the SA power system going black.

Findings

On balance, we conclude that AEMO used reasonable endeavours to maintain power system security during the event, in light of all the relevant facts and circumstances, and therefore complied with clause 4.3.2(a).

We acknowledge that maintaining the power system in a secure operating state is a complex task and that AEMO has broad powers to apply its expert knowledge to achieve the power system security responsibilities. AEMO has taken several steps that we consider have rectified the issues it experienced on the day with interconnector flows significantly exceeding the secure operating limit.

Our findings are fully discussed in the Findings, recommendations and AER actions section (section 2.7) below.

2.7 Findings, recommendations and AER actions

2.7.1 Arising from 2.6.1: Abnormal Conditions

Findings

By failing to utilise the updated weather warnings issued by BOM from 12:56 hrs when constantly reviewing the early morning decision not to reclassify, AEMO did not take all reasonable steps to ensure that it was promptly informed on a continual basis of how the abnormal conditions were evolving. Hence, AEMO did not fully comply with its obligations under clause 4.2.3A(b).

Under the NER framework, where there are abnormal conditions AEMO is expected to do more than it would under normal circumstances to monitor what is happening, proactively gather information to keep itself informed, and keep the market updated. This function is important so that AEMO knows what action it may have to take to maintain power system security, but also so that it can know what it should communicate to the market to facilitate a market response (including facilitating the provision of relevant information to AEMO by Market Participants). AEMO must exercise its judgment as to how it should best discharge its responsibilities at these times, having regard to its power system security responsibilities and the goal of maintaining power system security.

While in the period being investigated AEMO did respond to the abnormal conditions and took action it would not have taken under normal circumstances, it could potentially have done more to actively keep itself informed. We find that the provisions in the NER are intended to provide AEMO with the power and responsibility to proactively take steps to inform itself about abnormal conditions and determine what actions might need to be taken to maintain power system security in the light of those abnormal conditions.

At the same time, we accept AEMO was doing its best in challenging circumstances and consider that AEMO's failure to take account of the updated weather warnings did not contribute to the Event.

AEMO has itself recommended in its report that "during extreme weather conditions, more rigorous processes [should] be put in place to monitor weather warnings for changes in forecasts in order to trigger reassessment of reclassification decisions where relevant". In its Final Report, AEMO stated it had taken the following actions pursuant to that recommendation: [105]

- severe weather warnings are now being sent directly to the AEMO control rooms as well as to operations planning staff
- routine weather information available to the control room now contains a section on weather warnings
- a training package to improve the ability of control room staff to interpret the warnings as they are received and assess the risks they pose to the power system has been developed
- implementation of staff training, and
- BOM staff being contactable by NEM control centres.

We support AEMO's recommendations. However, we consider that AEMO should have more rigorous processes to monitor weather warnings as well as forecasts at all times, not just during extreme weather conditions. The NER require AEMO to take all reasonable steps to keep itself informed of abnormal conditions, and this is an ongoing obligation that exists independently of whether there are in fact abnormal conditions. In other words, AEMO's processes should ensure that AEMO is able to identify abnormal conditions (and make assessments about their possible effects on the system) by regularly monitoring relevant risks such as changes in weather conditions.

Recommendation

2.1 To keep itself promptly informed of abnormal conditions, AEMO to put in place more rigorous processes to monitor weather warnings and forecasts at all times, not just at times of extreme weather.

In response to Recommendation 2.1, AEMO states it has already established processes to improve its monitoring of weather warnings and forecasts at all times, including through the secondment of a BOM forecaster to AEMO.

We note that the AER and AEMO interpret the definition of "contingency event" differently. We consider AEMO has a broad, flexible discretion to decide what is a contingency event. A contingency event is an event affecting the power system which AEMO expects would be likely to involve the failure or removal from operational service of one or more generating units and/or transmission elements. As discussed above, we consider that it is open for AEMO to form the view that high wind speeds can affect the likelihood of a contingency event, such as feathering of generating units at multiple wind farms on a very large scale.

Conversely, AEMO considers that contingency events are "sudden, completely unpredictable events resulting in an instantaneous imbalance large enough not to be manageable in central dispatch". According to AEMO, intermittent generation related events and load ramping events do not fit this description and treating these as contingencies is not workable in the NEM context. AEMO does note, however, that:

> *While the contingency framework is unlikely to be suitable, particular consideration is being given to the potential for 'type' failures in areas where wind or other inverter-based generation without associated storage is prevalent and likely to experience the same conditions at more or less the same time—whether wind speed or fault conditions.*

Due to its narrower interpretation of what constitutes a "contingency event", AEMO considers that the current reclassification framework does not provide it with enough flexibility to deal with new and emerging potential security risks. As an example, AEMO notes that the Event "resulted from two simultaneous shutdowns of about 200 relatively small wind turbines". AEMO states:

> *A fit-for-purpose regulatory framework is needed to address the potential system security risks arising in the power system of today and the future, and*

105 AEMO, Final Report, p. 95.

the increasing potential for more extreme weather events. Using the existing contingency framework to expand contingency sizes comes at a very high cost to consumers, and a potentially unacceptable impact on the reliability of supply. Again, AEMO considers that additional, detailed and accurate information combined with flexible adaptive processes will be central to maintaining a secure and reliable system.

We reiterate that our interpretation of the reclassification framework allows AEMO sufficient flexibility to deal with new risks as they arise. Nevertheless, in the "Implications for the Regulatory Framework" chapter of this report, we set out AEMO's suggestion of a new "fit for purpose" regulatory framework in greater detail and highlight potential work for the AEMC in considering the scope of the current contingency framework and whether this framework is sufficient to address risks to power system security arising from intermittent generation and other emerging risks.

We note that AEMO has recently submitted a request to the Reliability Panel to have certain non-credible contingency events (including the potential loss of multiple generating units) associated with destructive wind conditions in SA declared as a protected event.[106] AEMO submits that it cannot use forecasts of destructive wind conditions to identify the loss of a specific generating unit as reasonably possible and hence cannot sufficiently manage the loss of multiple generating units using the current reclassification framework.[107]

2.7.2 Arising from 2.6.2: Providing notification to Market Participants

Findings

By failing to provide Market Participants with a notification as soon as practicable after identifying a non-credible contingency event which was more likely to occur because of abnormal conditions, AEMO did not fully comply with its obligations under clause 4.2.3A(c).

AEMO notifying Market Participants of non-credible contingency events that are more likely to occur is an important medium through which the NER seek to promote transparency and informed market responses.

This is particularly important where there are extreme circumstances. If Market Participants are well informed about abnormal conditions and the information AEMO has relied on in assessing these:

- Market Participants will better understand the relevant threats to power system security
- Market Participants will have advance notice that there could be a change in the manner in which AEMO will manage the power system while the risk remains, and
- Market Participants will be able to identify information gaps and inform AEMO if there is any additional information that may be relevant to power system security in light of the abnormal conditions and the type of non-credible contingency event identified in the market notice.

AEMO must exercise its judgment to determine relevant non-credible contingencies that are more likely as a result of abnormal conditions. While we note that the "more likely to occur" test is potentially very broad, in these particular circumstances, we find that it was clear from AEMO's actions during the day that it considered the potential failure or removal of more than one generating unit or transmission element due to the abnormal conditions was more likely in the pre-event period. The various steps AEMO took during the day (which we consider demonstrated AEMO was using reasonable endeavours to meet its power system security responsibilities) were in response to that increased likelihood.

We note that AEMO disagrees with our finding of non-compliance—as outlined above in section 2.6.2. Hence, AEMO considers clause 4.2.3A(c) was not enlivened. AEMO states:

> *A generic notice to the effect that things might happen will not enable market participants to assess whether and how they could take risk mitigation action and is likely only to cause confusion and potential price disruption. If NER 4.2.3A(c) means that AEMO should inform the market of non-specific risks to the power system, AEMO would have to publish a notice whenever abnormal conditions exist. That is not an interpretation that can be discerned from the words of NER 4.2.3A(b)(2) and 4.2.3A(c), nor would it serve any purpose to do so.*

106 AEMO, *AEMO request for protected event declaration: Potential loss of multiple generators in South Australia*, submitted November 2018.

107 Ibid, p. 8.

We do not consider that the risks AEMO was identifying on the day were non-specific.[108] However, nor do we consider AEMO's non-compliance with clause 4.2.3A(c) contributed to the Event. Even if AEMO had notified the market in accordance with clause 4.2.3A(c), ElectraNet would not have been able to provide information on risks to assets arising from storm supercells and localised tornadoes, since they were not forecast to occur. Further, we understand that AEMO claims not to have had any information about the multiple LVRT settings in the wind turbines operating in SA during the pre-event period and considered that the temporary loss of generation at wind farms during the pre-event would be satisfactorily handled through dispatch.

In relation to Recommendation 2.2, AEMO states it will review its processes and training to ensure compliance with clauses 4.2.3(c) and (d), but that in most cases, a reclassification decision will be made almost simultaneously with AEMO determining that a particular event is in fact more likely. AEMO adds that usually there will be no reasonable opportunity to inform the market of a "more likely" contingency. According to AEMO, it is likely to be most relevant for bushfires, where a heightened risk to particular assets may well be identified based on the current location of a fire, and the severity of that risk would change as conditions develop, necessitating information updates. We consider storms with high wind gusts in areas of wind farms can involve similar risk assessments being made. However, AEMO clarifies that it does not consider the NER require it to issue general warnings about heightened risks, or that it would assist the market to do so.

The AER and AEMO clearly hold different interpretations of clauses 4.2.3A(b)(2) and 4.2.3A(c) and how those provisions should be applied in practice. Our interpretation of the clause is set out in greater detail in appendix A. We consider our interpretation allows greater flexibility in planning for and communicating risks to the market and facilitating preparedness for potential major events. Nevertheless, in the "Implications for the Regulatory Framework" chapter, we further explore the various differences in how the AER and AEMO consider the current reclassification regime should work and suggest that the AEMC consider in its review whether the current framework is ambiguous or insufficiently flexible.

Recommendation

2.2 AEMO to review its processes for issuing notifications to Market Participants during abnormal conditions. AEMO's processes should be standardised and clearly communicated to Market Participants, such that if AEMO is of the view that:

- a non-credible contingency event is more likely to occur due to abnormal conditions, it must issue a notification to Market Participants in accordance with clause 4.2.3A(c)
- material new information has arisen relevant to its consideration of whether the event is reasonably possible, it must update the notification in accordance with clause 4.2.3A(d), or
- abnormal conditions are no longer materially affecting the likelihood of a non-credible contingency event, it must issue a notification to Market Participants to this effect.

2.7.3 Arising from 2.6.3: Considering whether a more likely non-credible contingency event is reasonably possible

Findings

We conclude that, within its existing reclassification framework, AEMO complied with clauses 4.2.3A(e), (f) and (g).

Despite complying with the relevant NER, we consider that this framework, and in particular the PSSG criteria, is too narrow and has not been reviewed in the manner envisioned under the NER. The recommendation arising from this finding is detailed in section 2.7.4 below.

2.7.4 Findings and Recommendations arising from 2.6.4: Reclassification criteria

Findings

AEMO has not conducted formal reviews of the criteria as a whole every two years in which stakeholders are explicitly invited to consider whether the criteria should be expanded. Hence, we conclude AEMO has not reviewed the criteria in the manner required by clause 4.2.3B in the three years prior to the Black System Event.

Although clause 4.2.3B does not require AEMO to anticipate every type of abnormal condition or risk that might conceivably arise, AEMO should ensure that the criteria

108 This is discussed in more detail under the heading "AEMO must identify any non-credible contingency event more likely to occur because of abnormal conditions" in section 2.6.1.

include a requirement to have regard to the particulars of risks to the power system from different types of abnormal conditions.

Although AEMO states that it relies on Registered Participants to advise AEMO of risks to equipment or power system security where AEMO does not have specific procedures in place, the PSSG do not reflect this criterion.

The PSSG should set out all criteria AEMO uses, including for abnormal conditions other than those explicitly identified in the PSSG.

The criteria review process specified in clause 4.2.3B is an important means through which AEMO and Registered Participants can jointly consider whether the reclassification criteria provide adequate guidance to control room operators and Registered Participants during abnormal conditions.

This relates not only to the existing lightning and bushfire criteria, but also to other abnormal conditions including—but not limited to—storms and severe weather conditions.

Through the consultation process, Registered Participants may identify new risks from abnormal conditions or even new types of abnormal conditions, which may not necessarily be evident to AEMO.

A general consultation process should also promote a greater understanding of how AEMO applies the PSSG and how AEMO and Registered Participants interpret them. The process should help reconcile any differences in interpretation and improve communication in relation to power system security risks.

Strong communication in this area is critical because AEMO relies on Registered Participants for information that is integral to its reclassification process, such as risks to equipment.

We note that AEMO's report includes a recommendation to review particular reclassification procedures to ensure "a more detailed risk-based approach", specifically:[109]

> *AEMO to work with the PSS Working Group to develop a more structured process for information exchange and reclassification decisions when faced with risks due to extreme wind speeds, which may include development of more sophisticated forecasting systems for extreme wind conditions including tornadoes. This proposal will be put forward for consultation with participants and other relevant parties such as weather service providers.*
>
> *It is planned to formulate this proposal and commence consultation by end June 2017.*

AEMO states it subsequently reviewed with NSPs whether any reclassification criteria could be developed for extreme wind conditions. The conclusion was that it would not be feasible to formulate specific criteria for severe weather conditions and storms "due to the diversity of construction and age of network infrastructure in different NEM regions".

However, AEMO now reclassifies the loss of certain transmission lines in SA based on forecast wind speeds.

We support the steps AEMO has taken to review its reclassification criteria so far but also conclude that a review which considers a broader range of conditions and stakeholders than those specified in AEMO's recommendation is required. To this end, we have formulated Recommendations 2.3 and 2.4 below

In response to the recommendations, AEMO states that "[g]oing forward AEMO will ensure that the criteria review process specifically incorporates a review of whether bespoke criteria can or should be developed for the assessment of any additional identified abnormal environmental or power system conditions".

We also conclude that AEMO and Registered Participants would benefit from a shared guide to what AEMO is likely to do when faced with abnormal conditions in which unprecedented risks arise. This is reflected in Recommendation 2.5 below.

AEMO's response to this recommendation is that it "will consider whether any more meaningful detail can be added, without restricting the flexibility to deal with specific new situations as they arise". It adds that "increasing the level of prescription can have unintended consequences, including a loss of flexibility to respond appropriately to previously unknown conditions (or more extreme conditions) as they arise."

109 AEMO, Final Report, p. 96.

Recommendations

2.3 AEMO to holistically review the criteria at least once every two years and in that process consult with Market Participants, TNSPs, Jurisdictional System Security Coordinators, relevant emergency services agencies and other relevant stakeholders such as BOM. In conducting this review, AEMO should not only assess whether existing criteria are adequate, but also whether there are any gaps in the criteria. This also includes assessing any non-credible contingency events that have happened and considering whether the criteria need to be adjusted, developed, expanded or explained in more detail, in light of that experience.

2.4 AEMO to ensure that the criteria include a requirement to have regard to the particulars of any risk(s) associated with any abnormal conditions that AEMO and relevant stakeholders identify through the consultation process.

2.5 AEMO to introduce a framework and criteria regarding its approach to the reclassification of non-credible contingencies due to abnormal conditions that are not explicitly identified in the PSSG, including a risk assessment framework.

2.7.5 Arising from 2.6.5: Maintaining power system security

Findings

On balance, we conclude that AEMO used reasonable endeavours to maintain power system security during the event, in light of all the relevant facts and circumstances, and therefore complied with clause 4.3.2(a).

AEMO has taken several steps that we consider rectify the issues it experienced on the day with interconnector flows significantly exceeding the secure operating limit.

We note and agree with AEMO's previous recommendations in its Final Report:[110]

- to modify existing transfer limits on the Heywood Interconnector to take into account the fact that the largest credible generator contingency under conditions of high wind generation is greater than previously assumed[111]
- to assess options for improved forecasting of when wind speeds will exceed overspeed protection settings on wind turbines, which would lead to "overspeed cut-outs". We consider this may help better align wind farm output with target output and hence reduce the likelihood of forecast inaccuracies putting pressure on interconnector flows, and
- to work with ElectraNet to determine the feasibility of developing a special protection scheme to operate in response to sudden excessive flows on the Heywood Interconnector, and to initiate load shedding with a response time fast enough to prevent separation. We consider this may help increase the likelihood that the Heywood Interconnector will return to a satisfactory operating state following a contingency event.

As this work has already occurred, no further actions are recommended.

110 Ibid, p. 9.

111 Ibid.

Appendix A—Legal framework

The key area of focus in respect of AEMO's conduct is how it exercised its powers and met its obligations in respect of maintaining power system security. Related to this is whether AEMO kept itself adequately informed of abnormal conditions and responded as required under the NER.

Central to those obligations are the concepts of "contingency event", "credible contingency event" and "non-credible contingency event". The NER were amended in 2008 to provide the market operator with greater flexibility, including greater flexibility to decide which contingency events are credible or non-credible, how it approaches reclassification and how it takes account of abnormal conditions. The historical context in which these changes to the NER occurred is important for understanding these requirements and it is discussed above in section 2.3.6.

Contingency events

NER clause 4.2.3(a) defines a "contingency event" as follows:

> A contingency event means an event affecting the power system which AEMO expects would be likely to involve the failure or removal from operational service of one or more generating units and/or transmission elements.

The definition is very broad. A contingency event can be any event that could pose a risk to the security of the power system through the failure or removal of a generating unit or a transmission element. Significantly, the definition is dependent upon an assessment by AEMO. A contingency event is an event that "AEMO expects" would have certain consequences. This reflects an underlying premise to this part of Chapter 4 of the NER, which is that AEMO has responsibility for making appropriate judgements about what are the relevant risks to the system, in any given conditions, and then managing the system to maintain power system security.

Contingency events are separated into "credible events" and "non-credible events". A credible contingency event is defined in NER clause 4.2.3(b) as follows:

> (b) A credible contingency event means a contingency event the occurrence of which AEMO considers to be reasonably possible in the surrounding circumstances including the technical envelope. Without limitation, examples of credible contingency events are likely to include:
>
> (1) the unexpected automatic or manual disconnection of, or the unplanned reduction in capacity of, one operating generating unit, or
>
> (2) the unexpected disconnection of one major item of transmission plant (e.g. transmission line, transformer or reactive plant) other than as a result of a three-phase electrical fault anywhere on the power system.

As with the definition of "contingency event", the definition of a "credible contingency event" is dependent on a judgement by AEMO. It is a contingency event that AEMO considers is reasonably possible at a given time.

The term "reasonably possible" inherently requires the exercise of judgement. The precise meaning must be gleaned from a consideration of the legislative context and purpose.[112] The AER considers that AEMO does not have to be satisfied that the event is "expected" or "likely" to make it credible, in the sense that it must be above a precise percentage of probability. Instead, in the context of its obligation to use reasonable endeavours to maintain power system security, the AER considers that AEMO has flexibility to make judgements about whether a risk to the system posed by an event is reasonably possible in the circumstances, and that the system should therefore be managed with that reasonably possible risk in mind. The standard is that of a reasonable market operator in all the circumstances.

The definition of "credible contingency event" provides some examples of what would be likely to constitute a credible contingency event. However, the provision also makes it clear that these are "examples" and they should not be seen as limiting what AEMO might consider to be credible in any given circumstances.

AEMO considers that in normal operating conditions an event which disconnects a single generating unit or a single transmission element (whether or not that leads to loss of generator(s) connected to that element) with a consequent loss of supply equivalent to the loss of that generation is reasonably possible and constitutes a credible contingency event. By covering the loss of generation equivalent to the largest generator (or group connected to one element), the loss of any single smaller generator in the State is also automatically covered. The range of actual events that might trigger the contingency event in normal conditions are not identified specifically.

112 See Project Blue Sky Inc v Australian Broadcasting Authority (1998) 194 CLR 355 at 384; ACCC v Metcash Trading Ltd [2011] FCAFC 151, and Australian Telecommunications Commission v Krieg Enterprises Pty Ltd (1976) 14 SASR 303 at 309-13.

A non-credible contingency event is defined in NER clause 4.2.3 as follows:

(e) A non-credible contingency event is a contingency event other than a credible contingency event. Without limitation, examples of non-credible contingency events are likely to include:

(1) three-phase electrical faults on the power system, or

(2) simultaneous disruptive events such as:

(i) multiple generating unit failures, or

(ii) double circuit transmission line failure (such as may be caused by tower collapse).

Any contingency event that is not a credible contingency event is a non-credible contingency event.

While the NER provides some examples of what might constitute a non-credible contingency event, this list is not exhaustive. It is expressed as being “likely to include”. The AER considers that the examples do not limit what AEMO might consider to be credible or non-credible in any given circumstances. What is credible or non-credible will change in different operating conditions. The key concept to note in the definition of a non-credible contingency event is that it covers every contingency event that is not a credible contingency event at the relevant time.

We consider the definition of “contingency event” is capable of applying to the simultaneous removal of multiple generating units due to feathering in severe wind conditions. It is an event affecting the power system that involves the removal from operation of multiple generating units (wind turbines) and therefore fits the definition. Determining whether such a contingency event is a credible contingency event will depend on the operating conditions. For example, in normal weather conditions it might be reasonably possible (even if not likely) for multiple generating units connected by one transmission element that are producing up to 260 MW to be removed from service across a particular region due to the loss of that transmission element. The loss of more than 260 MW would be a non-credible contingency event as more than one event would be required to occur simultaneously. However, if a storm front approached with strong wind gusts across a broad area, there may be an additional risk of multiple generating units at multiple wind farms being removed from operational service at the same time. This is additional to the risk of any single transmission element failing. This additional risk may require a reconsideration of what is credible or non-credible while those abnormal conditions persist around those assets.

Abnormal conditions

Whether a contingency event is credible or non-credible will change with the surrounding circumstances. The NER contemplates that there are normal operating conditions in which certain events are non-credible. However, from time to time there will be abnormal conditions that increase the chances of a contingency event happening. The focus of NER clauses 4.2.3A and 4.2.3B is on these “abnormal conditions”. Abnormal conditions are defined in NER clause 4.2.3A as follows:

> Abnormal conditions are conditions posing added risks to the power system including, without limitation, severe weather conditions, lightning, storms and bush fires.

This definition is very broad. Abnormal conditions are any conditions that pose added risks to the power system. Some examples are provided, but they are not meant to limit what might represent abnormal conditions. The examples listed expressly include severe weather conditions.

AEMO has certain statutory responsibilities in relation to abnormal conditions. NER clause 4.2.3A(b) provides:

(b) AEMO must take all reasonable steps to ensure that it is promptly informed of abnormal conditions, and when abnormal conditions are known to exist AEMO must:

(1) on a regular basis, make reasonable attempts to obtain all information relating to how the abnormal conditions may affect a contingency event, and

(2) identify any non-credible contingency event which is more likely to occur because of the existence of the abnormal conditions.

The first obligation in this provision requires AEMO to actively seek to inform itself about whether there are abnormal conditions at any given time. If AEMO is aware of abnormal conditions, then it must gather information about the effect of the abnormal conditions on contingency events and identify if it might be necessary to reclassify a contingency event.

The AER considers that this provision requires AEMO to strive for standards that appear high, as reflected in the use of the word *“all”* when referring to what steps must be taken and what information should be obtained by AEMO. This is consistent with the background context to the provision. The presence of abnormal conditions indicates that there is a state of heightened (or potentially heightening) risk to the security of the power system. AEMO is responsible for obtaining the information it needs from relevant sources to make informed decisions about whether there are any abnormal conditions, and how any such conditions might then affect risks to the system.

Nevertheless, while the standard for which AEMO must strive is high, the provisions also acknowledge the very practical consideration that AEMO will only be able to do what is reasonably possible in the circumstances. Hence, the obligation is to take *all reasonable* steps to be promptly informed and to make *reasonable attempts* to obtain all information. This emphasis on doing what is practicable is also evidenced in the Rule Change Determination of 2008, which states:[113]

> The requirement on NEMMCO to respond to abnormal conditions has been amended so that NEMMCO is now only required to respond when it is aware of those conditions. It is not reasonable to expect NEMMCO to respond to conditions that it is not aware of, which could result in NEMMCO unknowingly breaching the [National Electricity] Rules. Consequently, a new obligation has been placed on NEMMCO to actively seek to be made aware of abnormal conditions to maximise the timeliness and appropriateness of information collection.

What is reasonable in the circumstances should be understood in the context of all relevant factors—including the seriousness of the subject matter and the facilities that are available.

AEMO, being a body corporate, "thinks" and "acts" through its officers, employees and agents.[114] As a general rule, bodies corporate are taken to have knowledge of the things that authorised officers and agents know as a result of carrying out their authorised functions. The knowledge of a person with appropriate authority to deal with a matter on behalf of a body corporate will generally be imputed to the body itself.[115]

A body corporate will not necessarily know something merely because any officer or employee who might have any duties, however removed they might be from the issue at hand, is made aware of a particular fact. A corporation which has notice of something does not necessarily have knowledge of it.[116]

In the context of clause 4.2.3A, we consider AEMO would be keeping itself promptly informed of abnormal conditions if the relevant information is in its systems and it has taken all reasonable steps to ensure that its responsible officers are in timely receipt of that information, following which those officers act in a timely manner and actively consider that information.

The information that AEMO must gather and consider under clause 4.2.3A is for making assessments about whether there could be a heightened risk to the power system due to the abnormal conditions[117] and to identify whether any non-credible contingency event is "more likely" to occur because of those abnormal conditions.[118]

"More likely"

Having become aware of abnormal conditions, AEMO must identify whether there are any non-credible contingency events that are "more likely" to occur. The AER considers that the use of the words "more likely" is intended to represent an incremental but plausible increase in risk. The rise in risk does not have to reach a level where AEMO considers any non-credible event is now reasonably possible. It is a lower standard. This is clear from the terms of clause 4.2.3A(c)(3), which expressly contemplates that a contingency event can be "more likely" because of abnormal conditions while still not being considered reasonably possible (that is, it may remain at that stage a non-credible event). In these circumstances, AEMO must provide market participants with certain information. Clause 4.2.3A(c) provides:

> (c) As soon as practicable after AEMO identifies a non-credible contingency event which is more likely to occur because of the existence of abnormal conditions, AEMO must provide Market Participants with a notification specifying:
>
> (1) the abnormal conditions
>
> (2) the relevant non-credible contingency event
>
> (3) whether AEMO has reclassified this non-credible contingent event as a credible contingency event under clause 4.2.3A(g)
>
> (4) information (other than confidential information) in its possession that is relevant to its consideration under clause 4.2.3A(e), the source of that information and the time that information was received or confirmed by AEMO
>
> (5) the time at which the notification has been issued, and
>
> (6) the time at which an updated notification is expected to be issued, where this might be necessary.

113 AEMC, Rule Determination, p. 8.

114 See Northside Developments Pty Ltd v Registrar-General (1990) 170 CLR 146 at 171-2.

115 Beach Petroleum NL v Johnson (1993) 43 FCR 1; JC Houghton and Co v Nothard, Lowe and Wills Ltd [1928] AC 1.

116 Eagle Trust Plc v SBC Securities Ltd [1992] 4 All ER 488 at 497-8. See also Universal Telecasters (Qld) Ltd v Guthrie (1978) 18 ALR 531 at 535.

117 NER, clause 4.2.3A(b)(1).

118 NER, clause 4.2.3A(b)(2).

The key purpose of this provision appears to be to initiate information exchange and preparedness for an event, even if that event, at least for the moment, remains relatively unlikely to occur in AEMO's opinion (that is, it remains a non-credible contingency event). The intention of the provision, particularly when the purpose is understood in historical context having regard to the Rule Change Determination,[119] is to require AEMO to proactively notify market participants about abnormal conditions about which it is aware and the additional risks those conditions might impose. It must outline the relevant information in its possession and set in place a system for timed updates. It must do this even though it might not consider that the abnormal conditions have yet reached the point that any contingency event has changed from being non-credible to credible.

In this sense, the notification to market participants is intended to make sure that everyone is in a state of heightened preparedness, that all relevant participants are aware of relevant information, and that in the event of an escalation of risk, appropriate steps can be taken promptly, and on an informed basis. It also may help to prompt appropriate market responses, avoiding the need for more active management of the system by AEMO itself.

This can again be illustrated with an example. Let us suppose that in normal conditions the market operator considers that the loss of up to 260 MW through the failure or removal of generating units arising from the loss of one transmission element in the State is a credible contingency event. If winds are forecast to increase during the next six hours to speeds that may make the simultaneous shut-down of, say, 100 MW of wind generation in affected areas more likely, then a non-credible contingency event (involving the failure or removal of generating units or transmission elements) of up to 360 MW may be more likely. If a non-credible contingency event is identified as more likely then clause 4.2.3A(c) requires an appropriate notification to be provided to market participants

As explained above, we consider AEMO has a broad, flexible discretion to decide what is a contingency event. If AEMO's operators, through their discussions and actions, indicate that they consider the risk of a non-credible contingency event has become more likely (though not necessarily reasonably possible) due to abnormal conditions, then clause 4.2.3A(c) is enlivened.

These notifications must be updated while the abnormal conditions continue. Clause 4.2.3A(d) provides:

> (d) AEMO must update a notification issued in accordance with clause 4.2.3A(c) as it becomes aware of new information that is material to its consideration under clause 4.2.3A(e), and in any event no later than the time indicated in the original notification under clause 4.2.3A(c)(6), until such time as it issues a notification specifying that the abnormal conditions have ceased to have a material effect on the likely occurrence of the non-credible contingency event.

These obligations to notify market participants are complemented by AEMO's power system security responsibility to publish, as appropriate, information about the potential for, or the occurrence of, a situation which could significantly impact, or is significantly impacting, on power system security.[120]

We note that AEMO has a different interpretation in relation to these obligations, which is set out further above in section 2.6.2.

Reclassification and criteria

When there are abnormal conditions, there may come a point in time when AEMO considers that a non-credible contingency event has become reasonably possible. Clause 4.2.3A(e) addresses those circumstances in this way:

> (e) If AEMO identifies a non-credible contingency event which is more likely to occur because of the existence of abnormal conditions it must, on a regular basis, consider whether the occurrence of that non-credible contingency event is reasonably possible, having regard to all the facts and circumstances identified in accordance with clause 4.2.3A(b).

Reclassification of a contingency event to "credible" is triggered not by the existence of abnormal conditions but by the change in how credible AEMO considers any risk to the power system to be as a result.

To make that assessment promptly, the NER require reclassification criteria to be in place that establishes, transparently, how AEMO makes those reclassification decisions. Clause 4.2.3A(f) provides:

> (f) In undertaking its consideration in accordance with clause 4.2.3A(e), AEMO must have regard to the criteria referred to in clause 4.2.3B.

The criteria are made under clause 4.2.3B which provides:

> (a) Within six months of the commencement of this clause, NEMMCO must establish criteria that it must use when considering whether the existence of abnormal conditions make the occurrence of a

119 AEMC, Rule Determination, p. 7.

120 NER, clause 4.3.1(m).

non-credible contingency event reasonably possible under clause 4.2.3A(e).

(b) AEMO must review the criteria established under clause 4.2.3B(a) every two years after the date of establishment.

(c) AEMO may amend the criteria established under clause 4.2.3B(a).

(d) In establishing, reviewing or amending the criteria under this clause, AEMO must:

(1) first consult with relevant stakeholders including Market Participants, Transmission Network Service Providers, Jurisdictional System Security Coordinators and relevant emergency services agencies

(2) ensure that the criteria include a requirement to have regard to the particulars of any risk(s) to the power system associated with the various types of abnormal conditions that might arise, and

(3) publish the criteria on its website as soon as practicable after the criteria have been established or amended.

If abnormal conditions diminish or abate, there is a return to normal operating conditions, but if risks increase then non-credible contingency events might be reclassified as credible. In each case, AEMO has an obligation to notify market participants. Clauses 4.2.3(g) and (h) provide:

(g) If, after undertaking a consideration in accordance with clause 4.2.3A(e), AEMO decides that the existence of the abnormal conditions make the occurrence of a non-credible contingency event reasonably possible, it must reclassify that event to be a credible contingency event and must notify Market Participants as soon as practicable.

(h) If, after reclassifying a non-credible contingency event to be a credible contingency event in accordance with clause 4.2.3A(g), AEMO considers that the relevant facts and circumstances have changed so that the occurrence of that credible contingency event is no longer reasonably possible, AEMO may reclassify that credible contingency event to be a non-credible contingency event. If AEMO does so, it must notify Market Participants as soon as practicable.

Finally, clause 4.2.3A imposes a requirement on AEMO to consider how its processes operate in practice through a half-yearly report on reclassifications. Clause 4.2.3A(i) provides:

(i) Every six months, AEMO must issue a report setting out its reasons for all decisions to re-classify non-credible contingency events to be credible contingency events under clause 4.2.3A(g) during the relevant period. The report:

(1) must include an explanation of how AEMO applied the criteria established in accordance with clause 4.2.3B for each of those decisions, and

(2) may also include AEMO's analysis of re-classification trends during the relevant period and its appraisal of the appropriateness and effectiveness of the relevant criteria that were applied in the case of each reclassification decision.

An important point to note about this review obligation, and the similar obligation to review the reclassification criteria under clause 4.2.3B, is that nothing is necessarily fixed about:

- what AEMO should consider to be a contingency event
- what AEMO should consider to be credible in particular circumstances, or
- how AEMO makes the most appropriate decisions about risks from contingency events.

The NER contemplate that AEMO's views and actions on these matters will evolve in light of experience and will be assisted by regular formal reviews undertaken in consultation with stakeholders. There is an underlying assumption in the NER that both the reclassification criteria and reclassification administrative processes will be capable of continuous improvement. The NER provisions anticipate that not all risks and risk mitigation strategies will be immediately apparent. The existence or nature of risks may become more apparent after a major event such as the Black System Event, or as a result of technological changes and industry practices and the appropriate way to manage risks will evolve. The NER addresses this practical reality through formal and regular review processes.

Reasonable endeavours

The NER describe AEMO's role in respect of power system security through a framework of responsibilities (as set out in clause 4.3.1) and principles (as set out in clause 4.2.6). These responsibilities and principles do not have the same status as direct obligations on AEMO. Instead, they are given effect through clause 4.3.2(a), which states that AEMO must use reasonable endeavours as permitted under the NER to achieve these responsibilities in accordance with the principles.

This is an important distinction. The AER considers that if AEMO did exercise reasonable endeavours but did not achieve the power system security responsibilities or principles, it will not have breached clause 4.3.2(a).

Clause 4.3.2(b) provides that the reasonable endeavours standard applies also to other of AEMO's Chapter 4 obligations where it is to arrange or control any act, matter or thing or to ensure that any other person undertakes or refrains from any act.

Where such an obligation is imposed on AEMO, that obligation is limited to a requirement for AEMO to use reasonable endeavours as permitted under the NER, including to give such directions as are within its powers, to comply with that obligation.

The AER considers that "reasonable endeavours" is what was reasonably required to be done in the circumstances, having regard to AEMO's role, including its powers under the NEL and NER, its capacity and its responsibilities and obligations. When assessing AEMO's endeavours, it is therefore necessary to consider how AEMO's capacity, responsibilities and obligations are framed.

The NEL sets out an overarching requirement for AEMO to have regard to the National Electricity Objective when exercising its roles and functions.[121] This requires AEMO to take the National Electricity Objective into account and give weight to it as a fundamental element in making a decision but ultimately, in exercising its discretion, AEMO determines the weight given to it. AEMO must constantly apply its judgment in balancing power system security with the costs to consumers and the market, and what is appropriate in one set of circumstances may not be in another. We consider this means it is open to AEMO to run the power system more conservatively within the NER framework when there are abnormal conditions.

AEMO's power system security responsibilities under Chapter 4 are wide ranging and to be achieved in accordance with the power system security principles. The first of those principles qualify its responsibilities to securely operate the power system by the words *"[t]o the extent practicable"*.

What is *"practicable"* means what is "capable of being put into practice, done, or effected, especially with the available means or with reason or prudence; feasible".[122] In relation to those obligations which impose a reasonable endeavours standard, the High Court's interpretation of the phrase "so far as is reasonably practicable" in Baiada Poultry Pty Ltd v R [2012] HCA 14 provides useful guidance. The Court stated that the words "reasonably practicable":

> *…indicate that the duty does not require an employer to take every possible step that could be taken. The steps that are to be taken in performance of the duty are those that are reasonably practicable for the employer to achieve the identified end of providing and maintaining a safe working environment. Bare demonstration that a step could have been taken and that, if taken, it might have had some effect on the safety of a working environment does not, without more, demonstrate that an employer has broken the duty imposed…*

Also relevant to the "surrounding circumstances" is that AEMO, in its coordinating role, relies to a large extent upon the technical information provided by Market Participants and NSPs. It is therefore provided with certain powers, framed as positive obligations to consult and to disseminate information.

While a requirement to use reasonable endeavours to achieve a particular outcome is not as strict as an absolute or unconditional requirement (as in "AEMO must do X") that does not mean that it is a low standard. Drawing on contract case law, the AER considers that a requirement to use reasonable endeavours is probably not as high a standard as a requirement to use "best" endeavours or "all" reasonable endeavours (these latter terms often importing a requirement to take every practicable step available).[123] What amounts to reasonable endeavours when confronting a situation that is unprecedented, and therefore highly unexpected and unprepared for, is likely to be different to what amounts to reasonable endeavours when confronting a situation that has arisen previously. In the case of an unprecedented event, overall actions might still reflect reasonable endeavours even though there might be a certain level of (what turns out to be with the benefit of hindsight) missteps or missed opportunities as the event unfolded.

Our assessment of whether AEMO used reasonable endeavours to maintain power system security includes the following considerations:

- matters that AEMO must have regard to under the NER and NEL when making its decisions, including the National Electricity Objective, and the tension between maintaining power system security and potentially increasing wholesale electricity prices
- the information that AEMO knew at the relevant time, how it applied it and the extent of AEMO's practical ability to take action in relation to that information. This includes

121 NEL, section 49(3).

122 Macquarie Dictionary (https://www.macquariedictionary.com.au/features/word/search/practicable/).

123 See, for example: *IBM United Kingdom Ltd v Rockware Glass Ltd [1980] FSR 335;* Rhodia *International v Huntsman [2007] 2Lloyd's Rep 325;* Transfield Pty Ltd v Arlo International Ltd (1980) 144 CLR 83; Joseph Street Pty Ltd v Tan (2012) 38 VR 241; UBH (Mechanical Services) Ltd v Standard Life Assurance Co (unreported, The Times, 13 November 1986, CA), and Australian Securities Commission v Gallagher (1994) 11 WAR 105.

information pertaining to all risks that, on the evidence before the AER, AEMO operators were monitoring and managing during the pre-event period, regardless of whether those risks eventuated

- the extent to which AEMO could, and did, exercise its relevant powers and carry out its relevant responsibilities, and
- other practical considerations, such as the limitations of AEMO's finite resources.

Appendix B—Summary of weather information available to AEMO

This appendix summarises the information available to AEMO during the pre-event, noting that BOM did not forecast the storm supercells and tornadoes that caused the damage to transmission assets leading to the Event.

On 28 September, and the preceding days, BOM was forecasting a severe storm approaching SA. At 16:55 hrs on 26 September, BOM issued various forecasts stating that "[a] vigorous front and intense low-pressure system is expected to move across the State on Wednesday and Thursday [28 and 29 September]". Subsequent forecasts on 27 September repeated this statement, and BOM also issued a severe weather warning at 17:16 hrs that day for damaging winds on 28 September. At 06:10 hrs on 28 September, BOM's district forecasts stated that "[a] vigorous front associated with a deep low-pressure system will move across South Australia today. The deep low southwest of the Bight will gradually move eastwards over the next couple of days to be over Victoria by Thursday night [29 September]."

Figure 2 below shows all the weather forecast districts used by BOM and Weatherzone as well as the wind generators online in SA on 28 September (i.e. all SA wind farms except for Wattle Point WF). These weather forecast districts help identify "districts of interest" in which power system equipment (including transmission lines, generators etc.) may be affected.

Figure 2 shows that nearly 1000 MW of non-scheduled and semi-scheduled wind farms have been built in the Mid North weather forecast district. Hence, given the known feathering or overspeed reductions that can happen to wind generators in strong wind conditions, a severe weather system crossing this area would have a significant impact on aggregate wind farm output. Many of SA's 275 kV and 132 kV backbone transmission lines traverse the Mid North, Flinders, Adelaide Metropolitan and Mount Lofty Ranges districts. On at least two occasions in the last 20 years, transmission towers have been significantly damaged by severe weather conditions in the State. Severe weather warnings in these districts are significant in terms of signalling potential damage to the SA transmission network and wind farm generators.

All transmission faults on 28 September occurred in these districts.

Table 4 below shows all weather warnings issued on either 27 September or 28 September with respect to conditions on 28 September. The forecasts and warnings on these days predominantly focused on severe storm activity such as lightning, hail and severe gusts of wind.

At 17:16 hrs on 27 September, BOM issued its first severe weather warning for damaging winds in relation to 28 September. The warning stated:

> *… [a]n intense low-pressure system will move across the Bight towards the SA coast with strong to gale force winds impacting western parts. Wind speeds may increase later on Wednesday [28 September] to 50-75 km/h with gusts around 90-120 km/h, most likely near coasts and with squally showers and thunderstorms. These conditions are expected to extend further eastwards during Wednesday night and Thursday.*

BOM issued five subsequent severe weather warnings for damaging winds on 28 September between 20:14 hrs on 27 September and 07:30 hrs on 28 September. The affected locations varied between warnings but included the Lower Eyre Peninsula, Eastern Eyre Peninsula, West Coast and North West Pastoral Districts. The majority of transmission lines and wind farms ultimately affected were outside these forecast districts.

At 10:16 hrs on the day of the Event, BOM issued a severe weather warning for damaging winds, stating that "[W]ind speeds will increase later today to 50-75 km/h with gusts around 90-120 km/h, most likely near coasts and with squally showers and thunderstorms. These conditions are expected to extend further eastwards during Wednesday night and Thursday". The affected locations, similar to above, were the West Coast and parts of the Eastern Eyre Peninsula and North West Pastoral districts.

At 10:40 hrs, BOM issued its first severe thunderstorm warning for damaging wind for 28 September, indicating that maximum wind gusts in excess of 90 km/h were likely to occur in the next several hours in the Lower Eyre Peninsula and Eastern Eyre Peninsula districts, and parts of the West Coast and North West Pastoral districts.

BOM issued a severe thunderstorm warning at 12:56 hrs, this time for destructive wind, heavy rainfall and large hailstones over the next several hours, with severe thunderstorms being likely to produce wind gusts of up to 140 km/h (revised upwards from 90-120 km/h). The affected locations were the Eastern Eyre Peninsula and Flinders districts, and parts of the Yorke Peninsula, Mid North, North West Pastoral and North East Pastoral districts. The warning was cancelled for the West Coast and Lower Eyre Peninsula districts as severe thunderstorms had ceased to occur in those districts. This was the first warning for the Mid North, Flinders and Yorke Peninsula locations.

Later in the afternoon at 14:40 hrs, BOM issued another severe thunderstorm warning for destructive wind, heavy rainfall and large hailstones with likely wind gusts forecast to reach 140 km/h. The warning also noted that "[a] thunderstorm produced large hailstones at Cleve, a gust to 87 km/h and 14 mm [of rainfall] in 15 minutes earlier this afternoon". The affected locations were the Eastern Eyre Peninsula, Yorke Peninsula and Flinders districts as well as parts of the Mid North, North West Pastoral and North East Pastoral districts. At 15:53 hrs, a similar thunderstorm warning was issued but for a wider range of districts, including the Flinders and Mid North districts and, for the first time, the Adelaide Metropolitan, Mount Lofty Ranges and Murraylands districts.

The warning BOM issued at 16:19 hrs (just after SA lost power at 16:18 hrs) stated that "[d]amaging wind gusts between 93-100 km/h and mean winds of 60-70 km/h have been observed in Wudinna, Woomera, Roxby Downs, Port Pirie and Nullarbor".

Figure 2: SA's wind farms and weather forecast districts

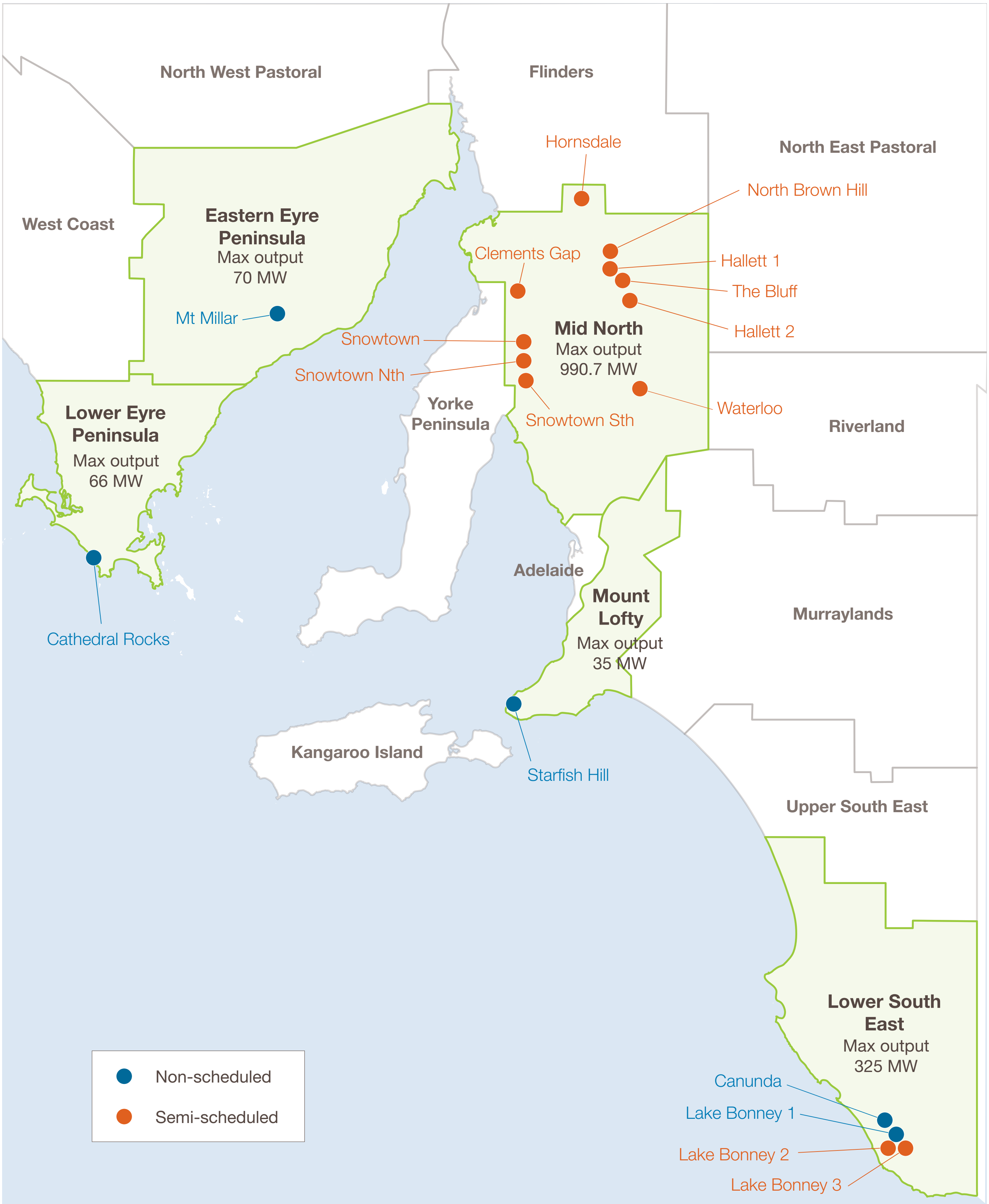


Table 4: Weather warnings available to AEMO on 27 and 28 September 2016

Time issued (AEST)	Type of warning	Wind speed (maximum wind gust) (km/h)	Districts affected	Time frame
17:16 hrs, 27 September	Severe weather warning for damaging winds	50-75 (90-120)	West Coast and North West Pastoral districts, and parts of the Eastern Eyre Peninsula district	28 September
20:14 hrs, 27 September	Severe weather warning for damaging winds	50-75 (90-120)	West Coast and North West Pastoral districts, and parts of the Eastern Eyre Peninsula district	28 September
22:59 hrs, 27 September	Severe weather warning for damaging winds	50-75 (90-120)	West Coast district and parts of the Lower Eyre Peninsula, Eastern Eyre Peninsula and North West Pastoral districts	28 September
01:59 hrs, 28 September	Severe weather warning for damaging winds	50-75 (90-120)	West Coast district and parts of the Lower Eyre Peninsula, Eastern Eyre Peninsula and North West Pastoral districts	28 September
04:31 hrs, 28 September	Severe weather warning for damaging winds	50-75 (90-120)	West Coast district and parts of the Lower Eyre Peninsula, Eastern Eyre Peninsula and North West Pastoral districts	28 September
07:30 hrs, 28 September	Severe weather warning for damaging winds	50-75 (90-120)	West Coast district and parts of the Lower Eyre Peninsula, Eastern Eyre Peninsula and North West Pastoral districts	28 September
10:16 hrs, 28 September	Severe weather warning for damaging winds	50-75 (90-120)	West Coast district and parts of the Eastern Eyre Peninsula and North West Pastoral districts	28 September
10:40 hrs, 28 September	Severe thunderstorm warning for damaging wind	(>90)	Lower Eyre Peninsula and Eastern Eyre Peninsula districts, and parts of the West Coast and North West Pastoral districts	Next several hours
12:56 hrs, 28 September	Severe thunderstorm warning for destructive wind, heavy rainfall and large hailstones	(140)	Eastern Eyre Peninsula and Flinders districts, and parts of the Yorke Peninsula, Mid North, North West Pastoral and North East Pastoral districts	Next several hours
13:19 hrs, 28 September	Severe weather warning for damaging winds	50-75 (90-120)	West Coast district and parts of the Eastern Eyre Peninsula and North West Pastoral districts	28 September
14:40 hrs, 28 September	Severe thunderstorm warning for destructive wind, heavy rainfall and large hailstones	(140)	Eastern Eyre Peninsula, Yorke Peninsula and Flinders districts, and parts of the Mid North, North West Pastoral and North East Pastoral districts	Next several hours
15:53 hrs, 28 September	Severe thunderstorm warning for destructive wind, heavy rainfall and large hailstones	90-100 (140)	Adelaide Metropolitan, Mount Lofty Ranges, Yorke Peninsula, Flinders and Mid North districts, and parts of the Eastern Eyre Peninsula, Murraylands, North West Pastoral and North East Pastoral districts	Next several hours
16:19 hrs, 28 September	Severe weather warning for damaging winds	50-75 (140)	West Coast, Lower Eyre Peninsula, Eastern Eyre Peninsula, Yorke Peninsula and North West Pastoral districts, and parts of the Adelaide Metropolitan, Mount Lofty Ranges, Kangaroo Island, Flinders, Mid North and North East Pastoral districts	28 September

Source: BOM data.

Appendix C—Wind farm output during the pre-event period

Graphical representations of large reductions in output at certain wind farms over short periods as referenced in section 2.4.3 are set out below. The correlation between reductions in wind farm output and increases in Heywood interconnector flows are set out in appendix D.

Between 14:28 hrs and 14:35 hrs, aggregate SA wind farm generation decreased from 1055 MW to 890 MW (165 MW or 16% decrease). Four-second data from this period shows:

- North Brown Hill WF reduced output by 93 MW from 127 MW to 34 MW (73% decrease) over the period from about 14:29 hrs to 14:32 hrs
- Hallett 1 WF reduced output by 79 MW from 87 MW to 8 MW (91% decrease) over the period from about 14:30 hrs to 14:33 hrs, and
- Cathedral Rocks WF reduced from 22 MW to 0 MW over about 40 seconds from 14:33:23 hrs.

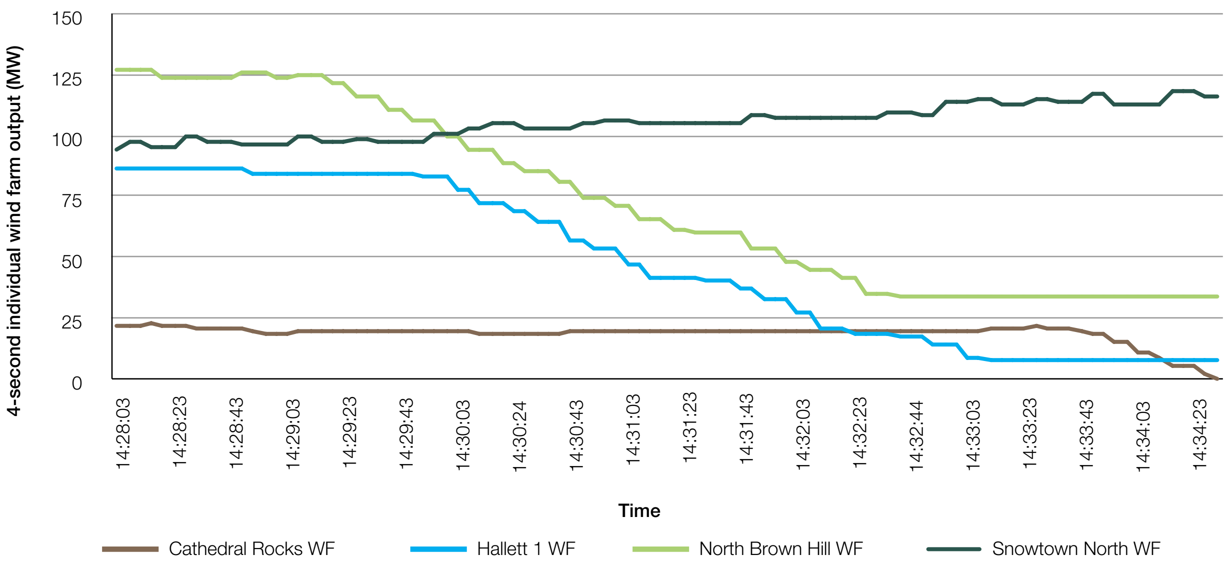
Figure 3 below sets out the main individual wind farm output reductions between 14:28 hrs and 14:35 hrs. Output at the Hallett 1, North Brown Hill and Cathedral Rocks WFs decreased rapidly during this period, while output at Snowtown WFs slowly increased, moderating the decrease in aggregate wind farm output to some extent.

Similarly, there was a material change in wind farm output between 15:42 hrs and 15:51 hrs. Over this period, aggregate SA wind farm generation decreased from 1165 MW to 916 MW (249 MW or 21% decrease). 4-second data from this period shows:

- Snowtown North WF reduced output from 142 MW to 0 MW from 15:44 hrs to 15:51 hrs
- Snowtown South WF reduced output by 41 MW from 108 MW to 67 MW (38% decrease) from 15:42 hrs to 15:51 hrs
- Snowtown WF reduced output by 39 MW from 39 MW to 0 MW from 15:43 hrs to 15:49 hrs (with a particularly rapid drop of around 20 MW over approximately 30 seconds at 15:45 hrs), and
- Clements Gap WF reduced output by 20 MW from 38 MW to 18 MW (53% decrease) from 15:47 hrs to 15:51 hrs.

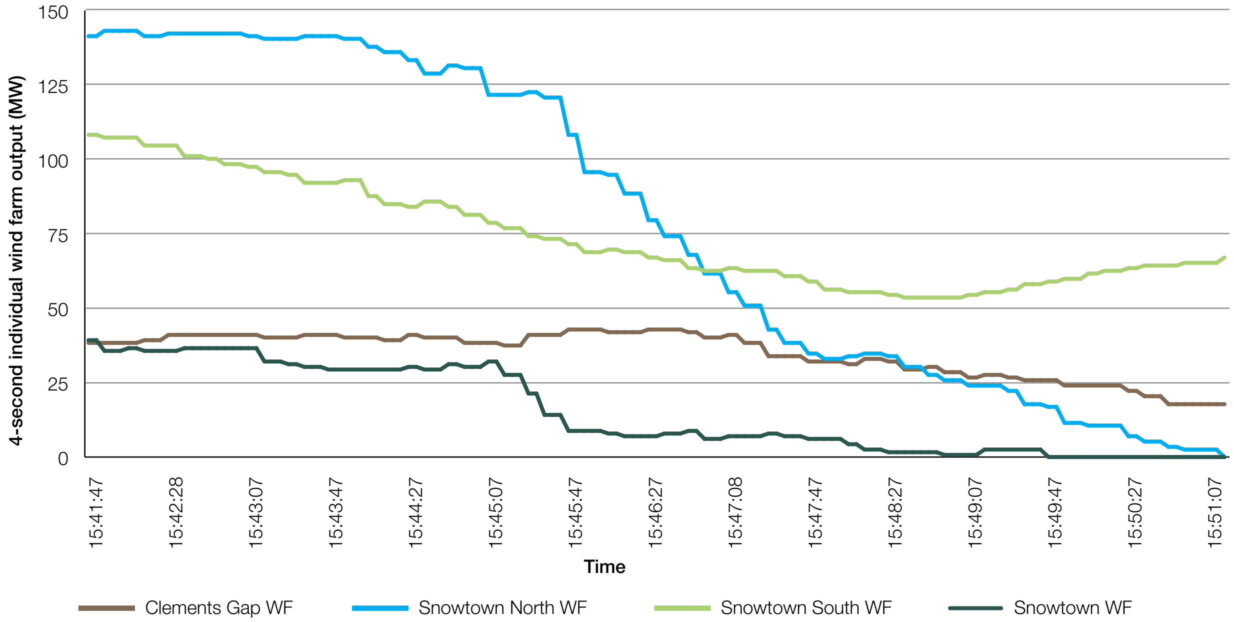
Figure 4 sets out the main individual wind farm output reductions between 15:42 hrs and 15:51 hrs. Output at the Snowtown North and Snowtown WFs decreased rapidly during this period, while output at the Snowtown South and Clements Gap WFs decreased more slowly.

Figure 3: 4-second wind farm output from 14:28–14:35 hrs at affected wind farms



Source: AER analysis of AEMO's "FCAS causer pays" data.

Figure 4: 4-second wind farm output from 15:42–15:51 hrs at affected wind farms



Source: AER analysis of AEMO's "FCAS causer pays" data.

Appendix D—28 September 2016 Heywood Interconnector flows and limits

On the day of the Event, 5-minute measured flows on the Heywood Interconnector into SA exceeded the expected (or target) flow and the import limit into SA for 46 and 29 out of 71 dispatch intervals, respectively, between the 10:25 hrs dispatch interval and the time of the Event. In one case, 5-minute measured flows exceeded the import limit by as much as 156 MW in a 5-minute interval. Most (but not all) of these discrepancies were not large or sustained. The most significant instances occurred during the 12:05-12:40 hrs, 14:35 hrs and 15:50-16:00 hrs dispatch intervals.

Figure 5 to figure 9 below examine the three periods during the pre-event period in which 4-second flows on the Heywood Interconnector significantly exceeded the import limit and target flow into SA.

Figure 5 compares 4-second Heywood Interconnector flows and 5-minute import limits and target flows into SA for the period from 12:00 hrs to 12:45 hrs (the 12:05-12:45 hrs dispatch intervals). It illustrates that interconnector flows consistently exceeded the import limit and target flow (the interconnector was dispatched to maximum imports) during these dispatch intervals. Overall, for this period, 4-second actual flows on the interconnector exceeded the 5-minute import limit and target flow 81% of the time.

Between 12:05-12:30 hrs, 4-second actual Heywood Interconnector flows into SA exceeded the target and the import limit continuously for five consecutive dispatch intervals and during the 5-minute dispatch interval ending 12:45 hrs, the 4-second data shows that the interconnector flow exceeded the 5-minute import limit and target flow by up to 111 MW.

Figure 6 compares 4-second Heywood Interconnector flows and 5-minute import limits and target flows into SA for the period from 14:25 hrs to 14:40 hrs (the 14:30-14:40 hrs dispatch intervals).

From 14:31-14:38 hrs, 4-second interconnector flows continuously exceeded the import limit and target flow, with a maximum exceedance of 85 MW and 174 MW, respectively.

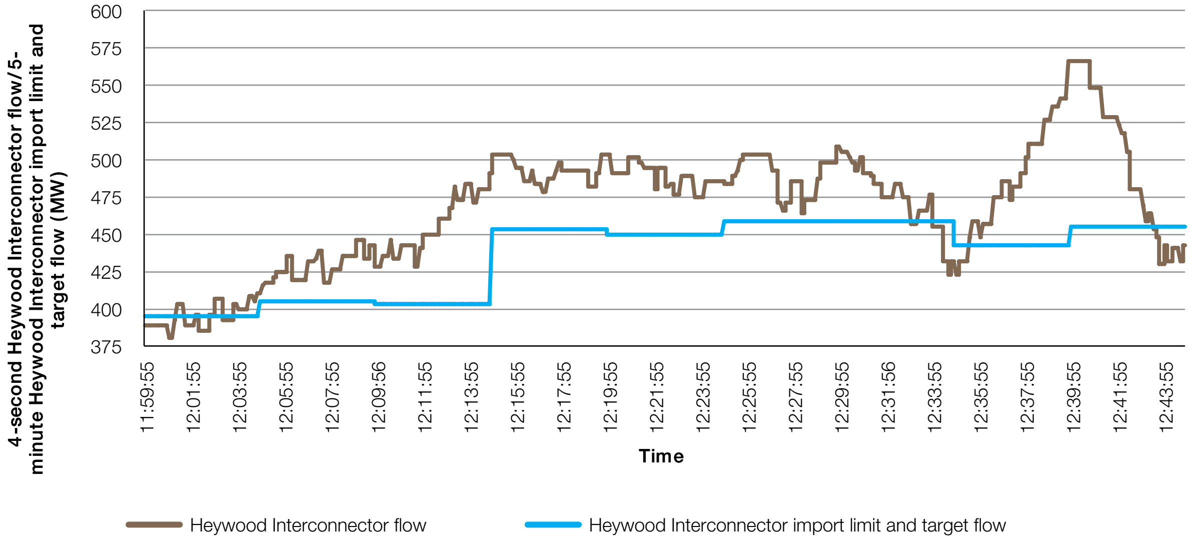
Figure 7 incorporates the 4-second wind farm output against the interconnector flows, target flows and limits from figure 6. This shows that as the wind output dropped the interconnector flows increased. Before the reduction in wind output, there was around 77 MW of headroom between the limit and target flow on the interconnector as the interconnector was expected to be flowing at 360 MW for the five-minute dispatch interval ending 14:30 hrs and the limit was 437 MW. The limit and target flow changed in the following dispatch interval to 417 MW and 328 MW, respectively. However, actual flows were well above the target flow from 14:30 hrs, reflecting the lower than expected output from wind farms from that time.

Figure 8 compares 4-second Heywood Interconnector flows and 5-minute import limits and target flows into SA for the period from 15:40-16:05 hrs (the 15:45-16:05 hrs dispatch intervals). From 15:46-16:04 hrs, 4-second interconnector flows continuously exceeded the 5-minute import limit and target flow, with a maximum exceedance, on a 4-second basis, of 183 MW and 252 MW, respectively.

Flows continued to exceed the limit for about 13 minutes after wind farm output had stabilised (at 15:51 hrs). From 15:47-15:59 hrs, flows exceeded the limit and target flow by more than 50 MW.

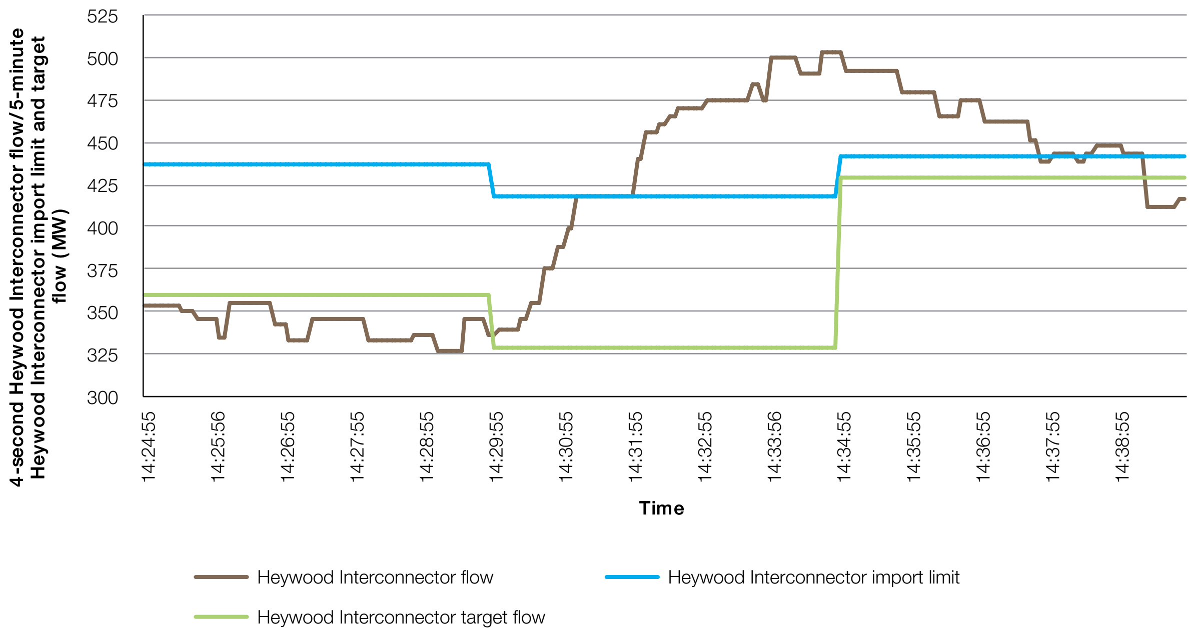
Figure 9 incorporates the 4-second wind farm output against the interconnector flows, target flows and limits from figure 8. This again shows that as the wind output dropped the interconnector flows increased. Before the reduction in wind output, there was around 128 MW of headroom between the limit and the target flow on the interconnector as the interconnector was expected to be flowing at 303 MW for the five-minute dispatch interval ending 15:45 hrs and the limit was 431 MW. The limit and target flow were similar in the following dispatch interval—430 MW and 317 MW, respectively. However, actual flows were well above the target flow from 15:40 hrs, reflecting the lower than expected output from wind farms from that time.

Figure 5: 4-second Heywood Interconnector flows and 5-minute Heywood Interconnector import limits and target flows during the 12:05-12:45 hrs dispatch intervals



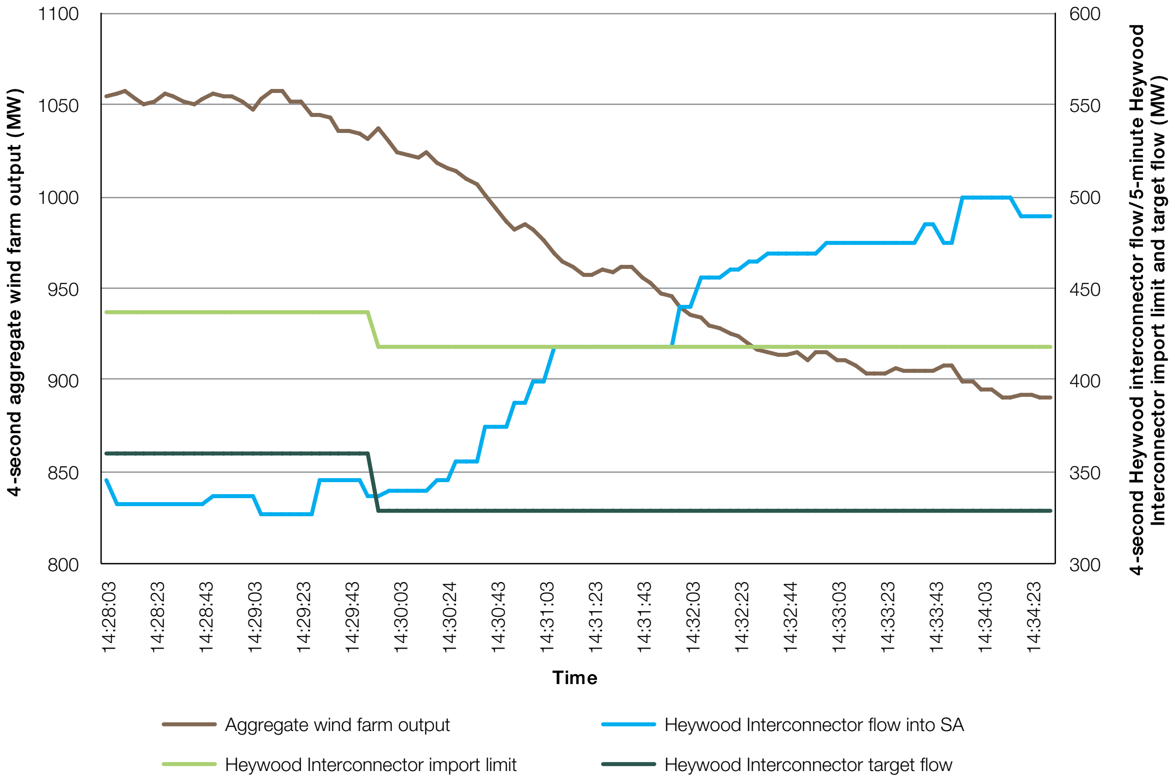
Source: AER analysis of AEMO's "FCAS causer pays" data.

Figure 6: 4-second Heywood Interconnector flows and 5-minute Heywood Interconnector import limits and target flows during the 14:30-14:40 hrs dispatch intervals



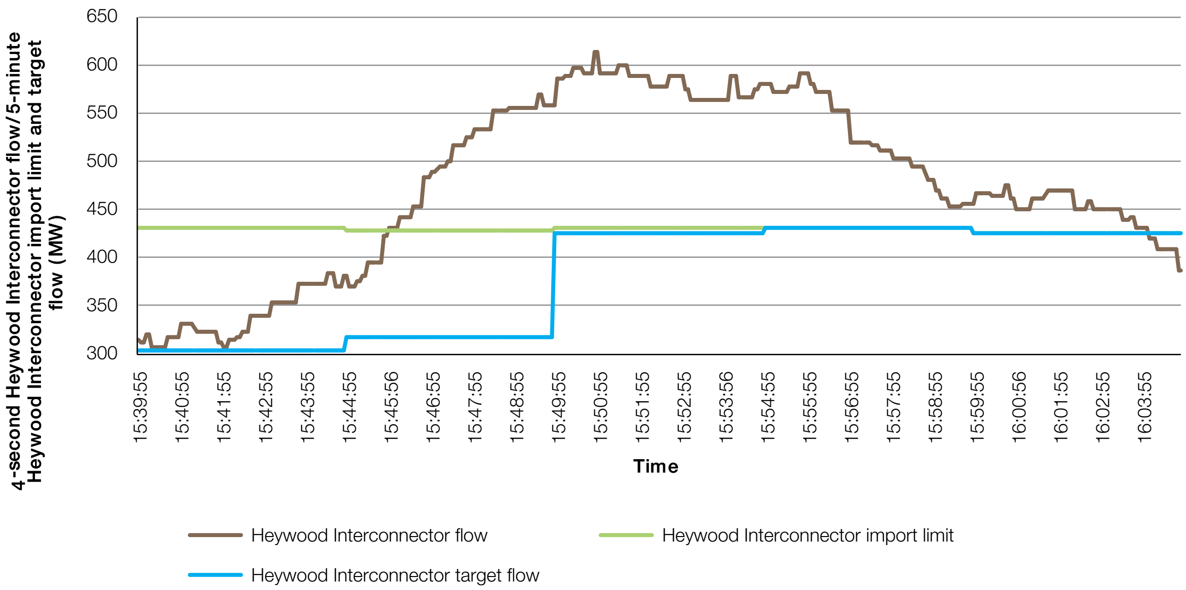
Source: AER analysis of AEMO's "FCAS causer pays" data.

Figure 7: 4-second aggregate wind farm output and Heywood Interconnector flows and 5-minute Heywood Interconnector import limits and target flows from 14:28-14:35 hrs



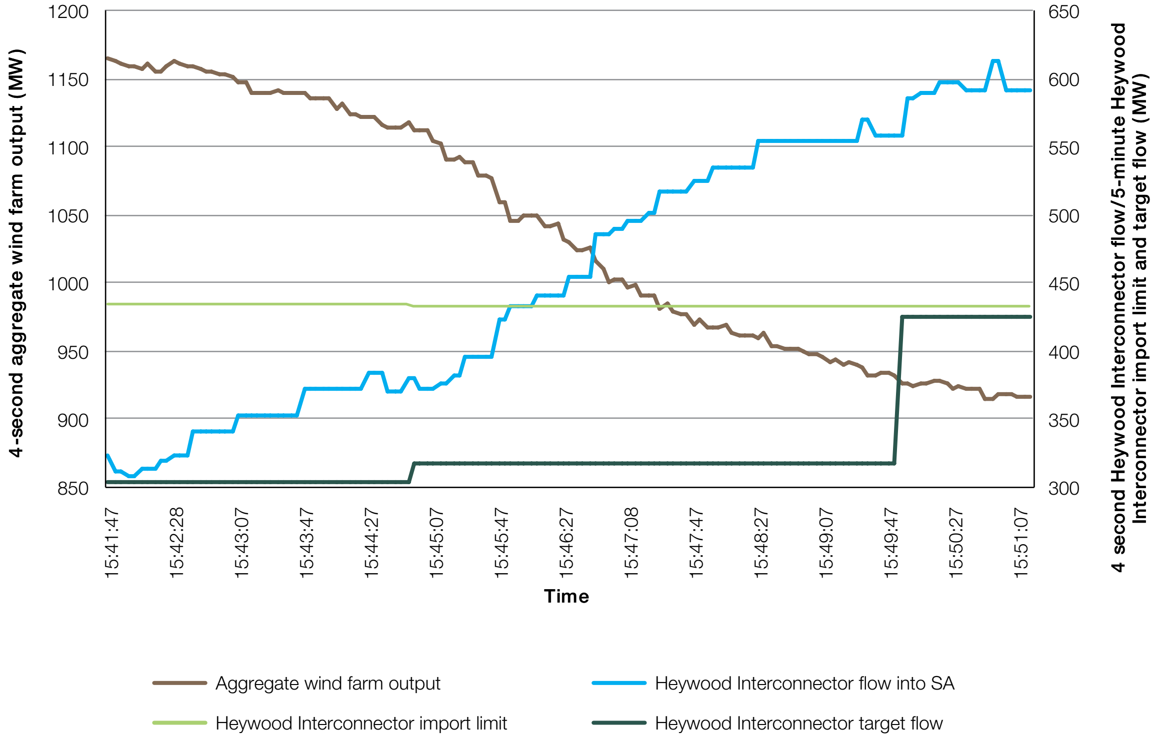
Source: AER analysis of AEMO's "FCAS causer pays" data.

Figure 8: 4-second Heywood Interconnector flows and 5-minute Heywood Interconnector import limits and target flows during the 15:45-16:05 hrs dispatch intervals



Source: AER analysis of AEMO's "FCAS causer pays" data.

Figure 9: 4-second aggregate wind farm output and Heywood Interconnector flows and 5-minute Heywood Interconnector import limits and target flows from 15:42-15:51 hrs



Source: AER analysis of AEMO's "FCAS causer pays" data.

Pre-event compliance assessment (ElectraNet)

3. Pre-event (ElectraNet) compliance

3.1 Summary

In its capacity as a TNSP, System Operator and Registered Participant,[124] ElectraNet had obligations under the NER in the pre-event period of the Black System Event.[125]

In combination, the relevant NER provisions require ElectraNet to:

- ensure that the transmission network elements are operated within appropriate operational or emergency limits
- promptly inform AEMO, when it becomes aware, of:
  - the state of the security of the power system (including assessing the impacts of the transmission network elements on the operation of the power system)
  - whether there are any actual or anticipated threats to power system security (including any threats to the secure operation of any equipment owned or controlled by ElectraNet), and
  - whether any action is, or is being contemplated to be, carried out to maintain or restore the power system to a satisfactory operating state
- ensure that it "satisfactorily interacts" with AEMO, TNSPs in other jurisdictions and SAPN, so that power system security is not jeopardised.

Consistent with our role of reviewing compliance with the NEL and the NER, we have examined the actions of ElectraNet during the pre-event period and in the context of ElectraNet's "system normal" approach. In particular, we considered ElectraNet's actions during the pre-event period in relation to monitoring weather conditions, assessing any threat to transmission network assets and communicating its assessment of power system security with AEMO.

Based on the information before us, we consider that ElectraNet monitored weather conditions and the state of its network on a continuous basis during the pre-event period such that it was able to be aware of, and assess, any risks to power system security to the degree expected of a TNSP. This included being aware of, and assessing, the impact and likely impact of the storm on its transmission network elements, as well as their impact on the operation of the power system.

We consider that ElectraNet took account of the forecast weather conditions in operating its transmission network within appropriate operational and emergency limits. We formed this view based on the information before us that:

- there was no information that would have led ElectraNet to advise AEMO of the need to reclassify any non-credible contingency event to a credible contingency event, specifically in relation to the loss of a double circuit transmission line or the simultaneous loss of multiple single transmission lines
- ElectraNet took appropriate risk mitigation actions available to it, including recalling planned outages, having additional crew and maintenance providers on standby, and having additional control room staff on hand, and
- there was no information that would have caused it to operate its network in a different configuration, including to proactively de-energise lines.

We consider that ElectraNet communicated in a manner consistent with its established communication practices. ElectraNet had no evidence of likely damage and consequential loss of service to specific assets, which would, based on past practice, normally form the basis of discussions regarding reclassification. ElectraNet communicated to AEMO its intention to recall planned outages and have emergency response standby crews available. Further, AEMO was privy to the same weather forecast information and the same monitoring systems as ElectraNet to assess the state of the power system and any risks to power system security. Based on usual practice, ElectraNet did not therefore have any additional information to relay to AEMO with respect to the state of the power system and any risks to power system security.

Based on the information provided to us by ElectraNet, including telephone logs, and AEMO's corroboration of communication it received from ElectraNet, we consider that ElectraNet satisfactorily interacted with AEMO, TNSPs in other jurisdictions and SAPN, such that ElectraNet's communication did not jeopardise power system security.

We therefore assess that ElectraNet has met its obligations under the NER.

In reviewing the material before us, we became aware of some asymmetry between ElectraNet's and AEMO's interpretation of ElectraNet's role and responsibilities in

124 A "Registered Participant" is defined in Chapter 10 of the NER as "A person who is registered by AEMO in any one or more of the categories listed in rules 2.2 to 2.7 (in the case of a person who is registered by AEMO as a Trader, such a person is only a Registered Participant for the purposes referred to in rule 2.5A). However, as set out in clause 8.2.1(a1), for the purposes of some provisions of rule 8.2 only, AEMO, Connection Applicants, Metering Providers and Metering Data Providers who are not otherwise Registered Participants are also deemed to be Registered Participants". It includes generators, customers, market participants, and network service providers.

125 "Pre-event period for the Black System Event" means the period from 09:00 hrs on 27 September 2016 up to and including 16:18 hrs on 28 September 2016.

relation to reporting information to AEMO. We therefore intend to conduct an industry-wide compliance review of clauses 4.3.3(e), 4.3.4(a) and 4.8.1 to verify that there is alignment between Registered Participants' and AEMO's expectations in relation to the extent and type of information to be communicated by Registered Participants to AEMO.

Table 1: Actions to be taken by the AER

Action	
3.1	The AER to conduct an industry-wide compliance review of clauses 4.3.3(e), 4.3.4(a) and 4.8.1 to verify that there is alignment between Registered Participants' and AEMO's expectations in relation to the extent and type of information to be communicated by Registered Participants to AEMO.

3.2 AER approach to assessing compliance

In undertaking our assessment of compliance during the Black System Event, the AER recognised the level of interest from stakeholders—from industry participants, policy makers to members of the general public—in the causes and precipitating events which led to SA going black.

ElectraNet played a crucial part in assisting AEMO to manage transmission network issues during the pre-event. The NER, in general, require ElectraNet to:

- ensure that the transmission network elements are operated within appropriate operational or emergency limits
- to the extent that it is aware, or ought reasonably have been aware, keep AEMO fully informed in a timely manner as to:
  - the state of the security of the power system (including assessing the impacts of the transmission network elements on the operation of the power system)
  - whether there are any actual or anticipated risks to power system security (including any threats to the secure operation of any equipment owned or controlled by ElectraNet), and
  - whether any action is, or is being contemplated to be, carried out to maintain or restore the power system to a satisfactory operating state
- ensure that it "satisfactorily interacts" with AEMO, TNSPs in other jurisdictions and SAPN, so that power system security is not jeopardised.

Consistent with our role of reviewing compliance with the NEL and the NER, we have examined the actions of ElectraNet during the pre-event period and in the context of ElectraNet's "system normal" approach. In particular, we considered ElectraNet's actions during the pre-event period in relation to monitoring weather conditions, assessing any threat to transmission network assets and communicating its assessment of power system security with AEMO.

As set out in further detail in sections 3.3.3 to 3.3.6 below, the AER is required to assess whether ElectraNet used reasonable endeavours to exercise its rights and obligations in relation to its networks so as to co-operate with and assist AEMO in the proper discharge of the AEMO power system security responsibilities. To some extent, this involves assessing the adequacy of ElectraNet's operational decisions given the information available to ElectraNet. We note this does not involve an assessment of whether ElectraNet's operational decisions were correct in the circumstances.

3.3 Background

3.3.1 "System normal" network system security management

Set out below is ElectraNet's usual approach to managing the risks posed by environmental conditions to its transmission network, including how it communicates these risks with AEMO. The environmental conditions that pose a risk to the transmission network include severe storms (such as that experienced on 28 September 2016), lightning, strong winds, flooding and bushfires.

General communication with AEMO

ElectraNet states that it does not have a formal documented communication protocol with AEMO, but that there is a long history of "custom and practice" of communication between ElectraNet and AEMO (and its predecessors). ElectraNet states that in compliance with the obligations specified in the NER, it supports AEMO in maintaining system security in the following ways:

- conducting security assessments of planned and unplanned outages
- operation of manual load shedding and restoration
- load restoration after automatic under-frequency load shedding once frequency is restored to the AEMC Reliability Panel frequency standards
- monitoring and controlling network voltage levels across the transmission network through the operation of voltage monitoring and control equipment
- monitoring and controlling plant and line loadings, and
- monitoring and modifying the power system configuration when fault-rupturing capacity may be exceeded.

ElectraNet states that it also regularly communicates to AEMO information relating to:

- the state of the network
- issues relating to specific plant and equipment, and
- information about environmental conditions.

ElectraNet maintains an Energy Management System (EMS) through which it undertakes real-time contingency analysis and communicates potential power system security violations on a regular basis with AEMO. The Energy Management System utilises real-time data from ElectraNet's SCADA system.

The next section sets out in detail how ElectraNet considers and monitors information about environmental conditions, as well as how it assesses what information to pass on to AEMO in relation to its assets.

Environmental conditions which ElectraNet monitors

ElectraNet monitors forecasts for lightning, high wind speeds, storm fronts, temperature, humidity, flooding and bushfires. It monitors forecasts for the SA region and nearby states.

According to ElectraNet, the major risks posed by environmental conditions include:

- lightning—risk of causing faults on the network and damage to line infrastructure (e.g. conductors, insulators)
- wind speed and direction (on a synoptic basis) and gust strength—risk of faults caused by impact on infrastructure
- severe weather storms—risk of causing damage to line infrastructure, either directly or through airborne objects contacting the line infrastructure (e.g. insulators and conductors)
- flooding—risk of causing damage to substations, of limiting ability to access infrastructure to rectify damage, and of causing damage to tower footings via erosion of ground soil, and
- bushfires—risk of causing damage to substations and other infrastructure in the path of bushfires and flashovers through the ionised smoke causing faults on the network.

Information available to ElectraNet to monitor environmental conditions

ElectraNet's control room operators, Network Services staff and Emergency Services Centre representatives receive weather forecasts. ElectraNet's control room is responsible for continuous real time operations management for the SA transmission system.

There is a weather dashboard in the control room that displays rain radar, observed lightning and other weather parameters (as per table 2). The weather data is overlaid onto a system map of ElectraNet's transmission lines and substation assets.

The forecast and real time information available to ElectraNet is set out in table 2 below. The forecasts provide information on temperature, wind speed and direction (on a synoptic basis[126]), lightning, storm front and movement direction, bushfire warnings and severe weather warnings.

126 'Synoptic' means 'view together' or 'view at a common point'. A synoptic weather map shows weather patterns over a large area by putting together many weather reports from different locations all taken at the same moment in time. In a synoptic weather map, local and regional weather observations are put together on a map covering a large area, typically 1000 kilometres to 2500 kilometres in diameter, but often larger. This is the scale in which high and low pressure systems operate.

Table 2: Forecast information available to ElectraNet

Information source	Timeframe	Conditions and primary purpose of information
Global Position and Tracking Systems (GPATS)	Real time	Lightning—to assess lightning activity and whether faults have been caused by lightning.
BOM	Real time to whole day with additional information in relation to bushfire risk conditions available in real time	A range of environmental conditions including but not limited to: • temperature and humidity—to assess impact on dynamic line ratings • flooding—to assess impact on proximity to assets, and • bushfire—to assess risk of potential bushfire severity.
Weatherzone	Real time to 1 hour ahead	A range of environmental conditions including but not limited to: • storm fronts—direction of the front's movement and proximity to network infrastructure, and • wind and gust strength—to assess movement of storm fronts and potential impact of faults caused by impact on infrastructure. Wind speed and direction is on a synoptic basis.
Windy TV	Real time	A range of environmental conditions including: wind speed; wind gust speed; wind direction; thunderstorm activity; lightning activity; rainfall, and temperature.
State Emergency Service Centre (SEC)	Real time to 1 hour ahead	Provides information about all conditions relevant to the event and the emergency services involvement, e.g. for bushfires, it will detail location, direction and those services involved in the event.
ElectraNet weather stations/ ElectraNet real time energy management system (i.e. SCADA)	15 minute average historical data	Information for determining dynamic real-time line ratings to maximise the power the line can safely transmit in real-time. Ratings reduce with low wind speeds (less than 10 m/s). The equipment does not provide localised high wind information such as gust strength and direction.
SA Country Fire Service	Real time	Provides bushfire maps showing the location of bushfires.

Source: ElectraNet

ElectraNet's use of weather information

ElectraNet states that it uses the weather information to assess the potential impact of the weather on:

- its infrastructure
- network security
- existing or planned outages, and whether these should be recalled or proceed as planned
- the location and safety of ElectraNet staff, and
- its preparedness to deal with issues potentially arising from the impact of adverse environmental conditions.

According to ElectraNet, control room staff monitor the weather warnings for any potential impact on the transmission system. Weather events are individually monitored and assessed in accordance with the region impacted and the type and severity of the weather event.

Assessing threats to assets

With respect to monitoring its assets, ElectraNet indicates that the weather forecast information enables it to undertake an area-based risk assessment rather than an asset-based risk assessment. This is because the BOM and Weatherzone weather forecast information (regarding temperature or wind and gust strength and direction) is provided on a regional or subregional level and on a synoptic basis, rather than at a localised asset level. ElectraNet submits that this has the impact of reducing the ability to make precise and definitive assessments of risk to particular assets. ElectraNet notes that there is currently no localised weather information which would provide for an asset-based risk assessment.

In relation to its own SCADA weather information, ElectraNet states that this information is primarily collected to determine dynamic line ratings for its assets. Line ratings are highly inversely related to low wind speeds.[127] The equipment

127 Approximately 10 metre/second and lower.

in place measures average wind speeds,[128] and does not provide localised high wind information such as gust strength and direction. ElectraNet states that the data received from its own equipment regarding variability, strength and direction of wind is therefore not useful to assess the risk of physical damage to infrastructure as a result of high winds, tornadoes and other similar events. Further, ElectraNet considers that weather conditions are inherently volatile and subject to change depending on the location and other environmental conditions, and weather conditions can develop even if not forecast. ElectraNet states that this limits the ability for ElectraNet to know precisely the assets that will be impacted by the environmental conditions.

Nevertheless, ElectraNet states that, in response to the broad weather information, it considers the actions it needs to take to protect personnel and minimise restoration time (through improved response times) if remedial action is required on its network. According to ElectraNet, the available options are to:

- recall any planned outages
- ensure staff are not exposed to dangerous conditions as a result of the weather, and
- to put additional staff on emergency response standby as required.

ElectraNet states that it does not consider de-energising lines in advance of a storm as it would make the network less secure and reliable overall. It explains that there are several reasons for this, the most important of these being:

- ElectraNet cannot definitely predict which lines are likely to sustain damage in advance. If a line is de-energised, the standard practice is that the line is patrolled to ensure it is safe before being re-energised. If ElectraNet was to de-energise a particular line and another line sustained damage, then two lines would be out of service rather than one. Where the first line may have picked up the load carried by the second, it would be out of service until it had been cleared to be re-energised. It would therefore have the effect of reducing the reliability and security of the network rather than increasing it.
- Temporary de-energisation in circumstances to allow a storm front to pass means that ElectraNet's control room real time monitoring of the asset condition via SCADA ceases. Awareness of a fault on a network asset is generated via an alarm from the protection equipment for that asset via SCADA to the control room. The protection only operates if the assets are energised. Therefore, to have up-to-date information on the state of assets—including damage to those assets - the asset must be energised. If a line is damaged while de-energised, re-energising the line may lead to safety risks. Hence, the line must be patrolled to ensure it is safe before being re-energised.

ElectraNet states it would consider temporarily de-energising a line in circumstances including:

- where required by a planned outage
- in the event of a fault leading to a short-notice outage
- where there is a risk of a bushfire starting due to a known defect on the line, or
- if there is the potential for the safety of the public to be at risk, for example where there is a damaged line that might breach clearance heights.

In the interests of public safety and the prompt restoration of supply, if a line is manually de-energised, ElectraNet applies a risk-based approach to determining the method and extent of line inspection patrols that need to be performed before re-energising a line. The purpose of the inspection is to assess damage that may have occurred during the period when the line was de-energised and ElectraNet's preferred usual method is physical inspection (aerial or ground) in these circumstances. In making a determination to re-energise, ElectraNet takes into consideration relevant circumstances and information available to it from various sources, including:

- observations from the control systems by its control room operators (including information on customer outages)
- reported damage to the distribution network and other information from SAPN
- emergency services
- media reports, and
- members of the public reporting damage to lines (such as towers that have been downed).

ElectraNet states that its assets are designed, built and maintained to the Australian Design Standards. The Australian Design Standards reflect local conditions, such that the assets are built to withstand the strongest sustained wind gust (in terms of a 3-second wind gust) over a 400-year period. While there may be wind conditions that exceed the Australian Design Standards, ElectraNet notes that it is not industry practice to overbuild to meet all possibilities, as this would not be economic. Furthermore, weather forecasts are provided on a synoptic basis rather than a localised level, which ElectraNet considers would be required for assessing specific asset vulnerability. The SA region is not classified as a cyclonic area. For this reason, ElectraNet states it does not consider wind speed proactively against specific network asset wind withstand ratings in the lead up to a weather event.

128 A 15-minute average is collected.

Assessing information to pass on to AEMO on network security

In relation to its assets, ElectraNet plays a significant role in assisting AEMO to maintain network security. ElectraNet states that its responsibility for network security only covers the radial network, with AEMO being responsible for the core of the network. The electricity network is managed for credible contingency events. ElectraNet notes that it monitors its network and advises AEMO when it assesses that there is a possible threat to power system security, beyond a credible contingency to which the network is routinely managed. This involves ElectraNet assessing whether circumstances exist that could be relevant to the decision whether to reclassify a contingency event.

ElectraNet states that it only advises AEMO of its assessment that there is potentially a basis for reclassifying a contingency event where there is evidence of a likely threat to a particular asset to justify the change. This is not expressly covered in the Power System Security Guidelines (PSSG).[129] ElectraNet gives the example of its advice to AEMO during the 2015 Pinery Bushfire. In this instance, ElectraNet observed the fire pass through two single circuit lines, with wind conditions pushing the fire towards the double circuit line. ElectraNet communicated its concern to AEMO once the double circuit was in the direct path of the fire. Based on ElectraNet's concern, AEMO reclassified the loss of the double circuit line as a credible contingency. ElectraNet's basis for this approach is that it considers AEMO has the same real time monitoring systems as ElectraNet and accesses the ElectraNet EMS contingency analysis system. The only information that ElectraNet considers is available to ElectraNet but not to AEMO, which ElectraNet relays by telephone, is information from ElectraNet's field crews. Therefore, ElectraNet considers that its value is to only advise AEMO of its assessment of an event where the threat is likely and is based on actual evidence (as opposed to forecasts).

ElectraNet states that the loss of a single circuit transmission line or the loss of any single transmission network element is automatically treated as a credible contingency. Hence, ElectraNet states that its decision-making focuses on the likelihood of both lines of a double circuit transmission line being impacted simultaneously (rather than one line which is always considered a credible contingency) or multiple single lines being impacted simultaneously.

With respect to the likelihood of both lines on a double circuit transmission line being lost, ElectraNet states that it expects this would only occur because of extreme environmental conditions, such as where a bushfire front crosses the line, or there is a tornado or strong downburst winds in the local area. ElectraNet states that the loss of a double circuit is not considered to be a credible contingency unless there is additional specific information to materially change the expected probability of it occurring. Nonetheless, ElectraNet does maintain a register of risks to assets. An example of a circumstance where a double circuit line might be lost is in the event of a bushfire close to the line.

With respect to lightning, ElectraNet states it can use GPATS to monitor the location of lightning. ElectraNet notes that, since no double circuit transmission lines in SA are classified as vulnerable to lightning using the criteria set out in the PSSG, they are not considered for reclassification.[130] ElectraNet nevertheless monitors where lightning strikes occur to assist it to determine fault locations more quickly and manage staff safety.

A bushfire may cause ElectraNet to recommend to AEMO to reclassify a non-credible event (e.g. loss of both lines on a specific double circuit transmission line) to a credible event, where there is direct evidence of the bushfire's proximity to lines.

In relation to wind, ElectraNet states that it is of the opinion that the wind speed ratings for specific lines are not required to inform control room operators' decision making regarding the reclassification of multiple lines to a credible contingency. Wind loads are taken into account by ElectraNet through its design engineers and others primarily when planning, building and maintaining the network. Furthermore, ElectraNet notes that because synoptic forecasts of wind conditions are ambiguous at an asset level it is problematic to use them as clear evidence of a threat to any specific asset, and ElectraNet has adopted a practice of only considering reclassification of a contingency event in relation to specific assets. According to ElectraNet, it is usually not possible to establish that there is a direct threat to a specific asset. It further notes that the changeable nature of forecasts and weather conditions means that it is difficult to establish evidence of a direct threat to a specific asset.

ElectraNet states that it is aware of the location of vulnerable assets (e.g. some towers on the F1910 and F1911

129 'PSSG' refers to Version 78 of the PSSG (published 29 August 2016) unless otherwise specified. This was the applicable version at the time of the Black System Event.

130 AEMO's PSSG set out the criteria for reclassifying a non-credible contingency event as reasonably possible due to lightning. Vulnerable transmission lines are defined as 'double circuit transmission lines which fall into the categories for Probable or Proven' (p. 28). 'Probable' refers to a double circuit transmission line that has experienced a lightning trip during a three-year rolling time period of assessment (p. 28). 'Proven' refers to: lines not shielded by an Optic Fibre Ground Wire or Overhead Earth Wire; lines where the TNSP has advised AEMO of a deterioration in relevant characteristics to the extent that the line should be categorised as proven, or there have been two lightning trips during the first three years of the three-year rolling time period (pp. 28-29).

transmission lines)[131] but that these are single transmission lines subject to a credible contingency classification already. Due to geographic dispersion, ElectraNet does not expect these multiple single lines to be taken out simultaneously.

ElectraNet states that if it were to receive a warning of a tornado or severe downdraft event located near its network assets then it would consider that to be a risk to its network assets and take appropriate action, including notifying AEMO.

3.3.2 Events on 28 September 2016

ElectraNet's transmission lines and towers in the storm-affected region

The ElectraNet assets in the storm-affected region are shown below in figure 1.

131 Some towers on the F1910 and F1911 transmission lines have a design that incorporates a rectangular base. This reflects design standards of the day, but the lines consequently have lower structural strength and integrity than more contemporary designs.

Figure 1: The ElectraNet assets in the storm-affected region

Source: ElectraNet

3.3.3 Relevant NER provisions applying to ElectraNet in the pre-event period

ElectraNet is required to use reasonable endeavours when exercising its rights and obligations under the NER. This is set out in clause 4.3.4(a) of the NER. In the Pre-Event (AEMO) Chapter, we discuss in some detail the meaning of “reasonable endeavours”, which qualifies many of the obligations imposed on AEMO. The “reasonable endeavours” standard also applies to certain obligations imposed on ElectraNet.

The standard of performance required of ElectraNet under its “reasonable endeavours” obligations to co-operate and assist AEMO in the discharge of AEMO’s power system security responsibilities is that of a reasonable network service provider, in the particular circumstances that confronted ElectraNet at the relevant time. That assessment would include, though would not be limited to, such considerations as the following:

- mandatory considerations that ElectraNet must have regard to when making its decisions, such as its rights and obligations in relation to its networks
- whether ElectraNet acted in accordance with the PSSG, any instructions from AEMO or any protocols or guidelines issued by AEMO
- the information that ElectraNet knew at the relevant time, how it applied it and the extent of ElectraNet’s legal and practical ability to take action in relation to that information
- the extent to which ElectraNet could, and did, exercise its relevant powers and carry out its relevant responsibilities, and
- other practical considerations, such as the limitations of ElectraNet’s resources.

A summary of ElectraNet’s key obligations and responsibilities under the NER in relation to the pre-event period can be found in table 3 below. A detailed overview of these obligations and responsibilities is set out in sections 3.3.4 to 3.3.6.

Table 3: Summary of ElectraNet’s relevant obligations and responsibilities

Obligation/ responsibility	Participant	Comments
Clause 4.3.3(e)	System Operators (other than AEMO)	ElectraNet in its capacity as a ‘System Operator’ is required to keep AEMO informed of: • The state of the security of the power system • Any present or anticipated risks to power system security, and • Any action contemplated or initiated to address a risk to power system security or to restore or maintain the power system in a satisfactory operating state.
Clause 4.3.4(a)	NSPs	Obligation to use reasonable endeavours to co-operate with and assist AEMO in the proper discharge of its power system security responsibilities.
Rule 4.8.1	Registered Participants	Obligation to promptly advise AEMO or a relevant System Operator of any circumstance which could be reasonably expected to adversely affect the secure operation of the power system or equipment.

3.3.4 ElectraNet, as a System Operator, to keep AEMO informed in relation to power system security

A *System Operator* must, to the extent that the *System Operator* is aware or ought reasonably to have been aware, keep *AEMO* fully and timely informed as to:[132]

1. the state of the security of the *power system*
2. any present or anticipated risks to *power system security*, and
3. any action contemplated or initiated to address a risk to *power system security* or to restore or maintain the *power system* in a *satisfactory operating state*.

The extent to which a system operator ought to have been reasonably aware of a matter, in relation to keeping AEMO informed of that matter, will necessarily depend on how clearly its expected role has been communicated to it.

"System Operator" is defined as "[a] person whom *AEMO* has engaged as its agent, or appointed as its delegate, under clause 4.3.3 to carry out some or all of *AEMO's* rights, functions and obligations under Chapter 4 of the *Rules* and who is registered by *AEMO* as a *System Operator* under Chapter 2".

AEMO has delegated some of its power system security responsibilities to ElectraNet under clause 4.3.3.[133] By virtue of this delegation ElectraNet is defined as a "System Operator".[134] ElectraNet has power to carry out the delegated functions as per the delegation instrument and as required under the NER.[135] ElectraNet, in its capacity as a System Operator, must also comply with clause 4.3.3(e) set out above.

The scope of the information ElectraNet is required to report to AEMO under clause 4.3.3(e) is qualified by the inclusion in the Rule of "to the extent that the System Operator is aware or ought reasonably to have been aware". We therefore consider that the information to be assessed and reported to AEMO is that which ElectraNet would be expected to have available to it in its capacity as a TNSP and consistent with any additional instructions provided by AEMO, in addition to information that may be made available to it by virtue of performing the delegated AEMO rights, functions or obligations.

We therefore interpret the clause 4.3.3(e) obligation as the requirement that ElectraNet pass on to AEMO information as it comes before ElectraNet regarding:

- the state of the security of the power system
- whether there are any actual or anticipated threats to the continued, safe operation and control of the power system, and
- whether any action is or is being contemplated to be carried out to restore or maintain the power system to a satisfactory operating state to the extent that this is information that ElectraNet has or would be reasonably expected to have available to it.

3.3.5 ElectraNet to co-operate with and assist AEMO with power system security

Pursuant to clause 4.3.4(a), each *Network Service Provider* must use reasonable endeavours to exercise its rights and obligations in relation to its *networks* to co-operate with and assist *AEMO* in the proper discharge of the *AEMO power system security responsibilities*.

"[P]ower system security responsibilities" is defined as "the responsibilities described in clause 4.3.1".

Clause 4.3.1 defines AEMO's responsibility for power system security. With respect to clause 4.3.1, the sub-clauses that we consider as being most relevant to ElectraNet during the pre-event timeframe under clause 4.3.4(a) are:

> (g) to ensure that all plant and equipment under its control or co-ordination is operated within the appropriate operational or emergency limits which are advised to AEMO by the respective Network Service Providers or Registered Participants
>
> (h) to assess the impacts of technical and any operational *plant* on the operation of the *power system*
>
> (w) to ensure that each System Operator satisfactorily interacts with AEMO, other System Operators and Distribution System Operators for both transmission and distribution network activities and operations, so that power system security is not jeopardised by operations on the connected transmission networks and distribution networks.

With respect to clauses 4.3.1(g) and (h), we note that ElectraNet is responsible for the operation of the transmission network, which includes towers and conductors (or lines). ElectraNet is therefore required to

132 NER, clause 4.3.3(e).

133 AEMO, *Schedule 1 extract from ElectraNet Instrument of Delegation*, 14 December 2013, <https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation/Schedules-for-Delegations>.

134 NER, clause 4.3.3 provides that AEMO may, from time to time, appoint such delegates as it considers appropriate to carry out on its behalf some or all of its rights, functions and obligations under Chapter 4.

135 NER, clause 4.3.3(d) and (e).

use reasonable endeavours to co-operate with and assist AEMO to:

- ensure that the transmission network elements are operated within appropriate operational or emergency limits, and
- assess the impacts of the transmission network elements on the operation of the power system.

With respect to clause 4.3.1(w), ElectraNet is required to ensure that it "satisfactorily interacts" with AEMO, TNSPs in other jurisdictions and SAPN, so that power system security is not jeopardised.

We note that ElectraNet's interpretation of its obligations under clause 4.3.4(a) are:

> *to use reasonable endeavours to exercise its rights and obligations in relation to the transmission network so as to co-operate and assist AEMO in the proper discharge of AEMO's power system security obligations.*
>
> *ElectraNet considers this requirement to be complementary to AEMO's overriding responsibility for power system security, which includes an obligation on AEMO to use reasonable endeavours, gather information and issue directions as appropriate (see cl 4.3.1 and 4.3.2). Accordingly, ElectraNet interprets clause 4.3.4(a) as requiring it undertake reasonable endeavours to respond to AEMO requests for assistance in managing the security of the power system.*
>
> *As explained* [in section 3.3.1 above]*, ElectraNet also proactively communicates with AEMO on system security issues.*
>
> *To satisfy the requirements of cl 4.3.4(a), ElectraNet always works co-operatively with AEMO on all power system security related issues and exercises its rights and obligations in relation to its network to achieve this end.*

3.3.6 ElectraNet to advise AEMO of threat to power system or equipment

Under clause 4.8.1 of the NER, a *Registered Participant* must promptly advise *AEMO* or a relevant *System Operator* at the time that the *Registered Participant* becomes aware, of any circumstance which could be expected to adversely affect the secure operation of the *power system* or any equipment owned or under the control of the *Registered Participant* or a *Network Service Provider*.

As a TNSP, ElectraNet is a "Registered Participant". It is therefore required to advise AEMO at the time it becomes aware of any circumstance which could be expected to adversely affect the secure operation of the power system or any equipment owned or under the control of ElectraNet.

3.4 Assessment of ElectraNet's compliance with NER obligations

In combination the three NER provisions require ElectraNet to:

- ensure that the transmission network elements are operated within appropriate operational or emergency limits
- promptly inform AEMO, when it becomes aware, of:
  - the state of the security of the power system (including assessing the impacts of the transmission network elements on the operation of the power system)
  - whether there are any actual or anticipated threats to power system security (including any threats to the secure operation of any equipment owned or controlled by ElectraNet), and
  - whether any action is or is being contemplated to be carried out to restore or maintain the power system to a satisfactory operating state, and
- ensure that it "satisfactorily interacts" with AEMO, TNSPs in other jurisdictions and SAPN, so that power system security is not jeopardised.

While AEMO restates the three NER provisions at section 11.2 of the PSSG, dealing with Registered Participant, NSP and System Operator responsibilities, the PSSG do not state what information AEMO is relying on participants to provide to it pursuant to these obligations in order for AEMO to perform its roles and functions as the System Operator.[136]

In assessing ElectraNet's compliance with its obligations to communicate with and assist AEMO, we considered ElectraNet's actions on 27 and 28 September 2016 in the lead-up to the Event.

This included considering ElectraNet's actions in relation to:

- monitoring weather conditions
- assessing any threat to transmission network assets,and
- communicating relevant issues, including its assessment of power system security, to AEMO.

3.4.1 Weather forecast information reviewed by ElectraNet

ElectraNet submits that during the pre-event period it received weather forecasts and notices throughout 27 and 28 September 2016 from its weather portal and from faxes received from BOM and Weatherzone. The content of the weather warnings is the same as those described in the Pre-Event (AEMO) Chapter at section 2.4.2 and appendix B. ElectraNet states that it considered these weather forecasts and notices as they were received.

136 AEMO, *Power System Security Guidelines*, version 78, 29 August 2016, pp. 21-22.

ElectraNet received the SEC weather briefings in the afternoon of 27 September 2016. ElectraNet reported that there was nothing remarkable in the 13:30 hrs weather reports received from the SEC. After the SEC briefing, ElectraNet held a meeting of its technical emergency response team to identify the preparations that were necessary for the impending weather conditions. According to ElectraNet, the actions ElectraNet undertook as a result of the meeting were to:

- arrange for the cancellation of two planned outages
- organise testing of network support generation arrangements at Port Lincoln with ENGIE[137] and
- ensure that the maintenance service provider was on standby for an immediate emergency response.

ElectraNet states that the initial forecasts indicated potential damage to parts of the transmission network on the Eyre Peninsula—hence, their initial focus was there.

ElectraNet states that on 28 September 2016, during the morning, ElectraNet continued to receive weather forecasts both through the weather portal and from faxes received from BOM and Weatherzone. Early on the morning of 28 September 2016, the weather which was forecast to impact the Eyre Peninsula did not eventuate. ElectraNet had communicated with ENGIE and SAPN, and there was standard "manning", as it looked like any normal day in ElectraNet's opinion.

During the middle of the day, ElectraNet notes that it:

- continued to receive weather forecasts
- followed the path of the synoptic weather front, and
- monitored the impact of the conditions on assets (by monitoring SCADA).

In the afternoon, ElectraNet states that it continued to monitor the weather conditions. According to ElectraNet, all lines were energised (that is, running as normal) and as a result ElectraNet was able to detect in real time any fault occurrences, confirming that the storm caused less damage than expected on the Eyre Peninsula. ElectraNet states that there were no disruptions to supply as the storm passed the Eyre Peninsula, Davenport Substation and the 275kV West Circuit. The weather front moved across the top of the Eyre Peninsula, and passed assets without reported damage or faults. ElectraNet adds that there was no evidence to suggest that the storm would strengthen and produce tornadoes as it moved over the Flinders Ranges and into the mid north.

ElectraNet's post-event assessment of the weather conditions is:

> *As at 27 September 2016 the broad area environmental conditions forecast for 28 September did not reflect the actual localised environmental conditions experienced. In addition, ElectraNet is of the view that the environmental conditions forecast did not provide sufficient information to understand the impact of the wind strength forecast, as it did not provide localised wind gust information, nor did it provide wind directions. Specifically, the forecasts did not reference tornadoes which the BOM later identified as the cause of the damage to ElectraNet's assets.*
>
> *As stated earlier, the ElectraNet weather stations do not provide real time data to make an assessment as to whether local conditions are approaching the wind withstand ratings of specific double circuit assets.*

ElectraNet states it was anticipating a low-pressure front moving from the western part of the State across the Eyre Peninsula, with some potential impact of strong winds and lightning. ElectraNet was not expecting the destructive tornadoes that BOM later identified as the cause of damage to ElectraNet's assets.

ElectraNet concludes that the forecasts did not indicate conditions or circumstances (e.g. tornadoes) which would have given rise to potential loss of either a double circuit or multiple single circuits in a short timeframe.

3.4.2 ElectraNet's assessment of threats to power system security

The weather forecasts for 28 September indicated a significant synoptic storm front moving across SA. The storm was widely reported to be significant. Consequently, ElectraNet's critical response team met to consider preparedness for critical response should there be any damage to the transmission network.

According to ElectraNet, it identified potential for faults across the transmission network. Given the forecast suggested that the Eyre Peninsula was likely to be impacted first, ElectraNet notes there was a risk that a fault on the 132kV radial line between Cultana and Pt Lincoln could lead to a loss of supply to the Eyre Peninsula. In preparation for the event, ElectraNet indicates that it requested the testing of the network support generators located at Port Lincoln, which successfully started on 27 September in accordance with the testing requirements.

ElectraNet states that it further prepared by:

- recalling planned outages

137 ElectraNet has a network support arrangement with the Port Lincoln power station, which is owned by Synergen Power. Synergen Power is jointly owned by ENGIE (72 per cent) and Mitsui & Co Ltd (28 per cent).

- issuing a safety warning to all staff
- putting back-up crews on stand-by
- putting suppliers and critical response staff on notice
- putting the maintenance service provider on notice, and
- ensuring that spares were available and ready for deployment.

ElectraNet submits that it understands the loss of a single line is always classified as a credible contingency and understood to be already accounted for in AEMO's constraint equations and other network planning arrangements.

Therefore, on 28 September 2016, ElectraNet states that its main consideration was whether there was an increased risk of double circuit or multiple simultaneous single circuit lines tripping due to the forecast storms. As set out above, ElectraNet considered that the relevant risks arising from the forecast information available consisted of lightning, high wind speed and wind gusts.

ElectraNet notes there were no ElectraNet double circuit transmission lines classified as vulnerable to lightning and so reclassification from a non-credible to credible contingency event is not currently envisaged under the procedures in AEMO's PSSG. Nevertheless, ElectraNet states it was monitoring the faults that occurred on the transmission network as a result of lightning, e.g. the transient fault on the Hummocks-Bungama 132 kV line at 15:49 hrs.

With respect to the forecast wind speed and wind gusts, the BOM and Weatherzone wind forecasts are synoptic, not localised to an asset level. From a reclassification point of view, ElectraNet states that it was aware of the location of vulnerable assets (e.g. some towers on the F1910 and F1911 transmission lines, where the design incorporates a rectangular base, constructed reflecting design standards of the day but which have lower structural strength and integrity than more contemporary designs) but considers that these are single circuit transmission lines already subject to a credible contingency classification. It adds that, as these assets are geographically dispersed, it was unlikely that more than one transmission element would fail or be removed from operation, based on the available evidence. ElectraNet therefore did not consider there was a basis for reclassification. We consider this was a reasonable conclusion in the circumstances. ElectraNet states:

> *Given the movement of the storm and the fact that the fault information indicated that the faults were auto reclosing, which means that the lines were remaining energised i.e. no structural damage to the lines or towers, this indicated an expectation that the storm may not cause any catastrophic damage to the network. In the absence of localised and specific environmental condition information such as the movement and strength of wind (both horizontal and vertical), ElectraNet did not have sufficient information to form the view that circumstances existed to notify AEMO of the loss of either multiple circuits or the double circuit.*

In assessing the weather forecasts for the impending weather event, ElectraNet notes that its Network Operations "did not consider there to be circumstances of potential risk to the transmission network or power system security which would require advice to AEMO".

ElectraNet further states that:

> *The BOM and Weatherzone forecasts did not anticipate the tornadoes and extreme wind speeds actually experienced on 28 September 2016. Had the forecasts provided specific information about the likely existence of tornadoes and the exact location of such tornadoes (i.e. in close proximity to various towers) and the localised strength, direction and nature (i.e. downdraft) of the wind, then based on experience of the control room operators in assessing these conditions as abnormal, it is expected that they would have formed the view that significant damage to multiple single circuit lines (i.e. F1910 and F1911) and/or double circuit lines (F1919/F1920) should be considered as a credible contingency and would have notified AEMO accordingly. It should be noted that ElectraNet has no history of wind events resulting in tower failure on F1919/F1920. Unfortunately, the weather forecasts on the day did not include that critical information.*

ElectraNet states that, while it assessed that there were insufficient grounds to advise AEMO of any potential threat to power system security, it did carry out risk mitigation activities including activating its emergency response procedures and recalling planned outages.

According to ElectraNet, its operational staff had discussions with AEMO operational staff and SAPN in relation to the weather warnings and discussed any actions required based on the foreseeable risks to the network.

ElectraNet states that, around early to mid-morning on 28 September 2016, ElectraNet discussed the anticipated weather event with AEMO. ElectraNet advised AEMO that several planned outages had been cancelled, several more planned outages were expected to be returned to service early, and field crews were on standby if required.[138]

In response to the changing weather forecasts, ElectraNet states that it:

- updated its action plan to manage outages in the mid north
- activated its emergency response procedures, and

138 AEMO, *Black System South Australia 28 September 2016—Final Report,* published March 2017 ('AEMO, Final Report'), p. 24.

- called in additional staff. In the control room, there were four operators plus one central coordinator.[139]

3.4.3 Communication with AEMO and other Registered Participants

Throughout 28 September 2016, ElectraNet states that AEMO was kept informed of the state of the network and any foreseeable risks the forecast weather posed to the assets, network and power system security, based on the information ElectraNet had at the time. Regular contact between the AEMO and ElectraNet control rooms was maintained before, during and after the Event. ElectraNet notes that it maintains a real-time Energy Management System and AEMO is aware of the status of its transmission assets via a real time SCADA connection.

ElectraNet provided control room phone logs and recordings of its communication with AEMO during the pre-event period. From our assessment of the transcripts, we consider that several discussions between ElectraNet and AEMO staff involved comments on the weather in a general sense. We note that there did not appear to be a parameter or threshold concept of risk assessment to the discussions.

ElectraNet also states that it "communicated with the other market participants, including SAPN, generators and network support providers and government agencies including the Department of State Development (Energy Division) and the State Emergency Centre during the Pre-Black System Event period".

ElectraNet adds that it "was also in contact with the Engineering Functional services group within the SEC to advise of our state of standby and to obtain the State Emergency Service (SES) state duty officer contact details. SEC also provided weather briefings and other notices".

3.4.4 Assessment of compliance

We have found that ElectraNet monitored weather conditions and the state of its network on a continuous basis during the pre-event period such that it was able to be aware of and assess any risks to power system security, to the degree expected of a TNSP. This included being aware and assessing the impact and likely impact of the storm on its transmission network elements and further, their impact on the operation of the power system.[140]

We assess that ElectraNet took account of the forecast severe weather conditions in operating its transmission network within appropriate operational and emergency limits. ElectraNet communicated with and assisted AEMO in a manner that was consistent with ElectraNet's knowledge and assessment of the weather conditions and the apparent risks to the network. We formed this view based on information before us that:

- having regard to the PSSG and past practice between AEMO and ElectraNet, there was no information that would have led ElectraNet to advise AEMO that any non-credible contingency event was more likely in the circumstances, specifically in relation to the loss of a double circuit or the simultaneous loss of multiple single lines
- ElectraNet took appropriate risk mitigation actions available to it, including recalling planned outages, having additional crew and maintenance providers on standby, having additional control room staff on hand and maintaining contact with AEMO, and
- there was no information available to ElectraNet that would have caused it to proactively de-energise lines.

We assess that ElectraNet communicated in a manner consistent with the established communication practices between it and AEMO. ElectraNet had no evidence of likely damage to specific assets, which, in line with past practice, would normally form the basis of discussions regarding reclassification. It communicated to AEMO its intention to recall outages and have standby crews available. ElectraNet kept in contact with AEMO through the relevant period. AEMO was privy to the same weather forecast information and the same monitoring systems for the purposes of assessing the state of the power system and any risks to power system security. Based on usual practice, ElectraNet did not therefore have any additional information to relay with respect to the state of the power system and any risks to power system security.

Having considered the information provided by ElectraNet, including telephone logs, and AEMO's corroboration of communication it received from ElectraNet, we conclude that ElectraNet satisfactorily interacted with AEMO and SAPN, such that ElectraNet's communication did not jeopardise power system security.

We therefore assess that ElectraNet has met its obligations under clauses 4.3.3(e), 4.3.4(a), and 4.8.1.

ElectraNet's and AEMO's views of ElectraNet's responsibilities

We note, however, that while AEMO's view of how Registered Participants are to fulfil their responsibilities regarding power system security appears to be mostly aligned with ElectraNet's view of its responsibilities, there are differences in understanding in some respects.

139 We understand that, during system normal conditions, there are two operators in the control room on weekdays and one on weeknights and weekends.

140 NER, clause 4.3.1(h).

AEMO states in its report that:[141]

AEMO had not been informed by ElectraNet or SA Generators of any circumstance which could have adversely affected the secure operation of the power system or their equipment under these forecast conditions (advice to AEMO of the existence of such risks is standard practice under clause 4.8.1 of the NER). Under procedures in place at that time, AEMO would only reclassify the loss of multiple circuits under high wind conditions if the maximum wind speed was forecast to be in excess of the [mechanical tower strength] design rating for the lines, as advised by the relevant transmission network service provider (TNSP). AEMO did not keep details of [mechanical tower strength] design ratings for wind loadings, and relied upon TNSPs, as asset owners, to alert AEMO.

We note that AEMO's PSSG, which provide guidance on contingency events and set out AEMO's criteria around the reclassification of non-credible contingency events to credible contingency events, do not contemplate reclassification due to a wind speed being forecast to be in excess of the mechanical tower strength design rating for multiple transmission lines.[142] In response to this observation, AEMO states that "the guidelines avoid being prescriptive to specific risks other than events that are relatively common and lend themselves to a common set of defined risk assessment criteria across the NEM". It indicates that the PSSG reiterate the content of the clause 4.8.1 obligation on Registered Participants. AEMO considers that the clause is "very clear and written specifically to catch all possibilities and scenarios that may arise as a threat to power system security and/or assets owned or controlled by an NSP or participant". In AEMO's opinion, it is not possible to prescriptively identify all possible threats.

As indicated above at 3.3.1, ElectraNet is of the view that it has an understanding with AEMO, based on practice, that it should only inform AEMO where it has evidence of a risk to a specific transmission asset(s) that would cause two circuits on a double circuit transmission line to fail or that would cause multiple single transmission lines to fail simultaneously. Due to the lack of specific wind information at an asset level provided under current forecasting methods, ElectraNet considers that it is not useful to make the assessment AEMO is describing—that is, of whether the forecast wind gusts are greater than the design rating.

ElectraNet has advised that in response to the events of 28 September 2016, AEMO has requested that all TNSPs provide AEMO with the wind withstand ratings for all lines within the network. AEMO, in consultation with ElectraNet, has put into place a temporary operating instruction for the F1910/F1911/F1961 transmission line to be reclassified when wind gusts are forecast to exceed 100 km/h and F1920/F1919 when wind gusts are forecast to exceed 165 km/h in their respective BOM weather districts.[143] ElectraNet states that it understands that, on two occasions since 28 September 2016,[144] AEMO has reclassified the loss of F1910 & F1911 as a credible contingency based on wind strength forecasts. However, ElectraNet observes that such reclassifications have not resulted in AEMO imposing new network constraints on NEM dispatch (to manage flows over these lines). This is consistent with ElectraNet's view that the loss of single circuits is already a credible contingency, and as such is already captured in network security assessments. We note, however, that AEMO has subsequently reduced the Victoria to SA export limit on the Heywood Interconnector concurrent with (although not as a result of) these types of reclassifications, citing severe weather warnings issued by BOM in its market notices. This is because a loss of a network element in SA is more likely to lead to a material loss of generation rather than a material loss of load, and hence an increase in import flows across the Heywood Interconnector into SA.

We also note that this does not address ElectraNet's assessment that a synoptic weather forecast does not provide the information required for assessment of specific risks to a particular transmission asset. It also does not address the issue that weather forecasts are changeable, and that the actual impact of weather-related risks may not be in the expected location. According to ElectraNet, in these circumstances, the addition of constraints (for example, to reduce the energy flow on a specific line) may undermine security rather than aid it.

In response to ElectraNet's position, AEMO states that it:

did not specifically enquire about design ratings but expected ElectraNet to inform AEMO generally if it was concerned about an impact to any of its assets as a result of the forecast conditions. This is consistent with ElectraNet's statements, in particular its confirmation that it would have identified such risks if tornado conditions had been forecast.

We consider that AEMO's statement is reasonable but does not change our conclusion that AEMO and ElectraNet had a different understanding of the relevance of design ratings in relation to assessing risks to transmission lines.

141 AEMO, Final Report, p. 24.

142 For the sake of brevity, we subsequently refer to 'mechanical tower strength design rating' as 'design rating'.

143 The 'F1961' line is also known as the Para-Templers West 275 kV line. The line is not relevant to our assessment of ElectraNet's compliance during the pre-event.

144 As at 3 July 2017.

We note AEMO does not accept that:

> *… there is, or was, any confusion regarding the information and advice AEMO expects from Transmission Network Service Providers (TNSPs) about particular risks to their transmission assets. ElectraNet's statements about its role in advising AEMO of any such risk are entirely consistent with AEMO's expectations, ElectraNet's NER obligations and the established history of TNSPs regularly providing such advice to AEMO.*

AEMO further states:

> *Articulating specific requirements or expectations in respect of registered participants' compliance with deliberately broad rules obligations like 4.3.3(e) or 4.8.1 is likely to be counterintuitive. Examples inevitably narrow the focus to those specific things, meaning other risks may not be properly considered and accounted for. In respect of System Operators, AEMO does not consider there to be any confusion as to their role.*

In the final chapter of this report, '*Implications for the Regulatory Framework*', we set out AEMO's broader suggestions for regulatory reform in relation to information sharing and planning.

For completeness, we note that ElectraNet has also undertaken the following actions since the events of September 2016:

- implementing a new direct communications path to SAPN, to overcome delays associated with communicating through the normal control room telephone numbers
- installing an additional satellite phone at the backup Control Centre
- implementing "lessons learnt" discussions at various organisational levels to develop better relationships and enable improved communication with SAPN, generators and direct connect customers
- investigating wind risk model development to better understand the potential impacts of climate change and severe weather on transmission line infrastructure, and
- undertaking a project to explore the possibility of improving the information extracted from the ElectraNet weather stations to allow for the capturing of other climatic and environmental conditions closer to real time.

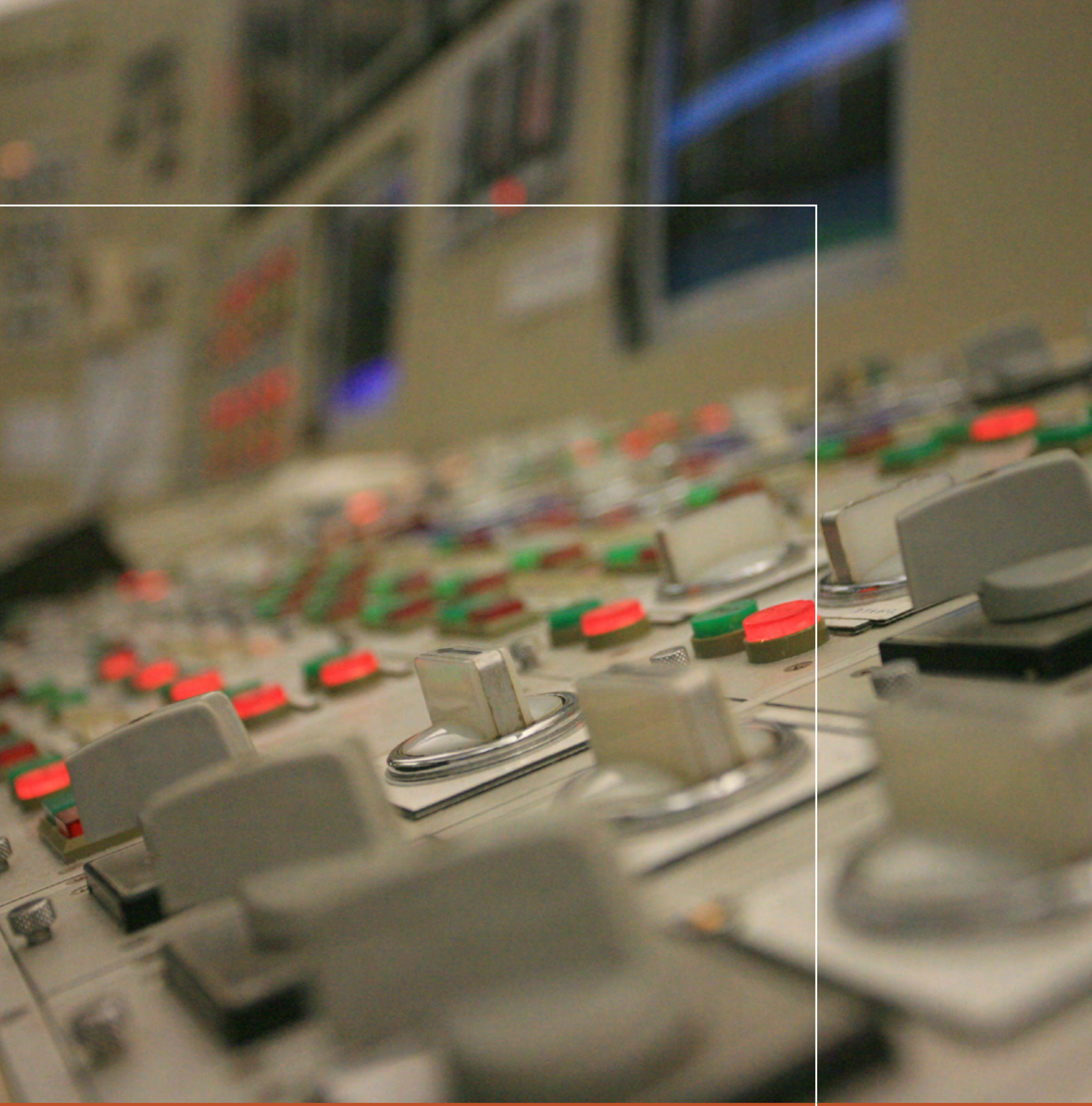
3.4.5 Findings, recommendations and AER actions

Findings

ElectraNet complied with its obligations under the NER, although there are different understandings by AEMO and ElectraNet in relation to the extent and type of information to be communicated by ElectraNet to AEMO.

AER actions

Given the nature of our findings, and the investigation's purpose to promote the long-term interests of consumers, the AER will undertake an industry-wide compliance review of clauses 4.3.3(e), 4.3.4(a) and 4.8.1 to verify that there is alignment between Registered Participants' and AEMO's expectations in relation to the extent and type of information to be communicated by Registered Participants to AEMO.



System restoration compliance assessment

4. System restoration compliance

4.1 Summary

Restoring a network following a major supply disruption is a complex task. It requires a fast assessment of the condition of the network, configuration of a restoration path and coordination between AEMO, the TNSP, System Restart Ancillary Services (SRAS) Providers, Generators and the DNSP(s) to implement the restoration. Extensive planning and testing is required for the restoration to be carried out as efficiently as possible.

AEMO must consider the technical capabilities and requirements of generators and customer loads when developing restoration path options utilising available SRAS. AEMO procures SRAS to meet a specified restoration standard, which dictates the time by which a certain amount of generation capacity is to be restored. Contracted SRAS Providers are required to demonstrate their restart capability through testing. The relevant TNSP develops detailed switching instructions for the restoration paths developed by AEMO.

Coordination is therefore key to successful restoration after a major supply disruption—all the relevant participants must work together to deploy available SRAS in the manner practised through prior testing.

At 16:24 hrs on 28 September 2016, AEMO declared a black system condition for the South Australian electrical sub-network. AEMO commenced restoration of the network at 16:30 hrs, reporting that 40 per cent of the load in South Australia capable of being restored had been restored by 20:30 hrs, with 80 to 90 per cent restored by midnight.

During restoration of the network on the 28 September 2016, one SRAS Provider (Mintaro) had earlier been declared unavailable, most likely due to lightning damage, and one SRAS Provider (Origin) failed to deliver its contracted SRAS.[145] Origin was not able to deliver SRAS due to the switching configuration used by ElectraNet, which caused the protection settings at Quarantine unit 5 (QPS5) to trip. We understand that Origin's failure to provide SRAS delayed supply to Adelaide generators by an hour, with the Heywood interconnector utilised to restore power.[146]

During our assessment of compliance during the system restoration period, it became clear that South Australian participants were motivated to facilitate the restoration of the network as efficiently as possible and participants worked well together.

Our investigation of the events has determined that there were no specific incidents of non-compliance with respect to system restoration. We have identified, however, improvements that could be made to address some gaps in SRAS processes.

Consistent with our role of reviewing compliance with the NEL and NER, we have examined the actions of AEMO, ElectraNet, Origin and Synergen Power (which owns Mintaro) in relation to the provision and use of SRAS to restore the network following the black system conditions of 28 September 2016. As part of this review, we have examined the SRAS processes undertaken prior to the activation of SRAS on 28 September 2016. These processes extend from the procurement of SRAS, the gathering of information in order to develop effective restoration paths and detailed switching instructions, and the testing of SRAS to provide confidence that these services could be delivered (see table 1).

145 We note that AEMO advised that Mintaro was not, and would not have been, called upon to provide SRAS on the day.

146 AEMO, *Black System South Australia 28 September 2016—Final Report*, published March 2017 ("AEMO, Final Report"), p. 72.

Table 1: Steps involved in SRAS delivery

Step in SRAS delivery	Source	Participant	Role/responsibility	Gaps identified
SRAS Procurement	NER 4.3.1(p) and 3.11.7	SRAS tenderer, AEMO	AEMO identifies issues with SRAS delivery from the SRAS delivery point. SRAS tenderer to identify issues with SRAS delivery internal to the SRAS delivery point.	No established process or requirement for information acquired during procurement to be passed to the NSP developing the System Restart SSP.
SRAS Agreement	NER 3.11.9	SRAS Provider, AEMO	SRAS Provider and AEMO to enter into, and comply with, SRAS Agreement SRAS tenderer to modify SRAS Agreement as required.	Not all detailed technical capability requirements were captured in SRAS Agreement.
LBSP	NER 4.8.12(d)	Generator, NSP, AEMO	Generators and NSPs specify restart capabilities and technical requirements associated with restart. AEMO approves LBSP. Provision for AEMO to provide LBSP to NSP.	SRAS technical requirements and capabilities not clearly and separately distinguished or captured in the LBSP. No established process or requirement to share LBSP with NSP.
SRAS test procedure/SSP	NER 3.11.7 and 3.11.9	SRAS Provider, NSP, AEMO	SRAS Provider responsible for development of test procedure and SSP. AEMO approves test procedure.	Not clear when NSP/third parties required to approve test procedure/SSP. No requirement to identify difference between SRAS test SSP and System Restart SSP.
System Restart Plan /SSP	NER 4.8.12	NSP, AEMO	AEMO develops the System Restart Plan. The NSP develops the System Restart SSP from the System Restart Plan.	System Restart SSP not routinely provided to or reviewed by the SRAS Providers.

Source: AER

The key technical issues we identified leading to Origin's SRAS not being delivered were:

1. ElectraNet had a different switching arrangement for Quarantine in its System Restart System Switching Program (SSP) (which utilised a hard start) to those it used in Quarantine's SRAS tests (which involved a soft start[147]).
2. Origin and AEMO did not know that the System Restart SSP had a different switching arrangement for Quarantine to that set out in the SRAS test SSP.

We also identified several gaps in the regulatory and administrative framework for SRAS. We consider these also contributed to the non-delivery of Origin's SRAS on the day of the event.

In particular, we found there was a lack of:

- clear understanding of roles and responsibilities
- clear guidance on what is required at each step, and
- rigorous approval processes at each step.

We have found that AEMO and ElectraNet complied with the obligation to formulate communication protocols[148] to facilitate the exchange of information required to implement the System Restart Plan, however we recommend the protocols be improved to better facilitate that exchange. We consider a rule change is the best way to do so.

Finally, we have assessed that AEMO fulfilled its obligation to use reasonable endeavours, as required under the NER, in respect of its broader obligations relating to its power system security responsibilities[149] by procuring and utilising SRAS and otherwise developing a System Restart Plan and associated procedures for South Australia in accordance with NER requirements.

While we consider AEMO's new SRAS Guideline[150] and pro forma SRAS Agreement[151] go a considerable way towards addressing each of the gaps described above (see table 1), we recommend implementation of additional mechanisms to ensure the SRAS process remains rigorous, while preserving the flexibility needed to respond to issues that might arise during a major supply disruption. These recommendations, including actions the AER will undertake, are summarised below.

147 A soft start is where the circuit between the QPS generator 1 or 2 and generator 5 is closed and then the voltage is increased from zero to the nominal value. This means that the ancillary equipment for generator 5 is gradually energised to manage inrush current that may operate protection. A soft start was required to prevent tripping of the QPS GT5 generator transformer protection due to harmonics present in the inrush current during energisation at full voltage.

148 NER, clause 4.8.12(j).

149 NER, clause 4.3.2(a).

150 See: https://www.aemo.com.au/-/media/Files/Stakeholder_Consultation/Consultations/Electricity_Consultations/2017/SRAS/Final/SRAS-Guideline-2017.pdf.

151 See: https://www.aemo.com.au/-/media/.../SRAS-Agreement-Proforma-2018-Final.pdf.

Table 2: Summary of recommendations and AER actions

Area of the SRAS process		Recommendation/action
SRAS process	4.1	AER to propose a rule change to clarify the TNSP's involvement in SRAS process beyond procurement. This involvement to extend to facilitating ongoing testing of SRAS to ensure that SRAS continues to be capable of being delivered and the actual deployment of SRAS during system restoration. This includes complying with applicable requirements in the SRAS Guideline.
SRAS Procurement	4.2	AER to propose a rule change to amend clause 3.11.7(d) of the NER to specify that the SRAS Guideline set out that the testing of SRAS is to include a comparison with the arrangements planned to be utilised during a major supply disruption.
LBSP development	4.3	AEMO, during its next review of the LBSP Guidelines, consult with Generators and NSPs on providing more detailed content in the LBSPs and on the level of guidance provided in the LBSP Guidelines. This will assist and guide the growing number of new, smaller participants who will be required to develop LBSPs.
Communication applied through the entire SRAS process	4.4	AER to propose a rule change to require AEMO and NSPs for each region to jointly prepare written communication protocols which set out the timing of and manner in which information will be exchanged and between which parties, both in preparation for and during a major supply disruption, and the nature of that information, including: • AEMO to liaise directly with all TNSPs and generators, including through the dissemination of LBSPs to other parties where appropriate and the SRWG • TNSPs to liaise directly with: – DNSPs and customers connected to their transmission network regarding the nature of connection point and load characteristics – Generators regarding connection point characteristics and the nature of switching that may need to be conducted during the process of system restoration • DNSPs to liaise directly with parties (including embedded generators) connected to their distribution network regarding the nature of connection point and load characteristics. We note that the exchange of information may include information that is confidential or protected and that any communication protocol will need to address such matters in accordance with the relevant legal requirements and powers.

4.2 AER approach to assessing compliance

We have assessed the compliance of each of the relevant NEM participants with their SRAS-related obligations both during the System Restoration period and during the period prior to Origin, the key South Australian SRAS Provider, being unable to deliver system restart services on 28 September 2016. Origin's inability to deliver SRAS delayed restoration to Adelaide generators by one hour. We note that this delay did not affect AEMO's ability to implement the system restart plan and AEMO has stated that the particular technical configuration of the QPS5 unit—and the associated soft start requirement—is very unusual in the NEM and the same situation does not exist with currently contracted SRAS providers.

Relevant NER obligations during the System Restoration period relate to the delivery of SRAS and implementing Local Black System Procedures (LBSPs). The NER also require AEMO and relevant NEM participants, including NSPs, to undertake preparatory steps prior to a major supply disruption, such as the procurement of SRAS services in each region and establishing System Restart Plans.

These steps are important to mitigating the risk of a black system event.

Procurement of SRAS is essentially a commercial arrangement between AEMO and an SRAS Provider. These arrangements, however, sit within the regulatory framework established by the NER. AEMO has a central role in the procurement. It plays a coordination and oversight role throughout the process, consistent with its obligation to procure SRAS to meet both the SRAS Procurement Objective and the System Restoration Standard. The provisions of the NER which relate to the procurement of SRAS recognise that AEMO may not be able to obtain the optimal SRAS to support a system restoration process during a black system event.

Equally important is the TNSP, given a TNSP's role in assisting procurement, testing and delivery of SRAS, and AEMO's reliance on NSPs to undertake network switching. In carrying out of these measures, NSPs will need to provide information on, amongst other things, plant and network capabilities to ensure they are able to meet the requirements of the System Restart Plan.

As a result, our compliance assessment is structured as follows:

- reviewing the conduct of Origin, ElectraNet and AEMO during the System Restoration period
- assessing AEMO's procurement of SRAS for South Australia (both Quarantine and Mintaro), and
- investigating the genesis of QPS5's failure—the use of switching arrangements incompatible with the protection settings.

Further details of the legal framework applied by the AER are set out in appendix A.

4.3 Background

4.3.1 What is SRAS?

When there is a major electricity supply disruption, a generator or number of generators are required to restart the system. System Restart Ancillary Services, or SRAS, are provided by generators with the ability to restart themselves independently of the electricity grid. Once they have restarted, they then provide enough energy to restart other generators. Blocks of customer load are brought on to stabilise the voltage and frequency of the electricity in the grid. The number of generators and the blocks of customer load are gradually built until the full electricity system is restored.

AEMO has an obligation to use reasonable endeavours to:

1. procure sufficient SRAS to achieve the SRAS Procurement Objective[152] and
2. meet the System Restart Standard, which is developed by the Reliability Panel for each region of the NEM.[153]

The SRAS contracted by AEMO is for a generator to deliver a certain amount of output (e.g. 80 MW at a particular delivery point) and maintain the restart capability for a certain amount of time in a year (e.g. 94 per cent reliability).

AEMO carries out modelling to determine the amount of generation output required to rebuild an area of the electricity network within a particular timeframe (see discussion below for the particulars according to the System Restart Standard). For each area, generators with black system restart capability are contracted as SRAS Providers to meet those requirements. AEMO has identified the following sub-networks in the NEM: Queensland North, Queensland South, NSW, Victoria, South Australia and Tasmania.

4.3.2 When is SRAS required?

AEMO contracts with SRAS Providers (under a SRAS Agreement) to provide restart services, if required, for system restoration following a major supply disruption.[154] A black system in a region is a major supply disruption where there is a loss of more than 60 per cent of predicted regional load, affecting one or more power stations following a major power system emergency in that region.[155]

AEMO will activate an SRAS Agreement where it is required to restart or assist in restarting the power system. In preparation for a major supply disruption, AEMO must develop a System Restart Plan for each electrical sub-network. For each System Restart Plan, AEMO specifies a number of Restoration Options, each one covering different parts of the electricity network within the particular electrical sub-network. This allows AEMO to select viable options for achieving system restoration depending on the prevailing circumstances. Each Restoration Option describes the restart source—typically either an SRAS Provider or an interconnector providing supply from another sub-network—and the generators that will be energised on the restart path, together with load blocks required to stabilise the frequency and voltage of the parts of the grid as they are restored.

4.3.3 How much SRAS is contracted?

As noted above, AEMO has a responsibility under the NER to procure adequate SRAS to coordinate a response to a major supply disruption.[156] Sufficient SRAS should be available in accordance with the System Restart Standard.[157] This Standard is determined by the Reliability Panel appointed by the AEMC.[158]

152 NER, clause 3.11.7(a1).

153 Ibid.

154 NER, chapter 10 defines a 'major supply disruption' as 'the unplanned absence of voltage on a part of the transmission system affecting one or more power stations and which leads to a loss of supply to one or more loads'.

155 AEMO, *SO_OP_3715 Power System Security Guidelines*, Version 78, 29 August 2016, p. 14.

156 NER, clause 4.3.1(p).

157 NER, clause 4.2.6(e).

158 NER, clause 8.8.1(a)(1a).

At the time of the Black System Event, and when procuring SRAS in the period prior, the System Restart Standard in force[159] specified two key requirements of the procured SRAS, namely that it could:

- re-supply and energise the auxiliaries of power stations within 1.5 hours such that there is sufficient capacity to supply 40 per cent of peak demand in the sub-network, and
- restore generation and transmission such that 40 per cent of peak demand in that sub-network could be supplied within four hours.

AEMO had an obligation to procure SRAS that achieved these capabilities for each service.

In addition, AEMO had an obligation under the NER to develop and publish SRAS Guidelines, which set out how AEMO should procure and test SRAS to meet the System Restart Standard. The SRAS Guidelines (2014) were in place when AEMO procured the SRAS in effect on 28 September.[160] The SRAS Guidelines (2014) include the technical and reliability requirements of SRAS, the process for determining the number and location of SRAS, the factors AEMO considers in assessing and testing SRAS and the procurement process.[161]

In the South Australian sub-network, at the time of procuring SRAS in 2015-2016, peak demand was 3400 MW. Hence AEMO had to acquire SRAS capable of restarting sufficient generation capacity to meet 1360 MW (equal to forty per cent of peak demand) within the specified timeframes.[162]

4.3.4 The SRAS Agreements

AEMO enters into SRAS Agreements with SRAS Providers. Each SRAS Agreement includes availability requirements, the tests required to demonstrate the capability of the SRAS to confirm that it can be delivered as contracted, the calculation of SRAS payments and schedules which identify the SRAS, describe the SRAS equipment, performance levels in terms of MW output and time to deliver the output, and the minimum availability and technical requirements.

Under each SRAS Agreement, SRAS Providers must arrange annual testing to demonstrate that they are able to deliver the SRAS for which they are contracted.[163] The SRAS Provider develops the SRAS test procedure in accordance with the SRAS Guidelines. Prior to providing the test procedure to AEMO for approval, the SRAS Provider requests the TNSP to develop any SRAS system switching programss (SSP) utilised in the test procedure and obtains the endorsement of the test procedure by all parties involved in the delivery of the SRAS.[164] AEMO is required to approve the SRAS test procedure prior to the test being conducted.[165] After the SRAS test is completed, evidence of SRAS deliverability (as set out in the test procedure) is submitted by the SRAS Provider to AEMO.[166] AEMO assesses the submitted evidence of SRAS deliverability, and approves it if satisfied.

4.3.5 The System Restart Plan

AEMO is required under the NER to develop a System Restart Plan 'for the purpose of managing and coordinating system restoration activities during any major supply disruption'.[167] The NER provides the System Restart Plan is confidential.[168] AEMO considered this restriction hampered the process by which relevant participants could prepare for and participate in system restoration activities. Accordingly, the NER were amended in 2018 to allow the disclosure of the System Restart Plan to Jurisdictional System Security Coordinators, NSPs, SRAS Providers and any other Registered Participants that AEMO considers necessary for the implementation of the System Restart Plan.[169]

The System Restart Plan must be consistent with the System Restart Standard[170] but otherwise the NER set no further requirements as to what the System Restart Plan is to include.

The System Restart Plan developed by AEMO and in effect at 28 September 2016 consisted of a number of procedures which outline the system restart principles and describe the actions to be taken by AEMO and NEM participants in response to a major supply disruption.

159 Reliability Panel, *Reliability Standard and Reliability Settings Review 2014*, 16 July 2014, which decided to leave the 2013 Reliability Standard settings in place.

160 AEMO, *SRAS Guidelines*, Version 1.0, 5 September 2014.

161 NER, clauses 3.11.4A and 3.11.5 (Version 71); NER 3.11.7(d) (Version 72 onwards); AEMO, *SRAS Guidelines*, Version 1, 5 September 2014.

162 DGA Consulting, *Independent Review of System Restart Ancillary Service Process Improvements*, 30 June 2015, p. 27.

163 SRAS Agreement, Schedule 1, clause 6. References to 'SRAS Agreement' in the footnotes to this chapter are to AEMO's pro forma SRAS Agreement in effect during the 2014/15 procurement.

164 AEMO, *SRAS Guidelines*, version 1, 5 September 2014, p. 11.

165 Ibid.

166 SRAS Agreement, clause 6.3.

167 NER, clause 4.8.12(a).

168 NER, clause 4.8.12(b).

169 AEMC, *National Electricity Amendment (System Restart Plan Release Provisions) Rule 2018*, 20 February 2018.

170 NER, clause 4.8.12(c).

In its System Restart Overview document, AEMO set out the system restart principles and describes the high level roles of AEMO and NEM participants in response to a black system or major supply disruption.

AEMO then has separate Regional System Restart Procedures for each sub-network in the NEM which set outs the applicable regional System Restart Plan.

The instruments which comprised the requirements for system restoration in the South Australian region include the System Restart Overview, the specific System Restart Plan for South Australia, and the LBSPs of South Australian generators and NSPs.

The purpose of the System Restart Plan for South Australia is to identify a number of possible Restoration Options for South Australia. A Restoration Option identifies a viable corridor from an SRAS Provider or neighbouring region via an interconnector to start other generators and bring on load blocks to stabilise the frequency and voltage of the parts of the grid as they are restored.

AEMO develops the Restoration Options with reference to the LBSPs developed by generators and NSPs and submitted to AEMO for approval.

4.3.6 The Local Black System Procedures (LBSPs)

The NER define LBSPs as 'the procedures, described in clause 4.8.12, applicable to a *local area* as approved by *AEMO* from time to time'.

Under the NER:

- AEMO is to prepare Guidelines for the preparation of LBSPs (NER 4.8.12(e)).
- LBSPs are to be developed by each Generator and NSP (NER 4.8.12(d)).
- LBSPs must provide sufficient information to enable AEMO to understand the likely condition and capabilities of plant following any major supply disruption, such that AEMO is able to effectively co-ordinate the safe implementation of the System Restart Plan (NER 4.8.12(f)(1)).
- LBSPs are specifically required to be consistent with SRAS Agreements and to incorporate relevant energy support arrangements (NER 4.8.12(d), 4.8.12(f)(2)).
- In considering whether to approve LBSPs, AEMO must take into account consistency with the LBSP Guidelines and the applicable System Restart Plan (NER 4.8.12(g)).
- AEMO may request a Generator or NSP to make amendments to its LBSPs where the integrity of the applicable System Restart Plan may be compromised (NER 4.8.12(h)).

As required, on 30 March 2015 AEMO developed and published Version 2.1 of *Guidelines for the Preparation of Local Black System Procedures* (the LBSP Guidelines) which were in effect as at 28 September 2016. The LBSP Guidelines set out, in a table in the Appendices, the information to be provided to AEMO. The information covers the technical requirements and limitations in a restart environment regarding generation and network plant. The LBSP Guidelines state "AEMO will assess whether the strategies detailed in LBSPs are sufficient for the power system to be restarted to meet the System Restart Standard. If the strategies detailed in Generator and/or NSP LBSPs are not adequate, AEMO will … request changes to the strategies presented by Generators and/or NSPs as required".[171]

4.3.7 South Australian SRAS Agreements

As at 28 September 2016, there were two SRAS Agreements in place for the South Australian electrical sub-network:

- Origin Energy Electricity Limited for QPS5, which was subject to a condition precedent of a successful completion of SRAS testing by 30 June 2015.
- Synergen Power Pty Ltd for its Mintaro unit, which was subject to a condition precedent of a successful completion of SRAS testing by 3 May 2016.[172]

171 AEMO, *Guidelines for Preparing Local Black System Procedures*, Version 2.1, 30 March 2015, p. 6.

172 AEMO, Final Report, p. 78. Note: Synergen Power is jointly owned by ENGIE Australia (72 per cent) and Mitsui & Co Ltd (28 per cent).

Box 1: Events of 28 September 2016 in relation to QPS5 and Mintaro SRAS

- At 16:18 hrs on 28 September 2016 ENGIE, Mintaro's operator, reported to AEMO that the emergency diesel generator tripped after 15 seconds of operation due to a stator earth fault which had severely damaged the diesel generator. Mintaro SRAS was bid unavailable by the operator from 18:30 hrs on 28 September 2016.[173] Hence the 80 MW of SRAS contracted between AEMO and Synergen Power was not available from Mintaro should AEMO have required it.
- At 16:30 hrs, following the declaration of black system conditions by AEMO, AEMO in conjunction with ElectraNet determined a system restoration strategy. The system restoration strategy consisted of using the Heywood Interconnector to provide auxiliary supplies to SA power stations and high priority loads, and to use the QPS5 SRAS to provide auxiliary supplies to South Australian power stations.[174]
- At 16:32 hrs, AEMO activated the SRAS Agreement with Origin to energise QPS5 and requested that QPS1 come on at minimum load at 16:37 hrs.[175]
- At 16:46 hrs, ElectraNet closed the final circuit breaker, in the sequence connecting QPS1 to QPS5. The circuit breaker tripped open. ElectraNet attempted to reclose the circuit breaker five times unsuccessfully. The stored energy for operating the circuit breaker was depleted on the third attempt, requiring manual intervention to close the circuit breaker. Due to the alternate interconnector path being re-instated, and inclement weather, field crews did not attend the site to reclose the open circuit breaker until 11:00 hrs on 29 September 2016.[176] Hence the 120 MW of SRAS contracted between AEMO and Origin was not available from QPS5.

4.3.8 Restoration Options in South Australia

The System Restart Plan for South Australia sets out possible Restoration Options. Any one or more of the Restoration Options may be used according to what is feasible in the conditions.[177] During the System Restoration period, AEMO and ElectraNet agreed that in the circumstances they faced, using QPS as SRAS (Restoration Option 1) in parallel with importing power from Victoria utilising the Heywood Interconnector (Restoration Option 2) was optimal. AEMO said that " …this was the quickest and safest way to restore supply to SA, and allowed segregation between restart paths to provide another level of redundancy, in case one method encountered difficulties".[178]

4.4 SRAS deployment during the System Restoration period

Once AEMO has declared a black system condition, it determines the cause of the event and assesses the status of the power system together with the relevant TNSP. AEMO, together with the TNSP, then develops a restoration strategy and activates the required SRAS Agreements.

Box 1 above provides an overview of events on 28 September 2016 (the System Restoration period).

During the System Restoration period, Origin was required to comply with a number of obligations including that it follow AEMO's instructions, and comply with the relevant provisions of its SRAS Agreement and its LBSP. On review of Origin's actions, we consider Origin did fulfil such obligations. Below is our analysis of each of these obligations.

While Mintaro was also not available during the System Restoration period, we note that the likely cause of this was lightning damage[179] and AEMO's advice that Mintaro was neither needed nor called upon. We have therefore not explored further whether Synergen could have taken additional steps to comply with its obligations under its SRAS Agreement.

4.4.1 Relevant NER provisions and assessment

Clause 3.11.1(d)—compliance with AEMO's instructions

AEMO may instruct a person to provide a non-market ancillary service (which includes SRAS) under an ancillary services agreement or otherwise in accordance with the relevant performance standards, and any person so instructed must use reasonable endeavours to comply with that instruction.

173 AEMO, *Update Report—Black System Event in South Australia on 28 September 2016* ("AEMO, Update Report"), 19 October 2016, p. 29.

174 AEMO, *Black System South Australia 28 September 2016—Third Report* ("AEMO, Third Report"), 7 December 2016, p. 60.

175 AEMO, Final Report, p. 183.

176 AEMO, Third Report, p. 68; AEMO, Update Report, p. 29.

177 AEMO also notes that it may be necessary to modify a Restoration Option to account for conditions.

178 AEMO, Final Report, section 4.2.

179 AEMO, Final Report, p. 80.

In relation to clause 3.11.1(d) we assess that Origin, as the contracted SRAS Provider for QPS5, complied with AEMO's instruction to use its reasonable endeavours to comply with that instruction. As detailed above, AEMO activated the SRAS Agreement at 16:32 hrs on 28 September and requested that QPS come on at 16:37 hrs.[180] The system switching program (SSP) provided by ElectraNet indicates that Origin was following the procedures in relation to QPS1 up to when the circuit breaker opened, causing QPS5 to be unable to start.

Clause 3.11.9(d)—compliance with ancillary services agreement

Clause 3.11.9(d) requires that a SRAS Provider must comply with an ancillary services agreement under which it provides one or more system restart ancillary services.

With respect to clause 3.11.9(d) we assess that the clauses of the SRAS Agreement which are relevant during an SRAS event are cls.4(c) and 5.2(a) and Schedule 2, item 5(b):

- Under cl.4(c) 'the SRAS Provider must use all reasonable endeavours to provide SRAS in accordance with this Agreement when requested by AEMO'.

  For the reasons set out in relation to NER clause 3.11.1(d) we conclude that during the System Restoration period Origin took all practical steps to implement AEMO's instructions as required under cl.4(c) of the SRAS Agreement.

- Under cl.5.2(a) of the SRAS Agreement, the SRAS Provider must notify AEMO immediately if the SRAS Provider considers that an SRAS is unavailable.

  AEMO, ElectraNet and Origin were in communication during the restart process. AEMO was therefore aware of the status of the QPS5 SRAS between 16:37 hrs (initiation of the SRAS) and 18:43 hrs (abandonment of further attempts to utilise the SRAS) on 28 September 2016. AEMO stated that Origin formally bid QPS5 unavailable at 22:00 hrs on 28 September 2016. It was bid available again at 11:00 hrs on 29 September 2016 following reset of the circuit breaker by ElectraNet, although the cause of the failure to energise QPS5 was ascertained later.

  We assess that, during the time that AEMO, ElectraNet and Origin were together working towards deploying QPS5, the communications between them reveal that all parties were aware of the issues almost contemporaneously with the issues being detected and investigated. Accordingly, in our assessment Origin notified AEMO immediately of the unavailability of QPS5, as required under cl.5.2(a) of the SRAS Agreement.

- Under Schedule 2, item 5(b) of the SRAS Agreement, upon notification from AEMO that a major supply disruption has occurred, the SRAS Provider must initiate the SRAS equipment to be ready to commence sending out energy.

  For the reasons set out in relation to NER clause 3.11.1(d), above, it is our assessment that Origin acted as required under Schedule 2, item 5(b) of the SRAS Agreement.

Clause 4.8.14(b)—compliance with local black system procedures

Clause 4.8.14(b) requires that a generator or NSP, on the advice of AEMO, must comply with the requirements of the LBSPs as quickly as is practicable.

We assess that Origin and Synergen (regarding Mintaro) followed their respective LBSPs as quickly as was practicable. We base this assessment on advice received from AEMO.

Clause 4.9.3A(d)—appropriate personnel or electronic facilities to be available

Clause 4.9.3A(d) requires that a Non Market Ancillary Services (NMAS) provider with whom AEMO has an ancillary services agreement must ensure that appropriate personnel or electronic facilities are available in accordance with that agreement at all times to receive and immediately act upon dispatch instructions issued to that NMAS provider by AEMO.

We conclude that Origin had in place appropriate personnel and electronic facilities available to receive and immediately act upon dispatch instructions issued by AEMO. We based our assessment on:[181]

- the transcripts of the exchange between AEMO and ElectraNet, which indicate that Origin was appropriately following the SSP steps for restart of the system
- information provided by ElectraNet and AEMO, which indicate that Origin was following the appropriate steps for restart of the system, and
- confirmation from AEMO that it had no concerns regarding compliance with this provision.

180 AEMO, Final Report, p. 183.

181 AEMO, Final Report, pp. 183-185, *inter alia*.

Findings

Based on the above, we find that Origin met the requirements for SRAS deployment under the NER. Our findings are fully discussed in the Findings, recommendations and AER actions section (section 4.15) at the end of this chapter.

4.5 Switching sequence during the System Restoration period

Origin's failure to provide the contracted SRAS from QPS5 was a result of the incompatibility of the switching sequence used by ElectraNet with certain protection settings of the unit. The sequence was different to what had been used during QPS5's SRAS tests.

4.5.1 Switching sequence used by ElectraNet on 28 September 2016

AEMO is required in System Restart Plans to identify potential Restoration Options for each electrical sub-network to manage and coordinate system restoration during a major supply disruption.[182] Any one or more of the Restoration Options may be used according to what is feasible in the conditions.[183] To begin system switching quickly following a major supply disruption, the TNSP (ElectraNet) develops detailed switching procedures (the System Restart SSPs) for each of these Restoration Options in advance.

During the System Restoration period, AEMO and ElectraNet agreed that in the circumstances they faced, the optimal decision combined use of QPS as SRAS (Restoration Option 2) in parallel with importing power from Victoria via the Heywood interconnector (Restoration Option 1).[184] Accordingly, the Origin SRAS Agreement was activated by AEMO and ElectraNet utilised its prepared System Restart SSP for Restoration Option 2 (SSP Restart 2). As part of that plan, QPS1 was started in order to start the largest QPS unit which then provides SRAS to other power stations. For QPS1 to supply power to QPS5, a number of circuit breakers must be closed to create a path between the two units. Most of these circuit breakers are located in the Torrens Island 66 kV switchyard and are owned and operated by ElectraNet.[185]

The switching sequence for the QPS units implemented on the day as set out in "SSP Restart 2", involved starting QPS1 before closing circuit breakers to QPS5. This is described as a "hard start".[186] As a consequence of this, an unexpected inrush current was detected by QPS5 plant and protection was triggered, opening a circuit breaker. The operation of these protection settings meant that QPS5 could not be energised and so could not deliver the contracted 120 MW of SRAS as part of Restoration Option 2. In fact, QPS5 at that time required a "soft start" or gradual energisation of its ancillary plant.

4.5.2 Difference between the 28 September and SRAS testing switching sequences

The SRAS Agreements in effect in 2016 required the SRAS Provider to undertake an SRAS test, at least once a year, to demonstrate that the SRAS was available in the event of a major supply disruption. The SRAS test must be carried out according to a SRAS test procedure that incorporates detailed switching procedures, the SRAS test SSP.

The switching sequence used in the System Restart SSP on 28 September 2016 differed from that used during the most recent QPS5 SRAS test on 21 May 2016. Origin scheduled its annual QPS5 SRAS testing for 21 May 2016, and organised ElectraNet to generate the SRAS test SSP for the test. The Origin Engineering Report submitted to AEMO for approval afterwards shows that the switching sequence used during the test first created a pathway between QPS1 and QPS5 by closing circuit breakers and then started QPS1 gradually. This sequence resulted in a gradual increase in current or a "soft start" of QPS5 ancillary plant. Ultimately this allowed QPS5 to start and begin generating.

Origin reported that the relevant protection settings had been in place since 2009 when QPS5 SRAS was first contracted. Origin stated, and ElectraNet confirmed, that the QPS5 SRAS test SSP had not materially changed between those developed in 2009 and those used in May 2016. All procedures utilised a soft start. Origin also stated that "ElectraNet had no involvement in developing, reviewing, approving or endorsing the QPS SRAS test procedure …. ElectraNet's role was to develop an SSP to enable Origin to carry out switching on ElectraNet's transmission network to facilitate Origin's SRAS testing".

Origin stated that "[p]rior to 28 September 2016 Origin was not aware that [SSP Restart 2] was different from the QPS5 SRAS test SSP used for" the test conducted on 21 May 2016 or any prior tests.

182 Clause 4.8.12(a) provides that 'AEMO must prepare, and may amend, a System Restart Plan for the purpose of managing and coordinating system restoration activities during any major supply disruption'. A 'System Restart Plan' is defined in Chapter 10 as '[t]he plan described in clause 4.8.12(a)'.

183 AEMO also notes that it may be necessary to modify a Restoration Option to account for conditions.

184 AEMO, Final Report, section 4.2.

185 AEMO, Final Report, p. 78.

186 AEMO, Third Report, p. 69.

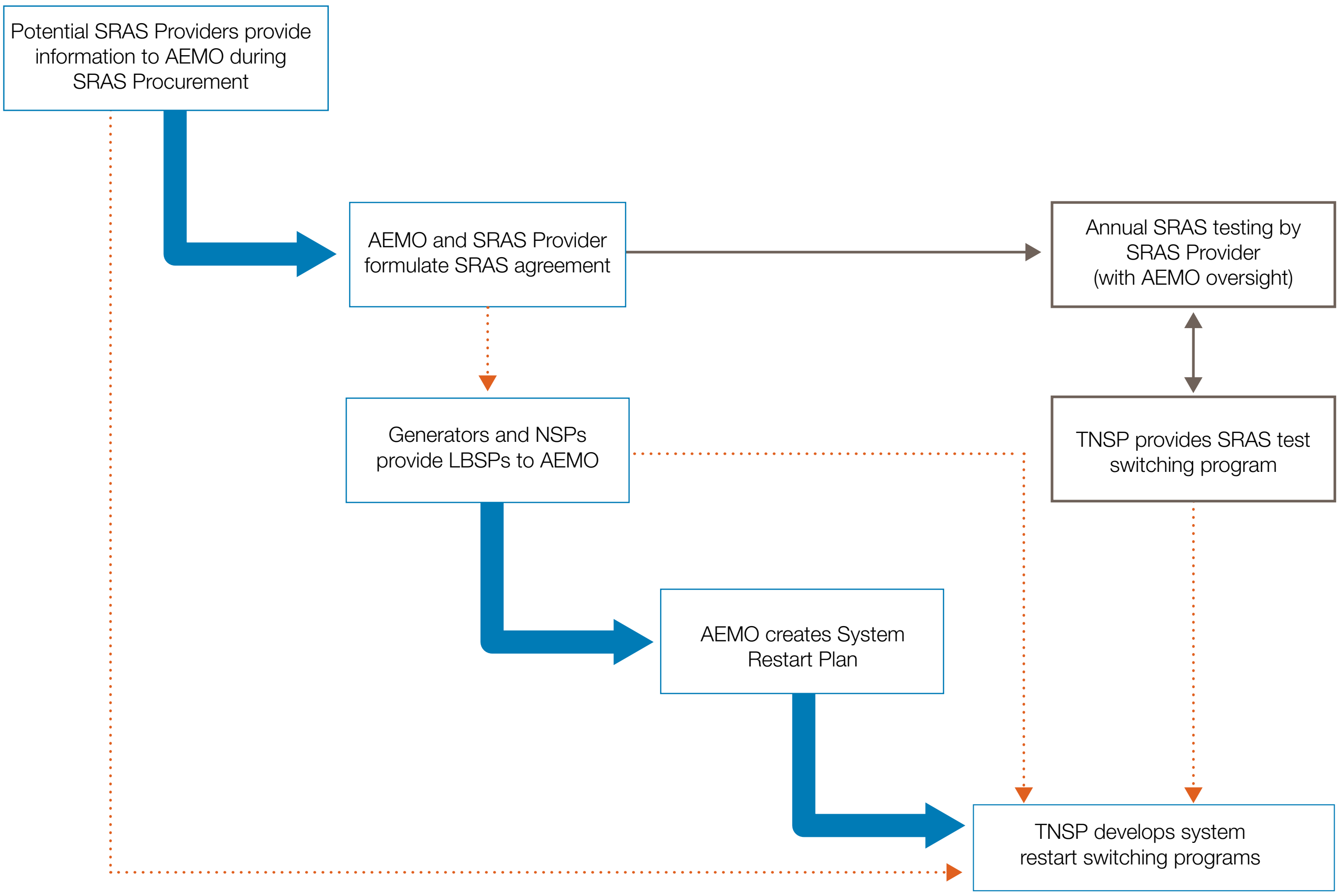
4.5.3 Development of Switching Programs

As set out in Figure 1, there are a number of steps leading to the development of system switching programs (SSP). These include:

- SRAS Agreements are entered into between AEMO and SRAS Providers.
- LBSPs are prepared by each generator and Network Service Provider and are to be approved by AEMO. These LBSPs are to be consistent with AEMO's LBSP Guidelines and any ancillary service agreements.
- AEMO uses the information provided in the LBSPs and the SRAS Agreements to prepare its System Restart Plan for the relevant region. The System Restart Plan consists of a series of Restoration Options.
- The TNSP operationalises the Restoration Options by developing System Restart SSPs for each Restoration Option.

We consider each of these steps and interlinkages in sections 4.6 to 4.10 below to assess whether there was compliance with relevant obligations and identify any deficiencies in the relevant process.

Figure 1 Steps and interlinkages of SRAS



Source: AER

Notes: The solid blue arrow indicates that information was provided from one part of the process as an input into another part of the process.
The broken red arrow indicates that information was not provided from one part of the process as an input into another part of the process.

4.6 SRAS Procurement

The first step in SRAS is AEMO's procurement of sufficient SRAS to meet the System Restart Standard. This section assesses the process undertaken by AEMO to contract the SRAS in place in South Australia as at 28 September 2016.

4.6.1 SRAS procurement process

Under the NER, AEMO must make reasonable efforts to acquire SRAS that meet the System Restart Standard at the lowest cost.[187] As outlined above, the System Restart Standard is determined by the Reliability Panel to meet the requirements of the NER.[188] Specifically, the System Restart Standard identifies the maximum amount of time that SRAS Providers are allowed to take to restore a specified supply level target.[189]

Section 4.3.3 of this chapter sets out the System Restart Standard in place for the 2015-2018 period. The restoration timeframe represents the 'target timeframe' to be used by AEMO in the procurement process. It is not a specification of any operational requirement that should be achieved in the event of a black system condition.

In accordance with the NER and the System Restart Standard, the SRAS service must meet a 90% reliability requirement for a primary service. AEMO will calculate a prospective service provider's facility reliability to determine if this requirement is met. There is no requirement to have further redundancy measures in place in the event that the SRAS equipment in place under SRAS Agreements are unavailable following a black system event. That is, the SRAS facilities are only expected to be available 90% of the time.

As set out below, AEMO must produce SRAS Guidelines which outline a number of elements relating to the procurement of SRAS.[190] AEMO then undertakes a two stage SRAS tender process whereby expressions of interest are first sought and then AEMO issues invitations to tender, after which AEMO enters into contracts with the successful SRAS tenderers.[191]

In the case of South Australia, we assessed two procurement processes for the South Australia sub region undertaken by AEMO, one as part of the NEM-wide procurement round in 2014/15 (NEM-wide SRAS procurement) when it entered into an agreement with Origin (QPS) and Alinta (Northern Power Station); and another South Australia-specific procurement process in May 2016, following which it entered into an SRAS Agreement with Synergen Power (Mintaro). The latter process occurred due to the exit of Northern Power Station as a contracted SRAS Provider when it closed.

As set out below, due to the timing of each procurement process the rule requirements differed as to how AEMO was required to procure the services. The discussion below relates to the NER obligations in effect when AEMO finalised the SRAS Guidelines in September 2014 and which applied during the 2014/15 NEM-wide SRAS procurement. It also relates to the initial procurement of Origin's Quarantine power station as a SRAS Provider in 2009, where relevant to the 2014/15 procurement. We have also taken into account the substantial changes to the NER clauses governing SRAS procurement which took effect from 1 July 2015 and which applied at the time that AEMO conducted its 2016 procurement process.

4.6.2 The SRAS Guidelines (2014)

The SRAS Assessment, Quantity and Tender Guidelines each formed part of the SRAS Guidelines (2014) and were guided by the NER requirements which encompassed both the tender process applicable to all non-market ancillary services,[192] as well as additional requirements particular to the acquisition of SRAS.[193]

Box 2 below sets out relevant content of the SRAS Guidelines (2014), which were in effect during the 2014/15 procurement round and the key milestones during that process.

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187 NER, clause 3.11.7(a1).

188 The relevant system restart standard took effect on 1 August 2013; NER clause 8.8.3 (aa) (Version 49).

189 NER, clause 8.8.3(aa) (3) (Version 49).

190 AEMO, *SRAS Guidelines for System Restart Ancillary Services* ("AEMO, SRAS Guidelines"), Version 1.0, 5 September 2014.

191 AEMO, SRAS Guidelines pp. 26, 27–28.

192 Defined as *network support and control ancillary services*, *system restart ancillary services* and other services acquired by *Transmission Network Service Providers* under *connection agreements* or *network support agreements* to meet the service standards linked to the technical requirements of schedule 5.1 or in applicable regulatory instruments. NER Chapter 10 Glossary (Version 64).

193 The SRAS Tender Guidelines are at section 7 of the SRAS Guidelines.

Box 2: AEMO acquisition of SRAS during 2014/15

AEMO finalised its SRAS Guidelines (2014) on 5 September 2014. The SRAS Guidelines (2014) contain a number of other documents that AEMO was required to publish, including the SRAS Tender Guidelines. The SRAS Tender Guidelines provided for a two-stage tender process: the expression of interest, and the invitation to tender[194] and included pro forma schedules for each of these as well as the SRAS Agreement.[195] At both the expression of interest and tender stages, the SRAS tenderer was required to provide data, models and parameters of relevant plant.[196]

The SRAS Tender Guidelines at section 7.3 reference the NER requirements that the Guidelines must impose an obligation on a NSP or other Registered Participant to assist an SRAS Provider to identify and, if possible, resolve issues that would prevent the delivery of effective SRAS.[197] It also sets out AEMO's interpretation of NER 3.11.5(f)(1): AEMO expects NSPs to negotiate in good faith with SRAS Providers on any issues pertinent to the provision of SRAS which an SRAS Provider wishes to discuss and resolve with that NSP.[198]

The pro forma Expression of Interest at clause 3.1 stated that 'the Recipient must provide evidence establishing that appropriate agreements or principles are in place, or agreed in principle, with the relevant NSP and owner of the SRAS equipment to permit delivery of the Service in accordance with the levels of performance detailed in Schedule 2'.[199]

Schedule 4.2 set out the modelling data that a tenderer must submit as part of its EOI.[200]

At section 4.3 of the SRAS Guidelines (2014), AEMO set out the power system studies it would undertake. Two of the reasons given for undertaking the power system studies were to:[201]

- "determine potential changes to operating modes and/or control system settings of the SRAS equipment", and
- "determine necessary changes to the settings of protective relays for the SRAS equipment and transmission network in the energisation path".

The SRAS Assessment Guidelines section set out the SRAS test requirements, including the parameters to be demonstrated.[202] It also detailed the information to be included in the test report, which must be submitted to AEMO for approval.[203]

The terms and conditions of the ancillary services agreement that a successful tenderer would be expected to enter into were provided in the pro forma SRAS Agreement at Schedule 7.3.[204]

The pro forma Invitation to Tender set out at clause C.12 that changes may be proposed by the tenderer to the pro forma terms and conditions of the SRAS Agreement and AEMO may amend the terms of the SRAS Agreement where appropriate.[205]

AEMO called for expressions of interest on 5 September 2014, issued invitations to tender on 16 February 2015, advised successful tenderers by 15 May 2015 and finalised all contracts in that procurement round by 30 June 2015.[206]

194 AEMO, SRAS Guidelines, pp. 26-27.
195 AEMO, SRAS Guidelines, p. 28.
196 AEMO, SRAS Guidelines, pp. 26, 27-28.
197 AEMO, SRAS Guidelines, pp. 27-28.
198 AEMO, SRAS Guidelines, pp. 11-12.
199 AEMO, SRAS Guidelines: Schedule 7.1—SRAS—Expression of Interest—EOI.pdf, p.12.
200 AEMO, SRAS Guidelines, p. 15.
201 AEMO, SRAS Guidelines, p. 10.
202 AEMO, SRAS Guidelines, pp. 11-14.
203 AEMO, SRAS Guidelines, pp. 11-12.
204 NER version 64, clause.3.11.5(b)(8), NER version 93, clause 3.11.7(d)(3).
205 AEMO, SRAS Guidelines: Schedule 7.2—SRAS-Invitation-to-Tender-ITT.pdf, p. 8–9, 11.
206 AEMO, System Restart Ancillary Services 2015 Tender Process Report, 2 July 2015, p. 5.

4.6.3 Relevant NER provisions and assessment

As noted above, due to the timing of the two separate SRAS procurements for South Australia, there were different rule requirements for each process. The relevant NER versions are outlined and assessed in sequence below.

2014/15 NEM-wide SRAS procurement

Set out below are relevant obligations[207] at the time of the NEM-wide SRAS procurement.

- Clause 3.11.4A(b) required AEMO to use reasonable endeavours to acquire SRAS in accordance with 3.11.4A (including the SRAS objective[208]).
- Pursuant to clause 3.11.4A, AEMO must have in place SRAS Guidelines relating to a number of elements of the procurement process. These included:
  - a detailed description of the SRAS service (3.11.4A(d))
  - the potential facility provider assessment framework, including the modelling and assessment of technical capabilities, physical testing and any other analysis AEMO considers appropriate (3.11.4A(e)), and
  - procedures for determining the number, type and location of the SRAS required for a sub-network consistent with the Standard. (3.11.4A(f))
- Clause 3.11.4A(c) required that the SRAS Guidelines be:
  - consistent with the SRAS objective
  - designed to meet the System Restart Standard, and
  - designed to ensure that the need for SRAS is met, to the extent that it is practicable and reasonable to do so, by AEMO entering into agreements for the provision of primary restart services.
- Clause 3.11.5(a1) required AEMO to call for offers to acquire SRAS from persons in a position to provide SRAS (as a relevant non-market ancillary service) in accordance with the tender guidelines.
- Clause 3.11.5(b) required AEMO to determine and publish tender guidelines for SRAS (as a relevant non-market ancillary service) which contained requirements that:
  - AEMO call for expressions of interest followed by an invitation to tender[209] and set out the principles it will apply in assessing these[210]
  - AEMO include the proposed terms and conditions of the SRAS Agreement[211]
  - a contracted SRAS Provider has the service tested within specified timeframes[212]
  - a NSP or other Registered Participant assist a prospective SRAS tenderer to identify and resolve, where possible, issues that would prevent the delivery of SRAS,[213] and
  - an SRAS tenderer provide data, models and parameters of relevant plant to facilitate a thorough assessment of the proposed SRAS.[214]
- Clause 3.11.5(f) required a NSP to negotiate in good faith with a prospective tenderer of NMAS and participate in or facilitate the testing of SRAS (of the prospective tenderer) as required by the NMAS tender guidelines where it is reasonable and practicable to do so. Relevantly this obligation was in effect in the same form in 2009.

2016 South Australia SRAS procurement

For the 2016 procurement process, AEMO was again required to procure SRAS to meet the System Restart Standard but under different rule requirements including the following:

- Clause 3.11.7(a1) requires AEMO to use reasonable endeavours to acquire SRAS to meet the System Restart Standard at the lowest cost (the SRAS Procurement Objective).
- Clause 3.11.9(a) requires that, if AEMO proposes to acquire SRAS, AEMO must enter into an ancillary services agreement with a prospective SRAS Provider following the completion of any procurement process to acquire SRAS which AEMO is satisfied will enable it to meet the SRAS Procurement Objective.

Assessment of SRAS procurement compliance—AEMO

SRAS Guidelines (2014) and NER clause 3.11.5(b); NER clause 3.11.4A(d) (Version 64)

We assess that the SRAS Guidelines (2014) as prepared by AEMO met the requirements of the NER set out in clauses 3.11.5 and 3.11.4A. The Guidelines set out each of the elements in 3.11.5(b) (see box 2).[215]

207 Version 71 of the NER as at finalisation of the procurement process; Version 64 as at the publication of the SRAS Guideline.

208 Clause 3.11.4A defined the SRAS objective as follows: to minimise the expected economic costs to the market in the long term and in the short term, of a major supply disruption, taking into account the cost of supplying system restart ancillary services, consistent with the national electricity objective.

209 NER, clause 3.11.5(b)(1).

210 NER, clause 3.11.5(b)(7).

211 NER, clause 3.11.5(b)(6).

212 NER, clause 3.11.5(b)(2) and (4).

213 NER, clause 3.11.5(b)(3).

214 NER, clause 3.11.5(b)(5).

215 NER, clause 3.11.5(b).

Further to this, we have no evidence to indicate that the procurement process undertaken by AEMO in relation to SRAS to be provided by Origin did not adhere to the SRAS Guidelines and the tender process set out in the Guidelines.[216] For example, Origin did provide data, models and the parameters of its relevant plan. As AEMO entered into the SRAS Agreement with Origin, this information provided by Origin appears to have been sufficient for AEMO's purpose: 'to facilitate a thorough assessment of the proposed SRAS'.

2014/15 SRAS Procurement and NER clause 3.11.5(a1) and (b); NER clause 3.11.4A(d) (Version 64)

AEMO initially procured SRAS for South Australia as part of the NEM-wide procurement round for the 2015–2018 period, which was conducted in 2014/15. The resulting SRAS Agreements which were in place on 28 September 2016 applied to SRAS services up until June 2018.

In accordance with the NER and SRAS Guidelines (2014), AEMO issued a call for expressions of interest (EOI) on 5 September 2014. Of the six EOIs received, AEMO provided an invitation to tender to three market participants that AEMO considered suitable to fulfil the SRAS requirements.

As a part of this assessment process, AEMO undertook modelling of the proposed tenderers to determine the optimal service capabilities. For this process, the modelling had changed from previous procurement rounds. Along with the modelling encompassing technical characteristics of the generators, the transmission network and relevant protection systems, the modelling also included an assessment of power system voltages along the SRAS path and dynamic and/or transient stability. We note that AEMO also had DGA Consulting review the modelling and assessment framework.[217]

Based on the modelling and assessment framework and the further DGA Consulting review assessment, AEMO in its 2015 selection process appropriately ranked the tenders according to their service capabilities for the SA sub network.

In accordance with its selection methodology, AEMO awarded two SRAS Agreements to Alinta (Northern Power Station) and Origin (Quarantine Power Station). According to the information provided to us by AEMO, the resulting arrangements for the provision of SRAS by these SRAS Providers met the System Restart Standard requirements for South Australia and provided the least-cost option based on the tenders it received.

Accordingly AEMO met the procurement objective of reasonable endeavours to procure SRAS in accordance with the NER and the procurement process set out in AEMO's SRAS Guidelines (2014).

2016 SRAS Procurement—NER clauses 3.11.7(a) and 3.11.9(a) (Version 79)

At the time of the 2016 procurement the NER relating to SRAS procurement had been changed. At this point in time, following a rule change, a new SRAS Guideline was to be prepared by AEMO. [218] This was to include provision for AEMO to contact potential SRAS Providers directly to negotiate for the provision of SRAS.[219] However, under transitional provisions of the NER, AEMO was only required to develop and publish the new Guideline once the System Restart Standard was revised.[220]

In early 2016, with the pending closure of Northern Power Station, AEMO was required to use reasonable endeavours to acquire new SRAS to meet the System Restart Standard at the lowest cost[221] to meet the service shortfall. Relying on internal modelling conducted during the initial 2015 bulk procurement, AEMO undertook internal analysis which would provide guidance as to which market participants may be able to provide SRAS in the SA sub-region. Following subsequent discussions with prospective providers, AEMO initially considered several power stations, including Mintaro, as viable candidates to supplement the Quarantine SRAS Agreement.

AEMO ultimately determined that Mintaro was the only viable generator within South Australia that could provide SRAS in conjunction with Quarantine. AEMO has stated that Mintaro was selected to extend the Quarantine restart path by providing network capability and support for the northern area of the network. In AEMO's view, by having Mintaro provide SRAS, other power stations supplying the region could commence generating sooner than would otherwise be possible. This capability meant that the System Restart Standard could be achieved in the South Australia sub-region.

In accordance with the SRAS procurement objective under clause 3.11.7(a1), AEMO must use reasonable endeavours

216 NER, clause 3.11.5(a1).

217 DGA Consulting, *Independent Review of System Restart Ancillary Service Process Improvements*, 30 June 2015.

218 Clause 3.11.7(d)(6) of the the NER (V 79). Version 79 of the NER included rules changes that commenced on 1 July 2015 following the AEMC's Final Determination of 2 April 2015: National Electricity Amendment (System Restart Ancillary Services) Rule 2015.

219 The new SRAS Guideline, when made, was to set out a number of elements relating to procurement of SRAS, including AEMO's approach to bilateral procurement of SRAS.

220 NER, clause 11.81.3.

221 As required under clause 3.11.7(a1) (V 79).

to acquire SRAS to meet the System Restart Standard at the lowest cost.[222] With the Quarantine SRAS Agreement in place, Mintaro was the only SRAS facility that could provide a service that could contribute to achievement of the System Restart Standard in South Australia.

We therefore consider that AEMO complied with the SRAS Objective (as it then was) and used reasonable endeavours to determine the most appropriate SRAS Provider. We accept that there were limited SRAS facility options available to AEMO in South Australia at the time, and AEMO took reasonably practicable steps to assess the available options by working with potential service providers. We therefore assess that AEMO complied with the obligations under clauses 3.11.7(a1) and 3.11.9(a) of the NER and otherwise complied with the NER requirements governing procurement.

Assessment of SRAS procurement compliance—Origin

We have reviewed the process by which Origin participated in the SRAS procurement, including whether the soft start requirements were identified and, if so, how that information was used. The tender process commenced under the existing provisions of 3.11.4A and the SRAS Guidelines at that time.[223]

As explained below, the procurement steps where the technical requirements relating to QPS possibly could have been identified include:

- during the provision of data by Origin in fulfilling the expression of interest (EOI) and invitation to tender (ITT) requirements and by AEMO when modelling the impacts of all relevant protection settings, and
- modification of the SRAS Agreement terms and conditions to reference the 'soft start' requirement.

Information from the EOI and ITT submissions and AEMO modelling of the impacts of the protection settings

Origin set out 'the procedure to complete the System Restart', including the description of the soft start, in its EOI submission for the 2014-15 SRAS procurement round.

AEMO acknowledges that a soft start was described in Origin's EOI. AEMO stated that it did not consider that using a soft start posed an issue with regard to providing restart services.

As described in box 2 above, AEMO states that it models the control system settings of the SRAS equipment and examines the settings of protective relays for the SRAS equipment and transmission network in the energisation path. However, AEMO stated that protections are modelled only for the interface between the generating system and the transmission network. This means that not all ancillary plant (and its associated protection) connected to an internal network (such as the QPS5 equipment requiring the soft start) was modelled by AEMO.

In the circumstances of QPS5, it is apparent that information that was important to the delivery of SRAS came to light during the procurement process.

Modification of the SRAS Agreement terms and conditions

In the Expression of Interest stage of the procurement process, tenderers are required to indicate 'yes/no' to the following two questions:

> 'Does the SRAS equipment have appropriate network controls and protection systems in place to avoid the SRAS equipment adversely affecting power system restoration, including the ability to control voltage and frequency?'
>
> 'Does the SRAS equipment have any restrictions or limitations that have the potential to adversely affect power system restoration?'[224]

The pro forma SRAS Agreement required the specification that the equipment had appropriate network controls and protection systems in place and there were no restrictions or limitations that had the potential to adversely affect power system restoration.[225]

The SRAS Guidelines and the EOI material did not include any specific guidance to a prospective tenderer as to what information might be relevant to answering these questions. The responsibility for understanding these questions was placed on the tenderer.[226] AEMO considers this was consistent with the Rules' concept of SRAS as a commercial service. AEMO considers it reasonable to expect a tenderer for a service to understand the purpose and application

222 Version 72 of the NER onwards.

223 AEMC, *Final Determination of 2 April 2015: National Electricity Amendment (System Restart Ancillary Services) Rule 2015*, p. 97. They included that a prospective SRAS provider submit as part of its tender modelling and assessment of the technical capabilities of the proposed SRAS and that it be tested in accordance with the tender guidelines.

224 AEMO, SRAS Guidelines: Schedule 7.1—SRAS—Expression of Interest—EOI.pdf, Schedule 3, clause 3, p. 13.

225 AEMO, SRAS Guidelines: Schedule-7.1—SRAS-Agreement.pdf, p. 28, clause 4(c)(iv) and clause 4(c)(ix).

226 AEMO, SRAS Guidelines: Schedule 7.1—SRAS—Expression of Interest—EOI.pdf, p. 5. C.2 Recipients to Inform Themselves—By submitting an EOI, a Recipient is taken to have: carefully examined and satisfied itself of the requirements of this Request for EOI; examined all information relevant to the risks, contingencies and other circumstances relevant to the Services, as may be available by making reasonable enquiries; and satisfied itself as to the correctness and sufficiency of the EOI.

of that service and the capability and limitations of its own equipment.

On the basis of the following, it may be considered reasonable for Origin to have formed the view that the soft start requirement would:

6. when combined with the protection settings, constitute an appropriate protection system because the lower voltage would limit the inrush current to prevent an inadvertent protection operation, such that the power system restoration is not adversely affected, and/or
7. not constitute a restriction or limitation that has the potential to adversely affect power system restorations because:
   a. Origin had successfully demonstrated in annual SRAS testing from 2009 that it could meet the SRAS contractual requirements using a substantially identical test procedure and SSP which employed a soft start
   b. AEMO had annually approved these test procedures and ElectraNet had carried out the switching, and
   c. the exposure of the soft start to other parties, namely AEMO and ElectraNet, without any exploration of its use or any request to alter it by these parties, could reasonably be interpreted by Origin to indicate acceptance that the controls and protection systems used in providing QPS5 SRAS were appropriate and that the SRAS equipment did not have any adverse restrictions or limitations.

In addition, a tenderer is to include the minimum technical requirements as set at Schedule 4.3 of the pro forma SRAS Agreement including any marked up changes.[227] However, other than these minimum requirements, there is no express requirement for a tenderer to include any information or documentation on plant specific technical requirements.

The Origin SRAS Agreement mirrored the pro forma terms and conditions. However, as discussed above, it may not be apparent to the SRAS tenderer that its proposed SRAS provision poses any likelihood of adversely affecting power system restoration or that the technical requirements of the SRAS equipment are such that they should be separately specified.

There is some specification of technical requirements and limitations in relation to SRAS equipment included in Origin's SRAS Agreement, although it does not appear to be exhaustive. In particular, the QPS5 soft start requirement is not specified in the SRAS Agreement. AEMO stated that it does not 'think it appropriate to specify processes in an agreement between AEMO and the SRAS Provider that AEMO does not and cannot verify'.

We accept AEMO's view that the SRAS Provider has knowledge and expertise that AEMO ought to be able to rely upon without undertaking independent verification. However, as AEMO is the system operator with responsibility to procure sufficient SRAS and plan and oversee power system restoration activities, we consider more detailed information would potentially enable AEMO to better identify potential risks and ensure appropriate mitigation strategies are in place.

We consider the new SRAS Guideline (2017) and pro forma SRAS Agreement go a material way towards ensuring that technical information about a SRAS is clear. AEMO could also consider requiring, as part of the SRAS Agreement, that plant specific technical requirements be specified, in addition to the location and components of SRAS equipment. This could then be cross-checked with the applicable LBSPs to ensure all technical information regarding an SRAS Provider is captured and shared with the TNSP.

Assessment of SRAS procurement compliance—ElectraNet

During SRAS procurement, NSPs have obligations regarding negotiation with, and facilitating testing of, prospective SRAS Providers. We examined ElectraNet's compliance with these obligations as it related to Origin as a prospective SRAS Provider using QPS5. We considered the 2015/16 procurement of Origin and also information before us regarding the 2009 procurement process, when QPS5 was first contracted to provide SRAS.

NSP Obligations and NER clauses 3.11.5(f)(1) and (2) (Version 71)

Clause 3.11.5(f)(1) required a NSP to negotiate in good faith with a prospective tenderer of NMAS to resolve issues of a kind set out in the NMAS guidelines. The clause does not explicitly state whether a particular (or either) party was expected to initiate the negotiations. However, given:

- the reference to the 'issues that NMAS tender guidelines require a prospective tenderer to discuss and, if possible, resolve with a Network Service Provider, and
- that AEMO's SRAS Guidelines set out that AEMO expected NSPs to negotiate in good faith with SRAS Providers on any issues pertinent to the provision of SRAS which an SRAS Provider wishes to discuss and resolve with that NSP,

it appears that the prospective SRAS tenderer would initiate contact with the NSP. Accordingly the NSP was required to negotiate in good faith if the prospective tenderer had initiated contact and sought to discuss and resolve identified issues.

227 AEMO, SRAS Guidelines: Schedule 7.2—SRAS-Invitation-to-Tender-ITT.pdf, pp. 8-9, 11.

The SRAS Guidelines (2014) included AEMO's stated expectation, based on the obligation in the NER, that a NSP will negotiate in good faith with a prospective tenderer to resolve issues of a kind set out in the Tender Guidelines.[228] The Tender Guidelines also referred to requirement that a NSP or other Registered Participant assist a prospective tenderer in identifying and, if possible, resolving issues that would prevent the delivery of effective SRAS.[229] We note that neither the NER or the Guidelines set out any requirements as to how or when this interaction might occur, what information might be exchanged in order to ensure that any issues are identified, or when another Registered Participant might need to be consulted.

ElectraNet stated that it was not involved in the 2014-15 procurement process for SRAS. However, AEMO points out, and ElectraNet confirms, that ElectraNet was necessarily involved in assessing whether the SRAS offered during that process were viable, as ElectraNet prepared the switching to support the testing of the SRAS. ElectraNet further stated it was not involved in discussions with Origin during either the 2009 or the 2014-15 SRAS procurement processes regarding any issues with the provision of the proposed QPS5 SRAS.

AEMO stated that, consistent with its reading of NER clause 3.11.5(4) (Version 71), it was not required to have direct involvement in any negotiations between NSPs and proposed SRAS providers, and did not do so.

Origin stated that no critical issues were identified in the 2014-15 EOI. Accordingly, we assess that the obligation on ElectraNet under clause 3.11.5(f) to negotiate in good faith to address any such issues was not enlivened.

With regards to the 2009 process, Origin noted that it had found evidence of some discussions with ElectraNet relating to switching during the 2009 procurement process; however, it noted that the passage of time had meant that it didn't have extensive records. Origin stated it had some discussions with ElectraNet regarding protection system operations during the soft start procedure. There was also some discussion regarding the need for two switching sheets [i.e. a test and a black start] and how the arrangements were to be carried out. It appears that the discussion did not directly refer to the use of a soft start or hard start.

ElectraNet advised that it was not aware of Origin's QPS5 soft start requirement, a requirement which in its experience is uncommon.

ElectraNet contends that:

> *the soft start requirement for QPS only came to light at a face-to-face meeting with Origin following the events of 28 September 2016. At that meeting Origin confirmed that they used a 'soft start' procedure, which ElectraNet understands was required to prevent tripping of the QPS GT5 generator transformer protection due to harmonics present in the inrush current during energisation at full voltage. Subsequent to the meeting, Origin has confirmed that the protection arrangements on QPS5 Generator transformer have been modified and that the QPS generators can now be restarted using the expected 'hard start' method i.e. GT1 or 2 energising the TIPS A bus with full operating voltage and frequency that is subsequently used to energise QPS Generator GT5. This was proved by an internal test that was carried out by Origin on 29 October 2016.*[230]

As noted previously, ElectraNet stated that it 'assume[d] that Origin would assess the impact of the SSP on any of their equipment. ElectraNet's expectation in preparing the System Restart SSP was that it was a 'hard start' and that this did not produce conditions outside normal operating ranges. ElectraNet had no information to suggest that any other method of starting would be used under system restart'.

It is not possible for us to ascertain the exact nature of the negotiations between Origin and ElectraNet but there is no evidence that Origin identified any issues or that ElectraNet breached its obligation to negotiate in good faith with Origin to address any such issues during the 2009 procurement process.

Finally, we have no evidence before us to indicate that ElectraNet did not participate in or facilitate the testing of Origin's SRAS as a prospective tenderer in breach of clause 3.11.5(f).[231]

We assess that the requirement for NSPs to negotiate with prospective tenderers provides a mechanism by which material issues can be uncovered. Accordingly we consider it was a missed opportunity for ElectraNet to understand whether a soft start was necessary or whether ElectraNet's preference for a hard start could have been accommodated by Origin.

228 NER, clause, 3.11.5(f)(1).

229 NER, clause 3.11.5(b)(4) included at clause 7.3 of the SRAS Guidelines. NER, clause 3.11.7(b).

230 We note that AEMO disagrees with ElectraNet's final statement, noting that the hard start test failed on 29 October 2016 which required a soft start procedure to be developed for a system restart scenario. However, AEMO also noted that a bypass of the internal network was completed in late June 2018 such that a hard start can be facilitated.

231 NER, clause 3.11.5(f)(2).

Findings

While all relevant parties complied with the requirements of the NER, the procurement process presented an opportunity to identify the need for a soft start requirement of QPS5 and for this to be communicated to all the relevant parties.

The procurement steps where the technical requirements could have been identified include:

- During the provision of data by Origin in fulfilling the EOI and ITT requirements and by AEMO when modelling the impacts of all relevant protection settings.
- Modification of the SRAS Agreement terms and conditions to reference the 'soft start' requirement.
- Interactions with the NSP.

Our recommendations in relation to SRAS procurement are fully discussed in Section 4.15, Findings, recommendations and AER actions, at the end of this chapter.

4.7 SRAS Agreement requirements prior to System Restoration

Under NER clause 3.11.9(d), Origin is required to comply with the SRAS Agreement that it has entered into with AEMO, both during a major supply disruption and prior to such an event.[232] In this section, we consider certain clauses in the SRAS Agreement that are relevant to this investigation and which broadly relate to Origin's conduct prior to the System Restoration period. We also assessed compliance with other clauses of the SRAS Agreement that apply to SRAS testing in section 4.8.1 and clauses relating to the use of SRAS during the System Restoration period in section 4.4.1.

We note that there is no civil penalty attached to the NER obligation which requires the SRAS Provider to comply with its SRAS contractual arrangements, and enforcement of contractual rights would be a matter for the parties to the contract. However, there is a requirement to comply with the NER obligation and we have examined Origin's actions prior to the System Restoration period in light of the contractual arrangements with a view to identifying if there might be any systemic issues that may need to be addressed.

We further note that clause 3.11.9(e) provides that a dispute between AEMO and Origin concerning any aspect (other than price) of a SRAS agreement must be dealt with in accordance with the dispute resolution procedures in rule 8.2 of the NER. This is mirrored in clause 14 of Origin's SRAS Agreement with AEMO.

4.7.1 Relevant clause provisions and assessment

Box 3 sets out a number of overarching obligations on Origin as the SRAS Provider to undertake certain steps to ensure that the SRAS was available at all times and would provide SRAS in accordance with certain standards.

In our assessment, we have taken into consideration AEMO's view that although Origin was unable to deliver its contracted SRAS and there was no event of force majeure that caused this, AEMO stated that it 'accepts that Origin was not aware of the switching issue and the operators did what they could on the day'.

AEMO has also stated that availability payments will not be made if testing of the SRAS indicates that the requirements and performance levels set out in the SRAS Agreement (as set out in Schedule 4.1 of the SRAS Guideline (2014)) are not met, and in fact adjustments were subsequently made to Origin's availability payments pursuant to the SRAS Agreement.

232 NER, clause 3.11.9(d).

Box 3: Relevant obligations in the SRAS Agreement

Origin entered into an SRAS Agreement with AEMO on 23 June 2015.

Under that SRAS Agreement Origin had obligations which included:

i. Clause 4(a): The SRAS Provider must use reasonable endeavours to ensure that each SRAS is Available[233] at all times during the Term.

ii. Clause 15(a)(i),(iii): The SRAS Provider represents and warrants to AEMO as at the date of this Agreement and at all times after the date of this Agreement that:

    i. it will render SRAS with due care and skill …

    iii. it will provide SRAS in accordance with all relevant Law, *good electricity industry practice* and relevant Australian Standards and codes of practice.

Reasonable endeavours to ensure SRAS is available

Origin was obligated under clause 4(a) of the SRAS Agreement to use reasonable endeavours to ensure that each SRAS was available at all times during the Term. Relevant to this is the distinction in responsibility for the SRAS test SSP and the System Restart SSP. Under the SRAS Agreement, the SRAS Provider is responsible for demonstrating that the contracted SRAS is capable of being delivered for the purpose of system restoration operations, including ensuring that the relevant TNSP supports such testing where necessary by working with the SRAS Provider to develop appropriate SRAS test SSP. The TNSP prepares the System Restart SSP.[234]

Origin has employed materially the same SSP for testing the QPS5 SRAS since 2009. Origin came to receive the SSP Restart 2 (being the relevant System Restart SSP for utilising QPS5 as a restart source) as follows:

- On 8 July 2015, when finalising its 2015 test report for QPS5 SRAS, Origin asked ElectraNet if it had a network procedure that would provide evidence to satisfy item 11 of schedule 4.1 of the SRAS Guideline (2014)—SRAS Test Requirements and Supplementary Information. Under Item 11 of Schedule 4.1, a SRAS Provider is to '[d]emonstrate how the SRAS Provider will manage the use of an external network to provide the SRAS—provide procedure or equivalent documentation endorsed by NSP'.
- On 10 July 2015 ElectraNet responded with part of the general instructions for the Restoration Option that utilises QPS5 as SRAS. ElectraNet stated that 'A more detailed switching procedure will be available in 2-3 weeks as it is being updated to reflect the new system topology. This switching procedure will be forwarded to QPS operators…'.
- On 13 July 2015, a representative of Origin responded that they were 'not sure that [the general instructions] is what we are looking for. Can you please send me a copy of the switching procedure when you have finished reviewing it …'.
- On 9 March 2016, ElectraNet sent an email to Origin attaching the SSP Restart 2. The email stated 'I have attached the SRAS procedure. Apologies for the delay. Just a note, the switching procedure is a confidential document. If you have any queries, the person to contact is …'.

Origin stated that it:

> *…did not review the document provided by ElectraNet, either at the time it was provided or in July 2016 prior to providing to AEMO. In hindsight, we acknowledge we should have done so although if we had we would only have identified the difference in the switching between the March 2016 System Restart SSP and the SRAS test SSP if we did a detailed line by line review. We did not do so because we expected that it would be the same as the SRAS test SSP.*

We agree with Origin's assessment that once it had received the System Restart SSP it should have taken the opportunity to review it, even if it otherwise had no basis for considering that there may have been a difference. We note that Origin's response indicates that it would have the necessary technical expertise to have identified the change made by ElectraNet. We have also assessed Origin's actions within the broader context with reference to the circumstances at the time that Origin received this information.

233 Available means, in respect of an SRAS at any time, that the SRAS is capable of being provided at all of the Contracted Levels of Performance by SRAS equipment that meets the Minimum Technical Requirements.

234 NER, clause 3.11.7(d) (Version 64); NER, clause 3.11.5(b) (Version 82), *inter alia*.

In particular, we have had regard to AEMO's understanding of Origin's knowledge as at 28 September 2016, based as it was on the System Restart Plan and SRAS testing of QPS5 earlier in the year. AEMO assessed that there was SRAS availability based on the SRAS test. We also have had regard to AEMO's acknowledgement that Origin did what it could on the day.

It is apparent that there was no process established or mandated by the NER or the SRAS Agreement for the sharing of the System Restart SSP between either ElectraNet and Origin or AEMO and Origin, and there appears to have been no expectation that Origin would have or should have had access to the System Restart SSP. Indeed, in this instance, Origin came to be in possession of the System Restart SSP through ElectraNet sharing documents that were not specifically requested or expected by Origin when it first sought from ElectraNet "a procedure that we could use for" compliance with item 11 of Schedule 4.1 of the SRAS Guidelines (2014) relating to SRAS testing.[235] In the circumstances, Origin acted in a manner that was consistent with how SRAS was being administered at that time as the responsibility for the development of the System Restart SSP was understood by all participants to rest with ElectraNet.

Equally, we consider that ElectraNet's inaction in drawing to Origin's attention, at any time since 2009, the difference between the System Restart SSP and the SRAS test SSP, contributed to Origin's erroneous assumption that the two SSPs were aligned.

Render SRAS with due care and skill

Clause 15(a)(i) of the SRAS Agreement requires that the SRAS Provider represents and warrants to AEMO that it will … render SRAS with due care and skill. The level of due care and skill to be rendered by Origin would reflect its technical expertise as a SRAS Provider. 'Due' care and skill is that which is 'rightful; proper; fitting', 'adequate' or 'sufficient'.[236] This is to be understood with regard to the scope and nature of the services that it agreed to make available under the SRAS Agreement and other relevant circumstances.

As indicated above, we agree with Origin that it should have taken the opportunity to review the System Restart SSP on receipt from ElectraNet. However, as discussed above, the approach Origin took was consistent with the established framework for the delivery of SRAS and reflected that under the SRAS Agreement, it did not have responsibility for System Restart SSPs. It also reflects AEMO's understanding that Origin did what it could on the day of the Black System Event.

Provide SRAS in accordance with all relevant Law

There are a number of regulatory and contractual obligations imposed in relation to the provision of SRAS. The Origin SRAS Agreement, imposes an obligation on the SRAS Provider, which must "represent and warrant to AEMO that it will … provide SRAS in accordance with all relevant Law, "good electricity industry practice" and relevant Australian Standards and codes of practice. Of general application is Chapter 5 of the NER, which includes an obligation on all Registered Participants to maintain and operate their equipment in accordance with relevant laws, the NER, 'good electricity industry practice' and relevant Australian Standards. Chapter 5 also sets out obligations relating to technical matters to be coordinated between a Generator and the relevant NSP. We note that some of these are detailed in Schedule 5.2 of the NER and include switching but do not apply to SRAS.[237]

On balance, with reference to our assessment of Origin's conduct under other specific provisions of the NER, we consider there is no basis on which to conclude that Origin failed to comply with these more general obligations as they apply to the provision of SRAS.

4.8 Fulfilment of SRAS testing requirements

The SRAS Agreement requires the SRAS Provider to undertake testing to demonstrate the SRAS capabilities as contracted in the SRAS Agreement. The SRAS test SSP are the detailed switching procedures which must be followed during the SRAS test. The SRAS test SSP firstly isolate the SRAS generator to simulate black start conditions, then step through the demonstration of the SRAS capabilities to restore the SRAS generator and any connected parties to normal function.

The SRAS Guidelines set out the requirements for SRAS testing, the parties to be involved and the process to be followed. The key parties involved SRAS testing are the SRAS Provider, AEMO, the relevant NSP (usually the TNSP) and, where applicable, the SRAS equipment owner.

235 AEMO, SRAS Guidelines 2014 (applicable at the time that the SRAS Agreement for QPS5 was entered), Schedule 4.1 Item 11, which states in relation to multiple site SRAS and the use of external networks between SRAS Sites, "Demonstrate how the SRAS Provider will manage the use of an external network to provide the SRAS—provide procedure or equivalent documentation endorsed by NSP."

236 Macquarie Dictionary.

237 These include switching and isolation facilities (NER Schedule 5.2.3(8)) and requirements for the Generator and the Network Service Provider to cooperate in the design and implementation of protection systems (NER Schedule 5.2.5.9(e)(2)-(3)). However, under NER Schedule 5.2.1(f), the Schedule 5.2 provisions do not apply to SRAS.

4.8.1 Relevant NER provisions and assessment

NER version 64 (effective at the date of creation of the SRAS Guidelines)—clause 3.11.4A(e)(2)—AEMO must develop guidelines for testing SRAS

AEMO must develop and publish guidelines for undertaking the physical testing of SRAS, in order to demonstrate that there is a reasonable degree of certainty that the SRAS will be delivered.

NER versions applicable at procurement and testing[238]—an SRAS provider must comply with its SRAS Agreement

An SRAS Provider must comply with an ancillary services agreement under which they provide one or more system restart ancillary services.

Box 4 outlines the requirements with respect to SRAS testing as set out in the SRAS Guidelines (2014) and SRAS Agreement. It also sets out the facts in relation to the QPS5 test carried out on 21 May 2016.

238 NER, clause 3.11.5(o) (Version 71); NER, clause 3.11.9(d) (Version 72 and all subsequent versions).

Box 4: SRAS testing requirements and details of the QPS5 SRAS test

SRAS Guidelines

Section 4.4 of AEMO's SRAS Guidelines (2014) set out the SRAS test requirements:[239]

- the SRAS Provider must develop a test procedure, which includes:
  - the steps required to implement the SRAS Test
  - a description of how the requirements and evidence set out in Schedule 4.1 of the SRAS Guidelines (2014) will be demonstrated and recorded
  - the provision of annotated operating diagrams showing the SRAS equipment and how the SRAS equipment is isolated and islanded from local supplies and network connections
  - addressing any other matters the SRAS Provider considers relevant.
- where applicable the relevant NSP and the owner of the SRAS equipment (if not the SRAS Provider) must endorse the test procedure prior to AEMO's approval (cl 4.4.2 of the SRAS Guidelines (2014))
- AEMO must approve the test procedure, and
- the SRAS test must be carried out in accordance with the approved test procedure.

Section 4.5 of the SRAS Guidelines (2014) set out the SRAS test report requirements. The test report was required to:[240]

- document the steps of the test and the results
- address any deviation from the approved test procedure where applicable
- state whether the contracted levels of performance and minimum technical requirements were achieved, and
- state reasons for any failure to establish any required item under Schedule 4.1 of the SRAS Guidelines (2014) and the remedial actions taken to resolve those matters.

Schedule 4.1 of the SRAS Guidelines (2014) set out 11 items to be assessed. These included capabilities such as starting without external supply, providing SRAS in the specified timeframe, to operate in a stable manner at zero export load, to control SRAS voltage and frequency, to close onto a de-energised busbar and to supply a specified capability of SRAS.

Item 11 referred to "Use of external network between SRAS sites" and required a demonstration of "how the SRAS Provider will manage the use of an external network to provide the SRAS" by providing the procedure or equivalent documentation endorsed by the NSP in support.

SRAS Agreement

Clause 6.1 of the SRAS Agreement required the SRAS Provider to conduct Tests under the SRAS Assessment Guidelines (which were incorporated into the SRAS Guidelines (2014)) at least once a year (item 6 of Schedule 2 of the Origin SRAS Agreement) or as requested by AEMO.

Clause 6.2 of the SRAS Agreement specified that AEMO must be notified by the SRAS Provider of its intention to conduct a Test, agree with AEMO on the timing and duration of the Test and invite AEMO to appoint a Representative to witness the Test.

Clause 6.3 of the SRAS Agreement required that the SRAS Provider provide to AEMO evidence that the Test has been conducted, together with the results of the Test, within 15 business days of the Test being conducted. The evidence submitted must demonstrate that the SRAS is Available.

Background relevant to the May 2016 QPS5 SRAS test:

1 April 2016: Origin approached ElectraNet to organise the SRAS testing.

2 May 2016: ElectraNet confirmed with Origin and AEMO that the arrangements were in place for testing to be conducted on 21 May 2016.

4 May 2016: Origin provided the SRAS test procedure to ElectraNet and AEMO for 'review'.

4 May 2016: AEMO stated that it would "check the procedure and assess the outage in the Network Outage Schedule

239 AEMO, SRAS Guidelines, pp. 11,13.

240 Ibid.

(NOS) accordingly".

5 May 2016: AEMO contacted Origin, copying in ElectraNet, regarding an omission in Origin's test procedure in relation to item 7 of schedule 4.1 of the SRAS Guidelines (2014) (demonstrating capacity to ramp to specified capability within specified timeframe).

5 May 2016: Origin responded to AEMO, copying in ElectraNet, with an amended test procedure. We note that in ElectraNet's System Switching Program Appendix 2—Single Line Diagrams, Appendix 3—Protection Settings QPS1+2 and QPS5, and Appendix 4 were blank.

5 May 2016: ElectraNet's Transmission System Operator (TSO) checked the SSP for the test (SSP 60332). This is the last step in checking and approving a Detailed Switching Plan. Origin was listed to receive a copy of the SSP.

6 May 2016: Origin received an automated ElectraNet email consisting of the message "Booking EN35924 has been approved by TSO. The SSP number for this booking is 60332" and attached SSP 60332.

16 May 2016: AEMO emailed Origin stating that "AEMO has approved the attached SRAS Test Procedure for Quarantine Power Station".

16 May 2016: Origin emailed ElectraNet regarding the NOS.

17 May 2016 ElectraNet stated "SSP60332 was submitted to the NOS on Thursday 14/04/2016. I have had a look in the NOS and it is still sitting in the submit state not [Short Term Likely to Proceed]". ElectraNet shortly after confirmed "that the NOS entries have been completed".

17 May 2016: Origin asked ElectraNet "Can you confirm switching will support the above time? This relates to step 1 of the Black Start procedure version 8".

18 May 2016: ElectraNet confirmed timing.

21 May 2016: Test conducted.

7 June 2016: Origin submitted its test report to AEMO.

11 July 2016: AEMO emailed Origin seeking details regarding QPS availability and also "for completeness could you forward the ElectraNet SRAS switching procedure".

12 July 2016: Origin emailed AEMO the System Restart SSP provided to Origin by ElectraNet on 9 March 2016.

Assessment of SRAS testing compliance—AEMO

AEMO complied with its obligation to develop and publish guidelines for undertaking the physical testing of SRAS, under clause 3.11.4A(e)(2) of Version 64 of the NER, which were in effect at the time AEMO published the SRAS Guidelines (2014). However, we identified that there was a lack of shared understanding between AEMO, Origin and ElectraNet as to the respective roles and responsibilities conferred upon the NSP, SRAS equipment owner and SRAS Provider, as well as the role of AEMO, in the testing regime set out in the SRAS Guidelines (2014).

Below we set out our assessment of the guidance on SRAS test requirements provided in the SRAS Guidelines (2014).

Lack of guidance on SRAS test requirements

The SRAS Guidelines (2014) establish requirements for the SRAS Provider to develop the test procedure and to conduct and report on the testing, the involvement of the NSP and SRAS equipment owner in the testing process, and oversight by AEMO.

The SRAS Guidelines (2014) required endorsement by an NSP of the test procedure, (in section 4.4.2 Test Requirements[241] and in Item 11 of Schedule 4.1[242]). Item 11 of Schedule 4.1 specified that it applied in circumstances in which the provision of the SRAS from multiple sites requires the use of an external network, but there was otherwise no clear indication of the circumstances in which the SRAS test procedure should be endorsed by an NSP or SRAS equipment owner.

We asked AEMO about the circumstances in which it considered that endorsement of the SRAS test procedure from the relevant NSP and/or owner of the SRAS equipment (if not the SRAS Provider) ought to be obtained by the SRAS Provider. AEMO responded:

> *The service provided under an SRAS contract is regarded as a single service to energise a nominated delivery point forming a connection to a transmission network. The SRAS Provider is responsible for coordinating and ensuring that all the required elements will operate to enable that point to be energised. At a minimum, this may involve the relevant TNSP in addition to the SRAS Provider, therefore TNSP endorsement*

241 AEMO, SRAS Guidelines, p. 11.

242 AEMO, SRAS Guidelines, p. 14.

may be required. Other parties may own equipment along the path to the Delivery Point, e.g. a DNSP or another generator—in which case their endorsement is also necessary.

We asked AEMO the reasons why AEMO required the SRAS Provider to obtain endorsement of the SRAS test procedure from the relevant NSP or the owner of the SRAS equipment. AEMO responded:

Testing an SRAS will typically involve tripping of the generating unit (i.e. disconnection from the network) to simulate black system conditions. This will require the TNSP's involvement both on the day and in planning. Similarly, any intervening third party equipment will need to be de-energised and re-energised.

On the basis of these two statements from AEMO it appears that the TNSP would always be required to endorse the SRAS test procedures. This is because it will always be involved in disconnecting the SRAS Provider's equipment from the network to simulate black start conditions and then reconnecting it to the network. Similarly, wherever the owner of the SRAS equipment is not the SRAS Provider, it would always be required to endorse the SRAS test procedures. This is because in an SRAS test, the SRAS equipment will always be in use. We asked AEMO how it interpreted the endorsement of the SRAS test procedure by the relevant NSP and the owner of the SRAS equipment. AEMO said:

Endorsement is interpreted as the relevant party having reviewed and agreed to the procedure. Effectively it also represents confirmation the third party will participate in testing to the extent its equipment is required, in accordance with the procedure.

When asked what evidence was provided of ElectraNet's endorsement of Origin's test procedures, AEMO stated:

No formal evidence was provided or specifically requested (other than the SSP). ElectraNet participates in the test procedure from its control room. ElectraNet was also part of the email chain (Attachment 2) and had entered the necessary network outages in the AEMO's network outage scheduler (NOS).

In relation to Item 11 of Schedule 4.1 of the SRAS Guidelines (2014), we asked AEMO whether an SSP is required and what evidence it expects in order to meet the requirements. AEMO stated that the evidence required is "not necessarily an SSP. An SSP is accepted as evidence that there is a process to manage the external network used in the SRAS test. As an alternative, for example, an SRAS Provider could provide a formal letter from the NSP confirming that an arrangement is in place for managing the network during the SRAS [sic] (with a description of that arrangement)". AEMO further submitted that "AEMO is not in a position to assess or approve the content of an SSP".

As AEMO is not in a position to assess or approve the content of an SSP, we consider that the SRAS Guideline should incorporate obligations that ensure appropriate measures are in place. Further detail is set out in the Findings, recommendations and AER actions section at 4.15 below.

Assessment of SRAS testing compliance—ElectraNet

We concluded that, notwithstanding the SRAS Guidelines (2014) specifying certain roles and responsibilities for NSPs, there were no explicit obligations imposed on ElectraNet with regards to conducting SRAS testing with contracted SRAS Providers. (Our assessment of ElectraNet's compliance with its overarching obligations in the NER are set out in section 4.11 and 4.13 below.)

Roles and responsibilities under the SRAS Guidelines (2014) for SRAS testing

The SRAS Guidelines (2014), which included the SRAS Test Requirements and SRAS Test Report requirements, were not directly binding on participants other than the SRAS Provider. Under the SRAS Agreement, the SRAS Provider must conduct annual testing under the Guidelines[243] and under clause 3.11.9(d) of the NER, it must comply with the SRAS Agreement.[244]

In relation to other participants, a NSP must comply with the SRAS Guidelines to the extent that the SRAS Guidelines require them to be involved in SRAS testing. We consider the wording of the NER provisions that apply to procurement and testing of SRAS incorporate a limitation that is undesirable—that is, they appear only to apply to *proposed* SRAS and *prospective* SRAS Providers.[245] The extent to which relevant NSPs comply with these provisions of the

243 Origin SRAS Agreement, clause 6.1, and Schedule 1, clause 6.

244 NER, clause 3.11.9(d). 'Available' means 'in respect of an SRAS at any time, that the SRAS is capable of being provided at all of the Contracted Levels of Performance by SRAS equipment that meets the Minimum Technical Requirements'.

245 See, for example, NER clause 3.11.7(b); and clause 3.11.9(g).

SRAS Guidelines is relevant to an assessment of whether the NSP has met:

- its general NER obligation to 'use reasonable endeavours to exercise its rights and obligations in relation to its networks so as to co-operate with and assist AEMO in the proper discharge of the AEMO power system security responsibilities',[246] and
- its more specific obligations to assist AEMO to assess SRAS capability,[247] negotiate in good faith with an prospective SRAS Provider to identify and resolve issues,[248] and to participate in, or facilitate testing of a SRAS proposed to be provided by a prospective SRAS Provider.[249]

These provisions do not specifically refer to the SRAS Guidelines. Moreover, we note the use of the term "prospective" in respect of an SRAS Provider in NER clause 3.11.9(i).

We also considered whether the SRAS Guidelines are binding, as "power system operating procedures" that fall within NER clause 4.10.1(a)(2) which include "any guidelines issued from time to time by AEMO in relation to power system security." Registered Participants are required to "observe the requirements" of power system operating procedures under NER clause 4.10.2(b).

On balance, we do not consider the SRAS Guidelines to be binding as:

- the NER does not explicitly provide for the SRAS guideline to be binding, either in Chapter 3 or clause 4.10.1
- AEMO's *Power System Security Guidelines* and other power system operating procedures explicitly state that AEMO has prepared them pursuant to clause 4.10.1, and
- the SRAS Guidelines, by contrast, do not refer to clause 4.10.1.

We turn to the SRAS testing process that under the Origin SRAS Agreement that existed at the time of the Black System Event. The responses to our information requests indicate that there was not a consistent understanding between AEMO, ElectraNet and Origin as to the requirements of the SRAS test. In this instance ElectraNet was both the NSP and an SRAS equipment owner.

In relation to the 2016 testing of QPS5, ElectraNet's involvement consisted of:

- Origin contacting ElectraNet to organise a suitable test date
- ElectraNet stating to Origin, 'I can confirm that the necessary arrangements are in place to enable testing to be carried out on the 21st May, as requested. Could you please forward a copy of the proposed test plan, at your earliest convenience, so that AEMO and ElectraNet can review it in good time.', and
- Origin providing the SRAS test procedure to AEMO and ElectraNet with the accompanying statement: 'Please find attached V7 of the Procedure for AEMO and ElectraNet review'.

However, ElectraNet stated that it 'had no involvement in developing, reviewing, approving or endorsing the QPS SRAS test procedure'. It further stated that it 'does not endorse the SRAS test procedures as this is outside of the role and obligations of ElectraNet as a Transmission Network Service Provider'. In describing its role in the SRAS test, ElectraNet stated its 'role was to develop an SSP to enable Origin to carry out switching on ElectraNet's transmission network to facilitate Origin's SRAS testing' and 'On receiving a request for an SRAS test from QPS, ElectraNet negotiates a mutually agreeable date/s for the outage window with the other connected parties, namely AGL TIPS [Torrens Island Power Station] and SAPN [SA Power Networks]'.

We understand ElectraNet to mean that it did not endorse the SRAS test and did not warrant that it has reviewed and agreed to the procedure. This appears to be inconsistent with AEMO's expectation that ElectraNet was required to endorse the SRAS test procedures and AEMO's assessment that ElectraNet had informally endorsed the SRAS test procedures.

Origin viewed the switching arrangements as part of the SRAS test procedure, stating:

> *The switching arrangements for the 21 May 2016 test were developed as part of the preparation of the SRAS test procedure… . Origin provided a draft SRAS test procedure, including a switching arrangement using the 'voltage ramp' procedure (i.e. not the "hard start") procedure based on the previous year's, to ElectraNet and AEMO by email on 4 May 2016. ElectraNet provided updated switching arrangements to Origin on 6 May 2016, which also used the 'voltage ramp' procedure. Origin took ElectraNet's email of 6 May 2016 as its approval of the updated switching arrangements it*

246 NER, clause 4.3.4(a).

247 NER, clause 3.11.9(i) (from Version 72 on).

248 NER, clause 3.11.5(f)(1) (from Version 64 to Version 71), clause 3.11.9(i)(2) (from Version 72).

249 NER, clause 3.11.5(f)(2) (Version 64 to Version 71), clause 3.11.9(i)(3) (from Version 72).

provided to Origin. Origin did not provide the updated switching arrangements to AEMO because it was not necessary at this time because the amendments made by ElectraNet related to interconnection with other assets which ElectraNet was responsible for.

Origin further stated that "AEMO's approval of the switching arrangements was provided as part of its approval of the SRAS test procedure …".

Origin's view that AEMO and ElectraNet had approved the SRAS test SSP does not appear to be consistent with AEMO's and ElectraNet's view. However, as the formulation of the SRAS test SSP is typically undertaken as a collaborative process by the relevant SRAS Provider and the TNSP, ElectraNet's contention that it did not approve the SRAS test procedure appears to us to be incongruous. We also agree that if AEMO has approved a test procedure, it must thereby have approved the manner in which the test is conducted, and all of its elements, even if it had not specifically studied and approved each individual step.

We consider the SRAS Guidlelines need to be clear about the respective roles and responsibilities for SRAS Providers, SRAS equipment owners, NSPs and AEMO, including what this means at a practical level. We note AEMO has heavily revised the testing regime in its 2017 review of the SRAS Guideline. Further detail is set out in Section 4.15 Findings, recommendations and AER actions.

Assessment of SRAS testing compliance—Origin

Origin undertook annual SRAS testing in accordance with its SRAS Agreement obligations. Origin completed the most recent SRAS test on 21 May 2016. It successfully demonstrated that it could meet the capability and deliverability requirements specified in its SRAS Agreement. This is notwithstanding some deficiencies in the documentation of Origin's 2016 testing of QPS5.

Omissions in SRAS test procedures and test reports

On review of the test documentation submitted to AEMO by Origin on 7 June 2016, it is apparent that the test procedure approved by AEMO for Origin's 21 May 2016 SRAS test did not reference any endorsement by ElectraNet and did not attach the ElectraNet approved SSP to the test procedure, specified to be at appendix 4 of the SRAS test procedure.

Following submission by Origin of its SRAS test report to AEMO on 7 June 2016, on 11 July 2016 AEMO emailed Origin seeking details regarding QPS availability and also requested that 'for completeness could you forward the ElectraNet SRAS switching procedure'. On 12 July 2016 Origin, in error, emailed AEMO the System Restart SSP instead of the SRAS test SSP. AEMO stated that it "did not review the content of the switching … AEMO checked that it was an ElectraNet document associated with Quarantine SRAS (as evidence that there is a process to manage the external network)".

We note that the first page of the System Restart SSP provided to AEMO reads:

Day and Date : To Be Arranged; Approximate Time : To Be Arranged; Reason for Switching: S.A. System Restart Using Quarantine Power Station.

This is in contrast to the SRAS test SSP used on 21 May 2016 which reads:

Switching Date: Saturday 21.05.2016 to Saturday 21.05.2016; Switching Time: 0730 Saturday 21.05.2016 to 1230 Saturday 21.05.2016; Work to be Done: Configure TIPS A 66kV Yard for Black Start test at QPS.

The document that AEMO checked was not a Quarantine SRAS test SSP but a System Restart SSP. It appears that AEMO assessed that this document was sufficient to meet the test requirements but it was on the mistaken assumption that the two sets of SSP would be identical. AEMO considers it was reasonable for it to expect the two to be the same given the context and legitimate expectations of AEMO (and the knowledge assumed to be held by Origin and ElectraNet) at the time. We note that the SRAS Guideline (2017) addresses this scenario exactly, and provides a process to identify any difference between the SRAS test SSP and the System Restart SSP and to clarify which SSP is to prevail.

Findings

We consider Origin fulfilled its obligations under the SRAS agreement to demonstrate SRAS capability via testing. Despite this, a lack of understanding among the relevant participants about the required switching procedures for QPS5 undermined the availability of QPS5 during the System Restoration period.

We acknowledge AEMO's new SRAS Guidelines (2017) will significantly overcome such circumstances in future. Our findings and recommendations in relation to SRAS testing are set in more detail in the Findings, recommendations and AER actions section (section 4.15) at the end of this chapter.

4.9 Local Black System Procedures

In its document 'Management of Local Black System Procedures,[250] AEMO states "the purpose of the LBSP is to allow AEMO and the relevant TNSP to understand the unique operating requirements of power stations and NSPs following a major supply disruption. This allows

250 AEMO, *Management of Local Black System Procedures*, 11 March 2016 at p. 5.

the formulation of more precise restoration procedures and plans."

LBSPs are therefore relevant to the development of viable System Restart Plans and regional Restoration Options—they inform AEMO of the conditions with which and around which it must work to re-energise the system after a major supply disruption. All Generators and NSPs are required to develop and keep updated their LBSPs, whether or not they may also be a party to an SRAS Agreement. If an SRAS Agreement is in place, we note the requirement that "LBSPs must be consistent with any SRAS Agreements".[251]

Therefore, the LBSPs completed by Generators and NSPs provide information on generation and network plant with respect to their technical requirements and limitations in a restart environment. AEMO relies upon information in LBSPs as a major input in developing its regional Restoration Options[252] and the content of LBSPs must be "sufficient" to allow AEMO to effectively implement the System Restart Plan.

4.9.1 Relevant NER provisions and assessment

The development of LBSPs are governed under clause 4.8.12 of the NER as follows:

AEMO to develop Guidelines

Clause 4.8.12(e) provides:

> Subject to clause 4.8.12(f), *AEMO* must develop and *publish*, and may amend, guidelines for the preparation of *local black system procedures* in consultation with *Generators* and *Network Service Providers*.

The reference to clause 4.8.12(f) is to the content requirements of LBSPs.

NER content requirements for LBSPs

LBSPs must:

- provide sufficient information to enable AEMO to understand the likely condition and capabilities of plant following any major supply disruption such that AEMO is able to effectively co-ordinate the safe implementation of the System Restart Plan; (NER 4.8.12(f)(1)). The relevant part of the definition of 'Plant' as set out in Chapter 10 of the NER is '…In relation to a connection point, includes all equipment involved in generating, utilising or transmitting electrical energy'.
- appropriately incorporate any relevant energy support arrangements[253] to which a Generator or NSP may be party. (NER clause 4.8.12(f)(2)).

Generators and NSPs required to develop LBSPs

Clause 4.8.12(d) requires Generators and NSPs to meet the above requirements and for LBSPs to be consistent with any SRAS Agreement to which that Generator or NSP is a party noting that NSPs cannot provide SRAS.

AEMO's Guidelines for Preparing LBSP (LBSP Guidelines), of which the current version 2.1 was in effect on 28 September 2016, were made on 30 March 2015.[254]

Box 5 sets out the information collected with respect to the technical capabilities and requirements for generators and TNSPs.

251 NER, clause 4.8.12(d).

252 AEMO, *Guidelines for Preparing Local Black System Procedures*, version 2.1, 30 March 2015, p. 4, *inter alia*.

253 In NER ch.10 "energy support arrangement" means 'A contractual arrangement between a *Generator* or *Network Service Provider* on the one hand, and a customer or *participating jurisdiction* on the other, under which *facilities* not subject to an *ancillary services agreement* for the provision of *system restart ancillary services* are used to assist *supply* to a customer during a *major supply disruption* affecting that customer, or customers generally in the *participating jurisdictions*, as the case may be'.

254 AEMO, *Guidelines for Preparing Local Black System Procedures*, 30 March 2015.

Box 5: Information to be provided by generators and NSPs in LBSPs

The LBSP Guidelines state, with respect to Generators, that 'A generic list of information to be provided is covered in the appendix 2, in the form of a template. Generators are expected to use this template to develop LBSPs'. Appendix 2 consists of specific questions under the broad areas of: general information on the power station; assessment of the situation and safe shut down of generating units; restarting the generating units; use of TTHL [trip to house load] capable generating units; restarting embedded generators; restarting wind generators; technical details associated with the power station; technical details associated with TTHL capable generating units; generator participation in energy support arrangements; communication facilities.

For TNSPs and DNSPs, appendix 4 of the LBSP Guidelines consists of specific questions under the broad areas of: general information; operational capability of control centres following the failure of primary supplies for an extended period; voice communication systems; continuity of NSP supervisory systems (SCADA monitoring and control); continuity of substation operational capability; relevant technical information for restarting the network; specific requirements of time critical major customer loads; operating arrangements between TNSPs, DNSPs and Generators; and assess and prepare network to accept supply.

Observations regarding the purpose of LBSPs

Under clause 4.8.12(f) LBSPs are described as having two mandatory requirements. They must provide sufficient information to enable AEMO to understand the likely condition and capabilities of plant so that AEMO is able to effectively co-ordinate the safe implementation of SRAS, and they must also appropriately incorporate any relevant energy support arrangements. In our view, an LBSP that meets those two requirements, and is consistent with AEMO's Guidelines and the relevant ancillary services agreement, would therefore comply with the Rules framework. The LBSPs examined by the AER typically contain such information about the condition and capabilities of power system assets after a total loss of supply.

However, the Rules also require that NSPs and generators to comply with their LBSPs as quickly as practicable.[255] This indicates that LBSPs were intended to encompass procedures at their local levels, such as the actions Generators (including SRAS Providers) and NSPs will undertake upon declaration of a major supply disruption, and yet the LBSPs do not contain procedures to be followed.

In AEMO's view:

> *despite their name, LBSPs are not procedures. While LBSPs identify black start capability, their primary purpose is to identify the condition and capabilities of power system assets after a total loss of supply. These are issues that could affect the ability to re-energise those assets and maintain stable operation on a potential restart path. Most of those issues will be relevant to both SRAS and non-SRAS generators (such as site access, availability of communications, fuel availability, loading limitations, time to energise after different periods off-supply etc.). Internal SRAS switching is not one of those issues.*

As AEMO can issue guidelines for the preparation of LBSPs and to request review and amendment of LBSPs, we consider LBSPs could be given a broader scope than the minimum information requirements set out in clause 4.8.12(f) (see clause 4.8.12(d) and (e)).

As a general observation, we note there were changes to the NER regarding LBSPs that arose out of the 2006 rule change proposal *System restart ancillary service arrangements and pricing under market suspension* put forward by NEMMCO.[256] Prior to this rule change, each generator providing black start-up facilities was required to arrange testing (in accordance with NEMMCO's requirements) of:

- its black start-up facilities which are the subject of an ancillary services agreement, and
- the approved local black system procedures

to demonstrate that each facility was capable of start up from a condition where it was disconnected from external power supplies and that the arranged facilities could actually start up the nominated generating units without assistance from the power system.[257]

This suggests that the local black system procedures at one time were to set out procedures that would be followed for a local black start.

We also note that NEMMCO appeared to contemplate that LBSPs would contain information regarding

255 NER, clause 4.8.14(b).

256 This rule change took effect in Version 4 of the NER.

257 NER, clause 4.8.13(a) (Version 3). Relevantly, clause 4.8.14(b) required LBSPs to be consistent with ancillary service agreements; clause 4.8.14(c) provided NEMMCO with the ability to require amendments to LBSPs and 4.8.14(d) required Generators and Makret Network Service Providers to comply with LBSP requirements.

generator's capability to restart without external supply through statements:

- envisaging that generators that secured SRAS contracts would subsequently revise their LBSPs,[258] and
- regarding its expectation that generators with black start capability that did not win SRAS contracts would set out such capability in their LBSPs.[259]

However, after the rule change, the purpose of the LBSPs arguably became less clear. We raise this issue in our Implications for the Regulatory Framework chapter.

Assessment of LBSP compliance—AEMO

The relevant provisions of the NER allow AEMO to exercise its discretion as to what amounts to sufficient information to effectively implement the System Restart Plan. We recognise that AEMO may assess the content of the LBSPs to be sufficient when considered alongside the other information available to AEMO, for example, information set out in the SRAS Agreement.

We also note that in accordance with its obligation to do so, AEMO developed and published its Guidelines for Preparing LBSPs on 30 March 2015.[260]

Therefore, we conclude that AEMO has complied with its obligations under clauses 4.8.12(e) and (g) of the NER.

Sufficient information

In relation to clause 4.8.12(f)(1), AEMO is to elicit sufficient information such that it is in a position to understand the likely condition and capabilities of plant following any major supply disruption to effectively co-ordinate the safe implementation of the System Restart Plan.

The System Restart Plan includes Restoration Options for restoring supply after a major supply disruption using SRAS Providers or the interconnector to start other generators and bringing on load blocks to stabilise the frequency and voltage of the parts of the grid as they are restored. Therefore generators, TNSPs and DNSPs are potentially involved in the System Restart Plan. The information to be elicited by AEMO ensures that the System Restart Plan can be implemented effectively after a major supply disruption, and that it does not cause any harm, injury, danger or risk in being put into effect.

Assessment of LBSPs and guidance provided by AEMO

In its LBSP Guidelines, AEMO states that the LBSPs are "the main source of information" on which it bases its assessment of the likely condition and the capabilities of the generation/network plant. AEMO also states that the "provision of accurate information in LBSPs is extremely useful and important for AEMO to be fully informed of the technical requirements and limitations of power stations and network plant, in developing robust system restart plans".

The LBSP Guidelines do not seek information on the provision of SRAS generally. The LBSP Guidelines' only reference to SRAS is to state that "[t]he Generator LBSPs must be consistent with the system restart ancillary service agreements to which that Generator is a party".[261] The LBSP Guidelines do not clarify what constitutes consistency nor how consistency is achieved, or how it is evaluated by AEMO. A NSP's LBSP also is to be consistent with any SRAS Agreement to which it is a party,[262] but the LBSP Guidelines refer only to Market Network Service Providers.[263] This is consistent with the reality that TNSPs and DNSPs are not parties to SRAS Agreements.

Under the NER, when considering whether to approve LBSPs, AEMO is to "take into account the consistency of local black system procedures with… the relevant components of the system restart plan". What is a "relevant component" of the System Restart Plan is not defined in the NER and is not elaborated upon in the Guidelines.

Section 4 of the LBSP Guidelines refers to AEMO's assessment of whether:

> *…the strategies detailed in LBSPs are sufficient for the power system to be restarted to meet the system restart standard. If the strategies detailed in Generator and/or NSP LBSPs are not adequate AEMO will use provisions in NER 4.8.12(h) to request changes to the strategies presented by Generators and/or NSPs as required.*

This appears to be a high-level assessment. It also does not clarify what might be adequate or the necessary level of detail to ensure adequacy. It may be that greater transparency around the nature of AEMO's assessment would provide greater clarity about the information required to make this assessment.

AEMO advised us that "As a matter of course, AEMO reviews the LBSP of an SRAS Provider during the contract

258 NEMMCO, *Review of system restart ancillary service arrangements—Final report* (Volume 1), pp. 36, 37, 41, 49.

259 NEMMCO, *Review of system restart ancillary service arrangements—Final report* (Volume 1), p. 48.

260 Source: AEMO website.

261 NER, clause 4.8.12(d) and *AEMO, Guidelines for preparing Local Black System Procedures*, version 2.1, p. 5.

262 AEMO, *Guidelines for preparing Local Black System Procedures*, version 2.1, p. 5.

263 A Market Network Service Provider is an NSP who has classified any of its network services as a market network service per clause 2.5.2 of the NER. Market network services can not include prescribed transmission services or direct control services.

procurement process to confirm the proposed contract specifications do not contradict any statement in the LBSP".

With respect to information on SRAS, AEMO submitted that it distinguishes between plant being used as an SRAS source and plant being energised on a restart path as part of the restoration process. AEMO initially stated that "the LBSP captures the technical capabilities and limitations of the plant when it is being energised on a restart path. AEMO considers that for SRAS Providers, where the technical capabilities and limitations of the plant are additional to those when it is being energised on a restart path, the additional technical capabilities and limitations should be captured in SRAS contracts". AEMO subsequently clarified that it does not consider that it has control over or expertise in relation to the processes that are necessary for the SRAS equipment to energise the specified delivery point (internal to the delivery point). AEMO consequently submitted that it is not appropriate for the processes to be specified in the SRAS Agreement.

AEMO submitted that: "There is limited overlap between the technical content of an LBSP and SRAS contract, and the SRAS contract specifications will be significantly more extensive. … LBSPs are not required to describe how a contracted SRAS will be provided". AEMO stated that: "if SRAS contract performance levels indicate capabilities and limitations inconsistent with those identified in the LBSP, AEMO can request the generator or NSP to update the LBSP under clauses 4.8.12(d) and (h)".

The LBSP Guidelines also require LBSPs to appropriately incorporate any relevant *energy support arrangements*[264] to which a Generator or NSP may be party. There is no explanation in the NER as to what "appropriately incorporate" means and no guidance in the LBSP Guidelines as to the level of information that might be sufficient to satisfy AEMO. We consider it refers to all information that may be relevant to resolve inconsistencies that may arise where the energy support arrangement, by its existence, causes the System Restart Plan to be different to what it would be if the energy support arrangement did not exist. For example, in ElectraNet's LBSP at item 8A, it stated that it had an energy support arrangement but did not state what impact on restoration that this might have.

More broadly, we note the LBSP Guidelines do not contain an explanation for the questions set out and this may lead to variations in the information provided by NSPs and Generators. For example, in answering the question on "transformer energisation current capability" and "whether generator excitation can be controlled to minimise transformer magnetising current" at item 3H of the LBSP Guidelines, Origin did not include the soft start requirement in the LBSP for QPS5, which contrasts with the information Synergen Power provided on this item with respect to its Mintaro plant.

We consider clearer guidance would assist AEMO in obtaining more complete information from Generators and NSPs in their LBSPs.

Information sharing

Equally as important as the inclusion of relevant technical information in the LBSPs is the dissemination of that information to relevant participants. This is prudent given that the TNSP develops the detailed switching procedures from the high-level Restoration Options to enable participant's' equipment to be restarted in black system conditions. This also provides each TNSP with the opportunity to follow-up any detail that is unclear in the LBSPs from its perspective, given that it is not involved in the approval process for LBSPs.

While AEMO's SRAS Guidelines provide for the possibility that relevant LBSP technical information may be provided to the relevant TNSP, AEMO stated that it did not provide Origin's LBSP information to ElectraNet. We note AEMO's submission that it "agrees that LBSPs should be shared with the relevant TNSP as a matter of course, and has tightened its internal procedures to ensure this is clearly documented in future".

Assessment of LBSP compliance—Origin and Synergen Power

We conclude that there is no evidence that Origin's LBSP were not in accordance with the LBSP Guidelines. This reflects AEMO's approach to the LBSP, which is that SRAS technical capabilities or requirements are not expected to be incorporated into LBSPs. There is also no apparent inconsistency between Origin's LBSP and the Origin SRAS Agreement, in line with the requirement that a LBSP be consistent with any relevant SRAS Agreement.

On the basis that Origin submitted its LBSP to AEMO, and it was assessed and approved by AEMO, we conclude that Origin has complied with its obligations under clause 4.8.12(d) of the NER.

We conclude that there is no evidence that Synergen's LBSP were not in accordance with the LBSP Guidelines and that there was no apparent inconsistency between Synergen's LBSP, as approved by AEMO, and the SRAS Agreement.

264 '*Energy support arrangement*' means "A contractual arrangement between a *Generator* or *Network Service Provider* on the one hand, and a customer or *participating jurisdiction* on the other, under which *facilities* not subject to an *ancillary services agreement* for the provision of *system restart ancillary services* are used to assist *supply* to a customer during a *major supply disruption* affecting that customer, or customers generally in the *participating jurisdictions*, as the case may be".

We therefore conclude that Synergen has complied with its obligations under NER clause 4.8.12(d).

Origin's LBSP

Origin's LBSP, as approved by AEMO,[265] followed the template provided in the LBSP Guidelines at Appendix 2. This is consistent with the other LBSPs we have reviewed as developed by other Generators and NSPs. Appendix 2 does not include any requirement to include specific information relating to SRAS.

Origin's LBSP did not contain information relating to the soft start requirement for QPS5. AEMO confirmed this following the Black System Event.

Although the LBSP Guidelines, specifically appendix 2, did not require Origin to submit or include any SRAS information, Origin did refer to SRAS in response to the information sought under section 3, item 3D of the LBSP Guidelines, where it set out a high-level outline of its restart plan for both scenarios—"If Black Start is not required" from the perspective of receiving supply and "If Black Start Required" from the perspective of supplying load.

We note that Synergen Power's LBSP for Mintaro similarly includes only a brief reference to its black start capability at section 3, item 3B (referencing the LBSP Guidelines) as well as indicating that it receives its external supply from Clare Substation. For section 3, item 3D (referencing the LBSP Guidelines) no summary of the restart plan is provided. Instead, Synergen's response states: "Not applicable as all units are black start capable and self-controlled".

Apart from assessing that Origin's LBSP included "sufficient information" in accordance with the LBSP Guidelines, AEMO also approved Origin's LBSP as consistent with the SRAS Agreement.

The minimum technical requirements specified in the Origin SRAS Agreement are at item 4 of Schedule 2.[266] There is some specification of technical requirements and limitations in relation to SRAS equipment included in the SRAS Agreement, although it does not appear to be exhaustive. In particular, the QPS5 soft start requirement is not specified in the SRAS Agreement.

The common technical requirements or capabilities between Origin's LBSP and its SRAS Agreement are: the capacity of the unit (in megawatts), time to synchronise and reach relevant MW output and minimum load requirement for stable operation. We assessed the information provided for each category as consistent between the two documents.

Synergen Power's LBSP

Synergen Power prepared LBSPs for its plant, including Mintaro, completing the appendix 2 template in the Guidelines. These were approved by AEMO. With respect to the separate obligation that the LBSP must be consistent with any SRAS Agreement, the minimum technical requirements specified in the Synergen Power SRAS Agreement are at item 4 of Schedule 1. The information to be specified is identical to that required in the Origin SRAS agreement.

While the SRAS equipment is specified in the SRAS Agreement, there is no specification of technical requirements and limitations in relation to that equipment. We note that in its review of SRAS, AEMO has identified that for SRAS Providers such as Mintaro, where the restart depends on initially starting a low-voltage generator, that this generator should be tested in isolation on a regular basis, in addition to the annual test of the entire SRAS source.[267]

As with Origin, the common technical requirements or capabilities between Synergen's LBSP and its SRAS Agreement are: the capacity of the unit (in megawatts), time to synchronise and reach relevant MW output and minimum load requirement for stable operation. The information provided was consistent between the LBSP and the SRAS Agreement.

Assessment of LBSP compliance—ElectraNet

We find there is no evidence that ElectraNet's LBSP were not in accordance with the LBSP Guidelines. There is no apparent inconsistency between ElectraNet's LBSP, approved by AEMO, and its Network Support Agreements, and we note that ElectraNet is not a party to an SRAS Agreement so no question of inconsistency arises.

We therefore conclude that ElectraNet has complied with its obligations under NER clause 4.8.12(d).

ElectraNet's LBSP

ElectraNet prepared LBSP, completing the appendix 4 template in the LBSP Guidelines. ElectraNet's LBSP did not contain information relating to SRAS as it is not an SRAS Provider.

ElectraNet did indicate that it had an energy support arrangement in place with Synergen Power for the Port Lincoln Power Station at items 1C and 8A, as required by the LBSP Guidelines. It provided no details as to any impact on restoration of supply at item 8A. It is possible that this energy support arrangement would have no material impact

265 AEMO has stated that it formally approved the 2008 LBSP and informally approved the 2014 LBSP.

266 Clause 4(a) requires that the Generating Unit must have the capability to deliver energy to the Delivery Point without taking supply from the power system. Clause 4(c)(iv) requires that SRAS equipment have appropriate network controls and protection systems in place to avoid the SRAS equipment adversely affecting power system restoration. Clause 4(c)(ix) requires that SRAS equipment have no restrictions or limitations that have the potential to adversely affect power system restoration.

267 AEMO, Final Report, Recommendation 14, p. 9.

on the restoration of supply elsewhere in South Australia, and this may well explain why this item was not completed. However, we note the workability of item 8A of the LBSP Guidelines may be improved by requiring information relating to existing energy support arrangements and their potential to impact system restoration.

Findings

While all relevant parties complied with the LBSP requirements of the NER, we consider that it would be useful to participants for AEMO to consult on the need for improved guidance on the LBSPs.

Further recommendations regarding LBSPs are set out in detail in the Findings, recommendations and AER actions (section 4.15) at the end of this chapter.

4.10 System Restart Plan

AEMO must prepare a System Restart Plan for use after a major supply disruption in order to achieve system restoration.[268] As set out in section 4.3.5 above, the System Restart Plan:

- describes the actions to be taken by AEMO and NEM Participants in response to a major supply disruption, and
- identifies a number of possible Restoration Options, which are viable corridors from an SRAS Provider or neighbouring region via an interconnector to start other generators and bring on load blocks.

Box 6 details the timeframe for development of the System Restart Plan in effect on 28 September 2016.

4.10.1 Relevant NER provisions and assessment

Prior to the Black System Event, AEMO was required to comply with a number of obligations relating to the preparation of a System Restart Plan for the South Australian electrical sub-network. On review of AEMO's actions, we consider that AEMO fulfilled its obligations. We set out below our analysis of these obligations.

Clause 4.8.12(a)—AEMO to prepare a System Restart Plan

AEMO must prepare, and may amend, a *System Restart Plan* for the purpose of managing and coordinating system restoration activities during any *major supply disruption*.

With respect to this obligation, we observe that AEMO has prepared a System Restart Plan. As described in box 6, the latest version of the System Restart Plan for South Australia was updated on 9 August 2016 following the retirement of Northern Power Station, the contracting of Mintaro for SRAS and the removal of the synchronising capability of Davenport Substation. Restoration Options 1 and 2 of the South Australian System Restart Plan were carried out on 28 September 2016.[269]

We therefore assess that AEMO complied with clause 4.8.12(a) of the NER.

Clause 4.8.12(c)—System restart plan to be consistent with the system restart standard

There is also an obligation under clause 4.8.12(c), that the System Restart Plan must be consistent with the System Restart Standard. We have found that the System Restart Plan is consistent with the System Restart Standard. In forming this view, we had regard to AEMO's procurement of SRAS as set out in section 4.6 above.

Box 6: System Restart Plan in effect at 28 September 2016

21 April 2016—AEMO sought ElectraNet's endorsement of the draft System Restart Plan for South Australia.

3 May 2016—version 11 of the System Restart Plan for South Australia was released to reflect the changes following the retirement of Northern Power Station and the contracting of Mintaro for SRAS.

9 August 2016—version 12 of the System Restart Plan for South Australia was released.

28 September 2016—AEMO and ElectraNet agreed on a restoration strategy, under which two Restoration Options would be implemented in parallel:

- Restoration Option 1: Import electricity to SA through the Heywood Interconnector from Victoria.
- Restoration Option 2: Utilise SRAS provided by QPS.[270]

268 NER, clause 4.8.12(a).

269 Ibid.

270 AEMO, Final Report, section 4.2.

Role of other parties in the System Restart Plan

In reviewing AEMO's approach to devising the system restart plan, we considered the role of other participants in the relevant region in assisting AEMO to devise a robust system restart plan.

In developing the System Restart Plan for South Australia (incorporating Restoration Options), AEMO stated that "[d]raft revisions are sent to ElectraNet for review and comment". AEMO stated that "if the update requires extensive switching or substation preparations that form a critical part of the restart plan, meetings will be arranged to discuss operational coordination and how best to document processes that are relevant to AEMO and ElectraNet".

Consistent with AEMO's view, ElectraNet considers its involvement was limited to reviewing the content of each iteration of System Restart Plan to assess ElectraNet's ability to execute the plan and did not extend to formal approach or endorsement. We note that the NER (cl. 4.8.12(a)) puts the onus on AEMO to "prepare" the System Restart Plan, and therefore we accept that ElectraNet does not "formally" approve the System Restart Plan.

AEMO stated that System Restart Working Group (SRWG) members have an opportunity to comment on the System Restart Plan before it is finalised. The SRWG consists of the TNSP, DNSP(s) and scheduled thermal generators in the relevant sub-network. In South Australia the SRWG includes AEMO, ElectraNet, SA Power Networks, ENGIE, Origin and AGL. AEMO stated that any technical issues raised are addressed before the System Restart Plan is finalised. However, Origin stated that it is "invited to attend working group meetings but generally has not attended because we have found the information available through the other sources [email, minutes of working group meetings and the AEMO web portal] adequate".

AEMO stated that it does not keep formal meeting minutes and that actions from meetings are reflected in adjustments to the System Restart Plan where applicable. It is therefore unclear how effectively issues are being raised and addressed by parties other than AEMO and ElectraNet. Further, it is unclear how effectively changes in the System Restart Plan are understood by parties other than AEMO and ElectraNet.

AEMO stated that it "makes each regional system restart plan available to the registered participants who will be involved in the activation of that plan".

Based on our observations of the development of the System Restart Plan, we consider that the SRWG is a potentially valuable forum for identifying any inconsistencies in understanding the operation of the System Restart Plan (including associated switching arrangements for identified Restoration Options) and could be used as a forum for verifying the feasibility of the System Restart Plan and System Restart SSP. However, this would necessitate a level of mandatory participation. We note AEMO's observation that requiring active participation in working groups and active review of the plans can't be enforced. AEMO also noted that requirements for more layers of review could also have the unintended effect of diluting accountability for the plan overall and the role of each organisation within it.

Findings

We have found no breach of the NER, and accept that responsibility for the plan should rest with AEMO. Other of our findings and recommendations address the dissemination of information and the role of the SRWG. A summary of Findings, recommendations and AER actions is at section 4.15 at the end of this chapter.

4.11 Development of the System Switching Programs for the System Restart Plan

In general, SSPs are developed by TNSPs "for use as required in day-to-day operation in addition to managing emergencies such as system restart".

System Restart SSPs allow the TNSP to operationalise regional Restoration Options set out in the Regional System Restart Procedures (which form part of the System Restart Overview). The SSP consists of a system diagram, subparts of the Restoration Option, followed by the detailed steps required to achieve each of the subparts. The system diagram shows the transmission lines, synchronisation points, static var compensators (SVCs) and the Generators/ Load to be re-energised for the particular Restoration Option. The detailed steps consist of the communication which must occur between ElectraNet, AEMO and Generators/DNSPs (namely obtaining permissions to proceed, advising of steps undertaken, confirming plant status), specific plant switching instructions (e.g. close circuit breaker CB6E6) and checks of the completed operations. The SSP are utilised to coordinate restoration of the system following a major supply disruption.

The System Restart SSPs are not included in the System Restart Plan and there is no specific requirement that they be approved by AEMO.

Box 7 sets out the steps taken when the SSP Restart 2 were updated in 2016.

Box 7: Development of the SSP Restart 2 used on 28 September 2016

2 March 2016—ElectraNet provided an update of the System Restart SSPs to AEMO.

13 June 2016—With the planned closure of Northern Power Station, a former SRAS provider, AEMO revised the System Restart Plan for South Australia, and provided it to ElectraNet for updating switching procedures.

17 June 2016—ElectraNet provided the last update of the System Restart SSPs, including for Restoration Option 2 (SSP Restart 2), to AEMO prior to the 28 September 2016. This version of SSP Restart 2 was used on 28 September 2016.

4.11.1 Relevant NER provisions and assessment

A TNSP's obligation to develop System Restart SSPs comes from several sources:

1. System Restart Overview which applies to the NEM as a whole.
2. Regional System Restart Procedures, which have been designated by AEMO as a 'power system operating procedure' under clause 4.10.1 of the NER. Registered Participants are obliged to observe the requirements of power system operating procedures pursuant to clause 4.10.2(b) of the NER.
3. Delegation by AEMO to TNSPs of some of its system operation powers under an Instrument of Delegation.[271]

We have assessed the effect of each of these sources on the process that was undertaken to develop the System Restart SSPs implemented during the System Restoration period.

System Restart Overview

The System Restart Overview is directed at what occurs in response to a black system or conditions following a major supply disruption with a TNSP's functions listed as those that it will undertake during a black system condition. AEMO devises a number of Restoration Options in recognition that the exact condition of the network after black start conditions cannot be known in advance. The System Restart Overview places an explicit obligation on NSPs to convert AEMO's general instructions into detailed switching steps and makes clear the system restart plan does not include these detailed switching steps.

System Restart Plan for South Australia

The System Restart Plan for South Australia is one of the Regional System Restart Procedures referred to in the System Restart Overview. AEMO had nominated this (but not the System Restart Overview) as a 'power system operating procedure'.[272] Consequently, under NER clause 4.10.2(b), Registered Participants 'must observe the requirements' of the System Restart Plan for South Australia.[273] This obligation to 'observe' suggests no more than that ElectraNet is to follow the procedure in the document; relevantly this document provides an overview of the process, not a detailed description of all of the steps to be taken in every scenario It reflects the nature of the System Restart Plan which is expressed as a broad general strategy of what should be possible or what might need to be done if a black system event occurs. ElectraNet's switching functions as described in the System Restart Plan for South Australia include those that will be required at the time of a black system condition, including to instruct and/or complete network switching during system restart. There is no express or direct reference to any switching procedures that may have been prepared in anticipation of such an event for each of the restoration options, and no express requirement for the switching procedures to correspond with those applied in SRAS testing. In part this may be because there is an understanding that not all aspects of a major supply disruption event can be known in advance.

Delegated functions

AEMO has delegated certain of its power system security responsibilities to each NEM TNSP which are then referred to as "System Operators" for this purpose.[274] Notwithstanding the delegation, AEMO remains liable under the Rules for performance of the delegated rights, functions and obligations.[275] System Operators must carry out their delegated functions as per the delegation instrument and as required under the NER.[276]

Of the powers delegated to ElectraNet, one is relevant to system restart switching:

> *Within the AEMO Operational Zone, AEMO's responsibilities to restore or maintain power system security following a major supply disruption. This delegated function must be carried out in accordance with the System Restart Plan and is restricted to the following activities: upon receipt of a direction under the NEL from AEMO to establish a specified restart path,*

271 NER clause 4.3.3 provides that AEMO may, from time to time, appoint such delegates as it considers appropriate to carry out on its behalf some or all of its rights, functions and obligations under Chapter 4.

272 NER, clause 4.10.1(a)(5); see clause 1(b) of the Plan.

273 NER, clause 4.10.2(b).

274 NER, clause 4.3.3.

275 NER, clause 4.3.3(g).

276 NER, clause 4.3.3(d) and (e).

ElectraNet must develop a detailed switching plan; liaise with AEMO and Registered Participants as necessary in the development of the detailed switching plan; and carry out network switching to implement the detailed switching plan and complete the restoration of load in accordance with the load shedding procedures. This delegated function does not extend to … any network switching in response to a direction under the NEL from AEMO to perform specified network switching; and development of [and compliance with] … ElectraNet's local black system procedures.[277]

To the extent they are aware or ought reasonably to have been aware, System Operators also have a general obligation under clause 4.3.3(e) of the NER to keep AEMO fully and timely informed as to the state of the security of the power system, any present or anticipated risks to power system security, and any action contemplated or initiated to address a risk to power system security or to restore or maintain the power system in a satisfactory operating state.[278]

We have reviewed ElectraNet's actions in respect of a number of obligations it is required to fulfil under the NER, both as the relevant TNSP and as a System Operator with delegated functions from AEMO, including:

1. the obligations associated with the preparation and implementation of switching programs under the System Restart Overview and the System Restart Plan for South Australia, including testing
2. the general obligation to use reasonable endeavours to assist AEMO in the proper discharge of AEMO's power system security responsibilities, and
3. the obligations which are triggered in the event of a major supply disruption.

We assess that ElectraNet complied with its obligations during the System Restoration period.

ElectraNet compliance with switching obligations

On review of ElectraNet's actions, we consider that ElectraNet did fulfil its defined switching obligations relating to the System Restart Plan—as set out in the System Restart Overview and the System Restart Plan for South Australia. It did so on 17 June 2016 by producing the System Restart SSPs from the Restoration Options and by activating the SSPs on instruction from AEMO. We note that ElectraNet's obligations to develop SSPs, include:

1. those under NER clause 3.11.9(i)[279] which extend to testing (discussed above at section 4.3.2)
2. its general obligation to use reasonable endeavours to assist AEMO in the proper discharge of AEMO's power system security responsibilities (discussed at sections 4.3.1 above and 4.13.1 below),[280] and
3. those concerning its conduct on the day of a major supply disruption as set out in the System Restart Plan for South Australia (discussed above).[281]

ElectraNet's actions during the System Restoration period indicate that it did 'observe the requirements' of the System Restart Plan for South Australia. There is no express requirement in the System Restart Plan for South Australia that the System Restart SSP ElectraNet uses on the day reflect either the System Restart SSP submitted to AEMO for the Restoration Options or incorporate the specific switching arrangements for SRAS Providers set out in the SSP used in SRAS testing. This is because the circumstances have to be assessed on the day.

In any case, ElectraNet followed the System Restart SSP that it had previously submitted to AEMO for Restoration Option 2, and for Restoration Option 1 (the interconnector).

Accordingly we consider ElectraNet complied with its obligation under clauses 4.10.2(b) of the NER to observe the requirements of the System Restart Plan for South Australia, as a designated 'power system operating procedure'.

In relation to the relevant SRAS-related power delegated by AEMO, ElectraNet's system restart delegated powers appear to be confined to the time "following a major supply disruption" when it receives a direction from AEMO to establish a specified restart path "in accordance with the system restart plan". As noted above, we consider ElectraNet fulfilled that obligation.

In relation to a System Operator's general obligation to keep AEMO informed, from the evidence available, it is not clear that ElectraNet ought reasonably to have known that Origin's protection setting or the change to the System Restart SSP were an 'anticipated risk'. ElectraNet states that it was not

277 Schedule 1 of ElectraNet Instrument of Delegation from AEMO dated 14 Dec 2013, https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation/Schedules-for-Delegations.

278 NER, clause 4.3.3(e).

279 Formerly NER clause 3.11.5 (Version 71); NER clause 3.11.9(i) provides, "A Network Service Provider must: (1) provide any information to AEMO which AEMO reasonably requires in order for AEMO to assess the capability of a system restart ancillary service to meet the system restart standard; and (2) negotiate in good faith with a prospective SRAS Provider in respect of identifying and, if possible, resolving issues that would prevent the delivery of effective system restart ancillary services proposed by a prospective SRAS Provider; and (3) participate in, or facilitate, testing of a system restart ancillary service proposed to be provided by a prospective SRAS Provider where it is reasonable and practicable to do so, and when participating in or facilitating such activities, the Network Service Provider will be entitled to recover from the prospective SRAS Provider all reasonable costs incurred by the Network Service Provider and for such purposes the activities of the Network Service Provider will be treated as negotiable services."

280 NER, clause 4.3.4(a).

281 To which AEMO's Delegation Instrument also refers.

involved in the procurement process for SRAS, and that it had no exposure to the modelling undertaken by AEMO. As discussed below, and as AEMO has noted, we assess that ElectraNet must necessarily have had some involvement in the process, or should have had. It is apparent, however, that its involvement in that process and its related obligations were limited. ElectraNet fulfilled its obligations in accordance with the established process by submitting its switching procedures to AEMO setting out the action contemplated to restore the power system. In addition, without established or mandated processes under the NER or otherwise for the sharing of information including the System Restart SSP, it is unlikely ElectraNet ought reasonably to have anticipated the risk.

Accordingly, based on the evidence before us, we consider ElectraNet did not breach clause 4.3.3(d) or (e) of the NER.

Information available and guidance for converting general instructions into detailed switching steps

As discussed above, there is an obligation on the TNSP to convert the general instructions from Restoration Options into detailed switching steps. We assess that the intent of this obligation is for the TNSP to develop SSPs, so that a Restoration Option can successfully be implemented.

We note that there is no guidance in either the System Restart Overview or the System Restart Plan for South Australia on the process for converting the general instructions into detailed switching steps.

This poses the question of what information the TNSP should consider in order to understand any technical requirements that could impact the successful implementation of a Restoration Option. We consider that potential sources of information that are available or that could be made available to the TNSP include the LBSPs, information exchanged under communication protocols, information discovered during the SRAS procurement process and information discovered from SRAS testing.

Even if these multiple information sources were made available to ElectraNet, there was no explicit requirement in the Rules or relevant AEMO documentation that ElectraNet have regard to them when developing the System Restart SSP.

With regards to the procurement process and the sharing of LBSPs, we note:

- Origin's EOI for the 2015/16 procurement round, which included details about a soft start, was not provided to ElectraNet as AEMO did not consider it was necessary to do so
- ElectraNet was required to negotiate in good faith with a prospective SRAS tenderer in respect of identifying and resolving issues and to facilitate the testing of SRAS where it is reasonable and practicable to do so. We assess, based on the evidence before us, that ElectraNet did not breach these provisions in relation to Origin, as discussed at section 4.6.3, and
- While AEMO may provide relevant information from the LBSPs to the relevant TNSP, AEMO did not provide Origin's LBSP to ElectraNet and, in any event, the LBSP did not indicate that a soft start was required for QPS5.

We consider the most relevant information source available to ElectraNet for developing System Restart SSPs came from ElectraNet's participation in Origin's annual SRAS tests for QPS5 (see section 4.8 above). Since 2009 the SRAS test procedure and accompanying SRAS test SSP have remained substantially unchanged. The SRAS test SSPs have consistently applied a soft start. These SSPs have been developed and provided to Origin by ElectraNet.

ElectraNet developed the SSP from Origin's SRAS test procedure. Although it had access to this procedure and participated in the development of the testing and the tests themselves since 2009, ElectraNet stated that it was unaware of the soft start requirement for QPS5:

> *Origin did not inform ElectraNet that QPS GT 1 or 2 would be required to 'soft start' to prevent tripping on a hard start, or that there were any technical limitations on the SRAS generator that would prevent energisation of GT5 using normal system operating voltages when being energised via GT1 or 2 via a hard start. ElectraNet's reasonable assumption was that normal operating voltages (0.9—1.1p.u.) would be present on the generator terminals of QPS GT1 or 2, as per normal operating practise and that GT1 was capable of energising GT5 Generator transformer.*

In response to our question of how the SRAS test SSP and the System Restart SSP came to be different, ElectraNet set out the two different switching paths, in particular identifying differences in how TIPS house supply is managed when the network is energised during SRAS testing versus when the network is not energised during a Black Start. It did not explain how they came to be different in relation to the particular circuit breaker that was respectively closed in the SRAS test SSP or open in the System Restart SSP.

In response to our question of whether ElectraNet, for each update of the System Restart SSP utilising QPS SRAS, considered the impact of the change on Origin's ability to deliver SRAS from QPS, ElectraNet stated "ElectraNet does not consider the impact of change on QPS' SRAS capability as this is outside of the role and obligations of ElectraNet as a TNSP".

ElectraNet stated:

> *[a]t no time before 28 September 2016 was ElectraNet aware that Origin were not expecting 'hard starting' their generator during actual system restart as per the system restart procedure. In ElectraNet's experience, the soft starting of a generator transformer is not generally practiced. ElectraNet have significant experience of operating other similar GTs (Mintaro and Port Lincoln) that are able to energise dead systems without the need to 'soft start'.*

We are unable to ascertain whether ElectraNet was explicitly informed of the soft start requirements. We have not been provided with any information that shows that Origin directly informed ElectraNet that a soft start was required at all times. We consider that in order for ElectraNet to provide SRAS test SSPs for QPS5's SRAS tests which specified a soft start, ElectraNet must have had information at some stage to indicate that this was the standard or possibly preferred switching procedure. However, this would not necessarily mean that ElectraNet was aware that QPS5's protection settings were such that it could only be energised using a soft start.

We accept ElectraNet's assessment that soft starts may be uncommon. However, it would seem to follow that ElectraNet should have queried why Origin implemented a soft start in SRAS testing and whether a soft start was implemented because a hard start could not be accommodated. In its System Restart SSP as submitted to AEMO, ElectraNet departed from the SRAS test SSP which specified a soft start. It made assumptions about the operating conditions of QPS5 without checking its assumptions with Origin or communicating to Origin its intention to depart from the SRAS test SSP. Furthermore, as discussed below, ElectraNet did not consider it was required to check this understanding with Origin.

Understanding of roles and responsibilities with respect to the System Restart SSP

ElectraNet stated that it develops the System Restart SSPs from each of AEMO's high-level Restoration Options; an experienced Transmission System Operator analyses the proposed restart path and breaks it down into step-by-step switching actions. ElectraNet advised it undertakes network studies to support the development of the switching programs and that its System Restart SSP were created, reviewed, checked and approved [by ElectraNet] in accordance with its internal processes. ElectraNet stated that "AEMO and other third parties have no role in the development of the detailed switching [program]s". This is consistent with AEMO's view expressed above.

ElectraNet stated that it provides the System Restart SSP to AEMO for verification and approval. ElectraNet provided the updated System Restart SSPs to AEMO on 17 June 2016. There was no explicit request for AEMO to verify or approve these updated SSP.

As set out above, ElectraNet stated that considering the impact of System Restart SSP changes on QPS' SRAS capability was outside its role and obligations as a TNSP. We asked ElectraNet how it assured itself that the relevant SRAS Provider can provide SRAS using the System Restart SSP. ElectraNet responded that AEMO is responsible for procuring SRAS capability. ElectraNet does not assess the capability of SRAS Providers. ElectraNet stated that it is not aware of any external verification of the System Restart SSPs, besides that of AEMO, or testing of the System Restart SSPs performed by third parties.

ElectraNet also stated that Origin was not involved in the development, review, updating or approval of the relevant System Restart SSP, and it understood that AEMO would be responsible for formally providing the relevant System Restart SSP to Origin as the SRAS Agreement is between AEMO and Origin. ElectraNet stated that it assumed that AEMO provided a copy of the System Restart SSP to Origin as AEMO is responsible for procuring SRAS and directing the restart. ElectraNet stated that it assumed that Origin would assess the System Restart SSP and any related impact on their equipment.

As set out in section 4.8 above, Origin had mistakenly received a copy of the System Restart SSP in March 2016 after requesting a procedure to support its SRAS test results from ElectraNet in July 2015. Origin did not review the document and did not identify the differences in switching. Origin otherwise did not receive copies of the System Restart SSPs.

ElectraNet stated that in relation to the switching for QPS5 set out in the System Restart SSP, the March 2016 version, the June 2016 version and the version of the SSP used following the Black System Event had no differences. All of these previous versions of the relevant System Restart SSP apply a hard start with respect to QPS5 SRAS.

AEMO stated:

> *AEMO does not approve the detailed SSPs developed by the generators or NSPs, who are expected to have the expertise in this area … AEMO checks the SSPs on receipt to confirm whether they are consistent with AEMO's overall restoration strategy, but does not*

> *perform a detailed review of each switching step. TNSPs have the expertise in this area and AEMO does not seek to duplicate that.*

AEMO further stated:

> *As per AEMOs procedures [System Restart Overview] it is the responsibility of NSPs to convert AEMOs general instructions into detailed switching steps.*

AEMO stated that "[t]he SRAS test process is the means by which AEMO seeks assurance that the SRAS can be provided. The SSP (extended and modified for test conditions as described above) may be part of that test procedure but it is not individually tested".

Based on these statements, it is apparent that there was a lack of a clear and consistent understanding of the roles in developing, endorsing or approving the System Restart SSP between AEMO, ElectraNet and Origin. Furthermore, there was no established process or practice for provision of the System Restart SSPs to participants with plant involved in the System Restart SSP (in this instance, Origin). This meant there was no formal opportunities or requirement for the relevant participants to check the System Restart SSPs.

We note the new SRAS Guideline (2017) materially addresses this shortcoming as all parties involved in testing (namely the SRAS Provider, any asset owner and the TNSP) must provide formal approval of the test procedure and provide advice to AEMO regarding differences between test arrangements and those that will be used in a major supply disruption.[282]

Findings

While all parties were compliant with the Rules, we found that:

- there was a lack of a clear understanding as to who was responsible for sharing the System Restart SSP with the SRAS Provider
- there was no established process or requirement for ensuring that the System Restart SSP was checked, and
- there was no established process or requirement for identifying and exploring any difference between the System Restart SSP and the SRAS test SSP.

A summary of the recommendations and actions proposed in response to these findings can be found at section 4.15 at the end of this chapter.

4.12 Communication protocols for sharing information

The ability to meet the obligations which result in the production of LBSPs, the System Restart Plan and the System Restart SSP depends upon the sharing of information between AEMO, TNSPs, DNSPs, SRAS Providers and other market participants.

Clause 4.8.12(j) requires AEMO and NSPs to jointly develop communication protocols to facilitate the exchange of all information relevant to the roles played by AEMO, NSPs, Generators and Customers in the implementation of the System Restart Plan. The requirement is an obligation to develop protocols, not an absolute obligation that requires all information be exchanged.

For the purposes of our assessment, we have focussed on this obligation as it applies to AEMO and ElectraNet.

4.12.1 Relevant NER provisions and assessment

AEMO and the NSPs are the primary coordinators of a system restart in the event of a major supply disruption. While AEMO has ultimate responsibility, it is the NSPs that carry out the switching which results in restoration of supply to customers. For this reason, AEMO and NSPs must have a common understanding and agreement for the implementation of the System Restart Plan. Therefore it is appropriate that they jointly develop the communication protocols for giving effect to the System Restart Plan.

AEMO stated that the communication protocols it had in place on 28 September 2016 to meet its obligations under NER clause 4.8.12(j) were:

- "normal communication as defined in SO_OP_3715: Power System Security Guidelines", and
- "specific communication responsibilities and protocols during system restart are defined in the …. System Restart Overview".

The SO_OP_3715: Power System Security Guidelines set out the roles and responsibilities of AEMO and other participants in relation to particular power system security issues. There are several references to the exchange of information in certain circumstances, but no communication protocols specifically to facilitate the exchange of information related to the implementation of the System Restart Plan.

The System Restart Overview sets out the respective responsibilities of participants relating to the activation of a System Restart Plan. These cover high level responsibilities during a black system event and steps that AEMO will undertake to communicate with participants.

282 AEMO, SRAS Guideline (2017); clause 4.2. We also note that the inclusion of this process into the new SRAS Guideline is consistent with AEMO's Recommendation 13 in the AEMO Final Report.

The communication protocols in the System Restart Overview are very broadly described and include little detail. They are limited to communications that AEMO and other participants would be expected to undertake *during* a major supply disruption or power system restoration phase. The protocols contain no comprehensive procedures *in preparation* for such events such as the information that might need to be exchanged prior to an event occurring and the mechanism by which such exchanges will occur.

AEMO stated that it "works very closely with ElectraNet in developing the [system restart] plan" both through direct correspondence and through the SRWG. AEMO also pointed to communication that took place during the System Restoration period between itself and ElectraNet and the Generators, as well as between the DNSP and ElectraNet, all in accordance with the protocols set out in the System Restart Overview.

In response to our question regarding the communication protocols that were in place on the date of the collapse of the power system, ElectraNet stated that "ElectraNet and AEMO do not have a formal documented communication protocol". ElectraNet further stated that "[f]ormal communications on 28 September 2016 were carried out between AEMO's Control Room and ElectraNet's Control Room as per the requirements of AEMO's document … System Restart [Plan for] South Australia". ElectraNet later clarified that it was involved in the development of both the System Restart Overview and System Restart Plan for South Australia through the SRWG. It stated that "AEMO and ElectraNet's practice of communications is recognised" in the System Restart Overview and that both documents reflect the "ordinary course of practice" or "an agreed method of operating and communicating, including in relation to the implementation of system restart plans." ElectraNet further submitted that the rule "does not require a specific written document detailing intended communication between parties".

Our review has found many instances where there was a lack of shared understanding of the roles, responsibilities and requirements of AEMO, NSPs, and SRAS Providers have during the system restoration process and what information must be exchanged– from the procurement stage through to implementing the System Restart Plan.

This is evidenced by:

- ElectraNet's statement that it was unaware of the 'soft start' requirement for QPS5, and
- statements by Origin and AEMO that they were unaware that the SRAS test SSP differed from the relevant System Restart SSP.

We note that the requirement for communication protocols was introduced into the NER following a proposal by NEMMCO.[283] In its proposal, NEMMCO submitted:

> *As NSPs will be undertaking physical switching in response to NEMMCO instructions it is vital that likely responses to, and impact of, possible switching combinations is well understood*[284]

It is now apparent how critical this is and the communication protocols should expressly facilitate the exchange of such information.

We consider that improvements to the communication protocols would assist all participants involved in a system restart. Any such changes should fully reflect participants' obligations and align with other of our findings and recommendations that a TNSP should be required to facilitate ongoing testing and the role of the SRWG should be formalised. In coming to this view, we found observations made by NEMMCO in its rule change submission informative.

We note ElectraNet's submission that the rule does not require a specific written document. We consider that any communication protocol must be in writing and identified as the protocol to be followed so that there is transparency and a shared understanding of expectations and obligations.

Finally, we note that AEMO's SRAS Guideline (2017)[285] has clarified some of the roles and responsibilities and information to be shared with respect to AEMO, SRAS Providers and NSPs during procurement and testing. Nevertheless we consider there to be opportunities to further strengthen the system restoration process without compromising the need for participants to remain sufficiently flexible to respond to major supply disruptions. ElectraNet has accepted that it could be useful to develop a more detailed written communications protocol with AEMO.

283 See https://www.aemc.gov.au/rule-changes/system-restart-ancillary-service-arrangements-and.

284 NEMMCO, *Review of system restart ancillary service arrangements*—Final Report Volume 1 (Recommended Arrangements) 8 July 2004, p. 47. https://www.aemc.gov.au/sites/default/files/content/87e0ca46-7959-42d9-bac6-954f0ed9d554/NEMMCO-Final-Report-Vol-1.pdf.

285 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, December 2017, p. 23.

Findings

As there were communication protocols in place during the System Restoration period, those included in the System Restart Overview and the System Restart Plan for South Australia, there was compliance with the NER.

We note that the intent of the NER provision is to cover communication at the time that an event occurs and the system restart plan needs to be implemented. While we agree with AEMO that this is what is required under the NER provision, we find that the protocols could be improved by including more detailed guidance and facilitating the exchange of information as part of any planning for a system restart, not only at the time of a system restart.

We discuss how this would best be achieved in the Findings, recommendations and AER actions section (section 4.15) at the end of this chapter.

4.13 Reasonable endeavours to assist AEMO

ElectraNet, in its capacity as a NSP, is required to use its reasonable endeavours to assist AEMO to discharge its power system security responsibilities. We have considered whether ElectraNet has met this broad obligation in relation to the delivery of SRAS.

4.13.1 Relevant NER provisions and assessment

Under clause 4.3.4(a) of the NER, NSPs are required to use reasonable endeavours to exercise their rights and obligations in relation to their networks so as to cooperate with and assist AEMO in the proper discharge of AEMO's power system security responsibilities.

We consider that ElectraNet did use its reasonable endeavours in respect of its broad obligation to cooperate and assist AEMO.

However, we consider that there were additional steps ElectraNet could have taken, namely, to consult with AEMO and/or Origin on the variation between the System Restart SSP and the SRAS test SSP.

AEMO power system security responsibilities

AEMO's responsibilities are set out in clause 4.3.1 of the NER. We consider AEMO's responsibility 'to utilise resources and services provided or procured as ancillary services or otherwise to maintain or restore the satisfactory operating state of the power system' to be the most relevant to this matter.

Relevantly:

- ancillary services are defined as encompassing non-market ancillary series, of which SRAS is one such service, and
- a key purpose of SRAS is the restoration of power system security (see clause 4.2.6(e)).

Network switching is an essential part of operating network equipment and must be utilised for the purpose of restoring power system security. This is reflected in the NER through:

- obligations on DNSPs to notify AEMO of certain switching activities which could materially affect power flows at points of connection to a transmission network (clause 4.10.4), and
- one of AEMO's power system security responsibilities, which is to ensure that high voltage switching procedures and arrangements are used by NSPs to provide adequate protection of the power system (clause 4.3.1(d)).

The NER also recognise the role of NSPs in the delivery of SRAS, including through obligations imposed on:

- AEMO to consult with TNSPs to identify and resolve issues regarding the capability of SRAS proposed to be provided by a SRAS Provider (clause 3.11.7(b))
- a NSP to negotiate in good faith with a potential SRAS Provider (clause 3.11.9(i))
- System Operators with delegated functions—in the case of ElectraNet, to establish a specified restart path on direction from AEMO following a major supply disruption, in accordance with the System Restart Plan, and
- TNSPs tasked by AEMO in the System Restart Overview with devising the detailed switching of the restart paths established by AEMO to utilise SRAS Providers to energise other generators.

Accordingly, we consider that the provision of switching with due care and skill is an obligation which ElectraNet has with respect to its network and that switching related to SRAS assists AEMO to ensure that practical and effective use of SRAS is adopted in restoring the power system.

We have considered the steps ElectraNet took to cooperate and assist AEMO in light of its rights and obligations:

- ElectraNet translated the higher level restart test procedures into specific switching in accordance with the System Restart Plan, thereby providing information that appears to have satisfied AEMO
- ElectraNet participated in SRAS testing in line with its role as the TNSP
- in developing and disseminating the System Restart SSP which were used during the System Restoration period, ElectraNet provided a copy of the System Restart SSP to AEMO. It did this on 17 June 2016, and
- ElectraNet followed the System Restart Plan on the day of the Event.

Of the circumstances relevant to our assessment of whether ElectraNet used its reasonable endeavours, we note in particular that:

- No formal process for the sharing of the System Restart SSP by ElectraNet with parties, besides AEMO, was in place or specifically required by the NER or the SRAS Agreement.
- No formal process for the approval of the System Restart SSP by AEMO was in place or specifically required by the NER or the SRAS Agreement.
- It was generally understood by participants that the SRAS test SSP may in some circumstances differ to the System Restart SSP used at the time of a major supply disruption but no formal process for identifying or exploring differences between the System Restart SSP and any SRAS test SSPs was in place, or specifically required by the NER or the SRAS Agreement.
- ElectraNet was not party to the SRAS Agreement, and submitted that it therefore assumed that AEMO was responsible for sharing the System Restart SSP with the SRAS Providers. We note that this assumption was made in the absence of any formal processes for the sharing of the System Restart SSP, as noted above.

Findings

Having regard to the regulatory framework as administered by AEMO, we conclude that on balance, ElectraNet did use its reasonable endeavours in respect of its broad obligation to cooperate and assist AEMO with system restoration. At the same time, we consider that there were possible additional steps ElectraNet could have taken, namely, to have consulted with AEMO and/or Origin on the change to the System Restart SSP. Our recommendations in relation to NSPs obligations in the SRAS process are fully discussed in the Findings, recommendations and AER actions (section 4.15) at the end of this chapter.

4.14 AEMO's power system security responsibilities

AEMO has a broad role in respect of power system security through a framework of responsibilities and principles. AEMO is to use reasonable endeavours in fulfilling these responsibilities. We have considered whether AEMO has met this broad obligation in relation to the delivery of SRAS.

4.14.1 Relevant NER provisions and assessment

As set out at Appendix A of this chapter, AEMO has power system security responsibilities under clauses 4.3.1 and 4.2.6 of the NER. Clause 4.3.2(a) requires AEMO to use reasonable endeavours to achieve the power system security principles. What amounts to "reasonable endeavours" is what was reasonably required to be done by AEMO in the circumstances at that time, having regard to AEMO's role, including its powers under the NEL and NER, its capacity and its responsibilities and obligations.

The power system security responsibilities under clause 4.3.1 of the NER which we have identified as relevant to this investigation include:[286]

> (d) to ensure that *high voltage* switching procedures and arrangements are utilised by *Network Service Providers* to provide adequate protection of the *power system*
>
> (g) to ensure that all *plant* and equipment under its control or co-ordination is operated within the appropriate operational or emergency limits which are advised to AEMO by the respective *Network Service Providers* or *Registered Participants*
>
> (h) to assess the impacts of technical and any operational *plant* on the operation of the *power system*

286 NER, clauses 4.3.1(d), (g), (h), (o), (p) and (w).

(o) to utilise resources and services provided or procured as *ancillary services* or otherwise to maintain or restore the *satisfactory operating state* of the *power system*

(p) to procure adequate *system restart ancillary services* in accordance with clause 3.11.9 to enable AEMO to coordinate a response to a *major supply disruption,*[287] and

(w) to ensure that each *System Operator* satisfactorily interacts with *AEMO*, other *System Operators* and *Distribution System Operators* for both *transmission* and *distribution network* activities and operations, so that *power system security* is not jeopardised by operations on the *connected transmission networks* and *distribution networks.*

These responsibilities are discussed below.

High voltage switching procedures and arrangements utilised by NSPs

Taking high voltage equipment out of service and returning it to service (via switching) can impact the overall power system, accordingly greater oversight and control is required around high voltage equipment than lower voltage equipment. Undertaking equipment switching is a fundamental part of a NSP's role in constructing, operating and maintaining its network.

The proper switching of high voltage equipment involves two elements:

- managing the safety of personnel and equipment, and
- managing the effect of changing equipment status on the power system.

The management of personnel and equipment (that is ensuring that equipment is taken out of and returned to service in a safe, well documented and rigorous process) is the role of the NSP while the management of the power system (ensuring that the impact of outages on the power system is identified and effectively managed) is AEMO's mandate. AEMO manages this predominantly through an established process of requiring NSPs to provide AEMO with information about the timing and impact of upcoming planned outcomes (for example through the Network Outage Schedule), ensuring that pieces of critical equipment are returned to service appropriately (for example, ensuring NSPs return multiple lines to service in the proper sequence) and that NSPs only take equipment in and out of service after obtaining AEMO's express permission to proceed.

We do not consider that AEMO's role extends to reviewing the particular sequence by which a piece of high voltage equipment is taken in or out of service (i.e. the system switching program) or even to giving direction to NSP as to what a system switching program needs to contain. This is within the NSP's role and expertise and AEMO is entitled to assume that NSPs will fulfil this role appropriately.

With regards to system restoration, we consider AEMO met the requirement in 4.3.1(d) to use reasonable endeavours by requiring that TNSPs convert the restoration options into detailed switching programs and monitoring that ElectraNet had done so. We do not consider AEMO was required to review the relevant SSPs to meet its reasonable endeavours obligation.

Plant and equipment operated within limits advised by NSPs or Registered Participants

AEMO's conduct in relation to the switching procedures is relevant to our assessment of whether it used its reasonable endeavours to fulfil its responsibilities under both clauses 4.3.1(g) and (h) of the NER.

Our assessment recognises that:

- AEMO did not control the plant and equipment. Its role was to coordinate via SRAS Guidelines, applicable SRAS Agreements, the System Restart Plan, the LBSPs, and oversight of the testing for the delivery of SRAS by SRAS Providers.
- ElectraNet and Origin were responsible for advising AEMO of any operational limits relating to their respective SRAS plant and equipment, and for operating within those limits, and furthermore, have a general obligation under the NER to assist AEMO (see section 4.13 of our report).

The following steps taken by AEMO are relevant to these power system security responsibilities:

- It met its obligations under the NER to prepare, and where required by the NER, did so with input from the relevant participants. It prepared the relevant guidelines and plans, entered SRAS Agreements to ensure adequate SRAS and ensured that testing was undertaken in accordance with those SRAS Agreements.
- During the procurement of SRAS, AEMO required tenderers in their Expression of Interest at Schedule 3, item 1 to identify the proposed approach to SRAS delivery. This included the manner of starting, capability

287 The NER clause 4.2.6(e) principle mirrors the NER clause 4.3.1(p) power system security obligation, requiring: 'Sufficient system restart ancillary services should be available in accordance with the system restart standard to allow the restoration of power system security and any necessary restarting of generating units following a major supply disruption'.

diagrams and Generator Modelling Data (including protection settings) to be submitted to AEMO. Origin specified a soft start for QPS5 in its materials.

- AEMO carried out modelling of the Restoration Options to ensure that it could derive a combination of SRAS that would enable it to meet the System Restart Standard.
- During SRAS testing, using test procedures AEMO approved, a soft start was used by ElectraNet. The SRAS tests demonstrated that SRAS was able to be successfully delivered to the delivery point.

Under NER chapter 4, it is apparent that AEMO is reliant to varying degrees on other market participants for technical expertise and for the execution of certain acts especially where it involves the plant or equipment of another participant. AEMO has powers to obtain the information it needs to manage SRAS under SRAS Agreements, the System Restart Plan and the LBSPs, and to "make accessible" such information as it "considers appropriate".[288] It is open to AEMO to form its own judgement as to the information it needs to perform its functions and as to what other participants need to perform their obligations.

The NER does not require AEMO to directly manage switching. We accept that AEMO's approach to coordination was premised on its understanding that the SRAS Provider is responsible for the delivery of SRAS to the delivery point and so is responsible for the switching to the delivery point.

Having regard to the above, and taking into account that the reasonable endeavours standard does not impose an absolute obligation to take all possible steps, we consider that AEMO took reasonable steps to ensure that all plant and equipment under its control or co-ordination was operated within the appropriate operational or emergency limits which were advised to AEMO at the time. It also took reasonable steps to assess the impacts of technical and any operational plant utilised in the provision of SRAS on the operation of the power system as part of its preparation for and delivery of SRAS.

Use ancillary services to restore the satisfactory operating state of the power system

AEMO is obligated to use reasonable endeavours to utilise resources and services provided or procured as ancillary services or otherwise to maintain or restore the satisfactory operating state of the power system.

- After declaring a Black System Event at 16:25 on 28 September 2016, AEMO and ElectraNet commenced planning the restart of the South Australian electrical sub-network.
- AEMO activated the QPS SRAS Agreement it had in place for the South Australian electrical sub-network as part of the System Restart Plan at 16:32.[289]

On the basis of these actions we find that AEMO met its obligations under NER 4.3.2(a) with respect to its power system security obligations under NER 4.3.1(o).

Procure adequate SRAS

AEMO is obliged to use reasonable endeavours to meet the broader power system security responsibility of procuring adequate SRAS to enable AEMO to co-ordinate a response to a major supply disruption.[290]

In relation to the 2014-15 procurement of SRAS, we find that AEMO used reasonable endeavours; that is, it did what was reasonably required to be done in the circumstances, having regard to AEMO's role, including its powers under the NEL and NER, its capacity and its responsibilities and obligations, to fulfil its obligation to procure adequate SRAS to enable AEMO to co-ordinate a response to the Black System Event. We have come to this conclusion on the basis of the facts set out above, and summarised below, namely that AEMO:

- pursued an open tender process to ensure that the available restart options were before AEMO for assessment
- undertook modelling to ensure that the System Restart Standard would be met by the short-listed tenderers, and
- entered into SRAS Agreements with SRAS Providers in order to have available the required capacity to meet the System Restart Standard.

We had regard to DGA Consulting's report which reviewed the modelling and outcomes of the SRAS tender process.[291] DGA Consulting found that AEMO had met the System Restart Standard.

In relation to the 2016 procurement of SRAS to replace the Northern Power Station SRAS capacity, AEMO used reasonable endeavours to fulfil its obligation to procure adequate SRAS to enable AEMO to co-ordinate a response

288 NER, clause 4.3.2(d)(1).

289 The Mintaro SRAS Agreement was not activated.

290 NER, clause 4.3.1(p) and clause 4.3.2(a).

291 DGA Consulting, *Independent Review of System Restart Ancillary Service Process Improvements*, 30 June 2015, pp. 27 and 29.

to the Black System Event. We have come to this conclusion on the basis of the facts set out above. Namely, that AEMO:

- sought tender applications from a range of possible sources
- fully explored the capabilities of the tender options
- undertook modelling to ensure that the System Restart Standard would be met by the short-listed tenderers, and
- entered into an SRAS Agreement with Synergen in order to have available the required capacity to meet the System Restart Standard.

We reviewed the modelling which AEMO submitted to us as evidence that the Mintaro SRAS capacity enabled the System Restart Standard to be met in the South Australian electrical sub-network.

We therefore assess that AEMO met its obligations to achieve power system security under clause 4.3.2(a) of the NER with respect to the provision of SRAS (under clause 4.3.1(p) of the NER) and with respect to the provision of SRAS to meet the System Reliability Standard (under clause 4.2.6(e) of the NER).

Ensure that each System Operator satisfactorily interacts with AEMO, other System Operators and Distribution System Operators

There is a further broad obligation on AEMO under clauses 4.3.1(w) and 4.3.2(a) of the NER that require AEMO to use reasonable endeavours to ensure that that each System Operator satisfactorily interacts with AEMO, other System Operators and Distribution System Operators for both transmission and distribution network activities and operations, so that power system security is not jeopardised by operations on the connected transmission networks and distribution networks.

In assessing whether AEMO met its broad obligations in relation to clauses 4.3.1(w) and 4.3.2(a) of the NER, we have had regard to the transcripts of conversations, records of communication and information provided by participants regarding the interaction between AEMO, ElectraNet and SAPN during the restoration of the South Australian electrical sub-network. We conclude that the three parties communicated in an operationally constructive and timely manner to ensure that the restoration was carried out as safely and efficiently as possible.

We therefore find that AEMO complied with its obligations to achieve power system security under clause 4.3.2(a) of the NER by ensuring that System Operators interact satisfactorily under clause 4.3.1(w) of the NER.[292]

Findings

AEMO used reasonable endeavours to comply with the power system security responsibilities relevant to the delivery of SRAS. We formed this view based on the information available to AEMO at the time, the actions undertaken by AEMO, and the results of those actions.

However, we recommend that AEMO take steps to improve the sharing of information between participants. We discuss how this would best be achieved in the Findings, recommendations and AER actions section (section 4.15) at the end of this chapter.

292 NER, clause 4.3.2(a).

Changes made to SRAS Guideline since September 2016

Subsequent to the events of 28 September 2016, AEMO undertook an extensive consultation process before releasing updated SRAS Guideline on 15 December 2017.

As part of this consultation, the AER recommended that:[293]

- AEMO provide more clarity regarding the specification of roles and responsibilities of the relevant parties involved in the SRAS process
- AEMO require formal arrangements to be put in place, and evidence provided of the existence of arrangements, between SRAS providers and any third party or NSP involved in the delivery of SRAS
- AEMO provide information identified through the procurement process and the SRAS Agreement to TNSPs for use in devising System Restart switching arrangements via formal processes
- AEMO provide additional guidance in the Guideline:
  - regarding NSPs' obligations to assist prospective SRAS tenderers identify and where possible resolve issues around delivery of SRAS (clause 3.11.9(i) of the NER)
  - regarding AEMO's obligations to consult with NSPs to identify and resolve issues in relation to the capability of proposed SRAS (clause 3.11.7(b) of the NER)
  - in relation to what is contemplated in certain areas of the Guideline/SRAS Agreement relating to the potential of SRAS equipment to affect power system security
- AEMO include further details in the pro forma SRAS Agreement:
  - Around technical requirements of the SRAS Agreement for cross check with LBSPs
- the proposed surprise testing regime be enhanced via requiring formal approvals of the test procedures and test switching arrangements by NSPs and relevant third parties. This would also include verification of whether the test switching arrangements were consistent with those to be used in a real life black start. Where different, we recommended the SRAS provider be required to explain any differences and warrant that this difference would not affect delivery of the service, and
- AEMO approval of the SRAS test procedure be contingent upon receiving approvals from relevant third parties and NSPs. AEMO to independently review any implications or risk associated with any differences between test and system restart switching arrangements.

In response to our submission, AEMO agreed that the Guideline should make clear the respective roles and responsibilities of AEMO, the SRAS Provider, TNSP and other relevant third parties. This included that:[294]

- SRAS Providers are responsible for managing and identifying all technical issues up to the delivery point (to the shared network)
- AEMO is responsible with TNSPs for identifying issues in the network from the delivery point
- each party involved in the delivery of SRAS (i.e. SRAS Provider, TNSP, third party equipment owner) has to provide confirmation that there are documented arrangements in place to ensure SRAS can energise the delivery point and they will participate in testing.

AEMO also amended the Guideline to:

- make clear AEMO's intention is to seek verification by the relevant TNSP of technical information provided by a prospective SRAS Provider in relation to the provision of a particular SRAS, prior to contracting that SRAS,[295] and
- explicitly refer to the role of NSPs pursuant to clause 3.11.9(i). The Guideline made it clear that specific requirements set out elsewhere in the Guideline (for NSPs to provide information, advice and assistance to AEMO for some aspects of the procurement and testing process for SRAS) did not limit the obligations or rights of NSPs under clause 3.11.9(i) and in relation to preparing LBSPs.[296]

293 AER, *AER Submission in response to AEMO's Draft SRAS Guidelines and SRAS Agreement*, October 2017.

294 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, December 2017, p. 29.

295 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, December 2017, p. 29.

296 AEMO, [Final] *SRAS Guideline* (marked-up), December 2017, p. 8.

AEMO did not provide any guidance on its expectations in relation to NSPs meeting the obligation of clause 3.11.9(i) in the SRAS Guideline, as AEMO 'considers that the breadth of the NER requirements is appropriate and does not warrant further detailed specification at this stage'.[297] AEMO stated that it remains open to development of protocols with TNSPs with the benefit of experience.[298]

AEMO amended the SRAS Guideline to explicitly state that the terms of any SRAS offer and any subsequent agreement, should be consistent with the SRAS Provider's LBSP.[299] It also amended the final pro forma SRAS Agreement to provide additional guidance that all components of SRAS equipment should be specified, including third party assets.[300] With regards to our recommendations regarding testing AEMO amended the final SRAS Guideline to:

- make it clear NSPs/third party equipment owners are to provide approvals for test procedures and AEMO approval is conditional on this. AEMO included additional guidance in the SRAS Guideline on the matters to be approved.[301]
- explicitly reflect AEMO's expectation that the test procedure for SRAS should replicate that used following a major supply disruption and where different, test procedures must:
    i. identify the differences
    ii. explain why the test procedure cannot reasonably replicate that process
    iii. specify what additional or different steps are required to provide the SRAS following a major supply disruption, and who will take those steps, and
    iv. include evidence demonstrating that those steps can be successfully performed with no adverse impact on the delivery of SRAS.[302]

AEMO did not consider additional warranties, beyond those set out in the SRAS Agreement, from the SRAS Provider (as to why a difference between the test and system restart switching arrangement exists and that they are satisfied that the difference will not compromise SRAS delivery) were required. AEMO also considered that matters relating to the development of the System Restart Plan and associated switching programs are beyond the scope of the SRAS Guideline.[303]

AEMO advised that it did not intend to independently review the test procedure (as suggested where there were differences between the test and system restart switching arrangement) beyond a checklist exercise that the relevant parties have provided the requisite approvals. AEMO did make clear in the final Guideline that it would not be independently reviewing the procedure.[304]

297 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, December 2017, p. 25.

298 Ibid.

299 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, December 2017, p. 29.

300 AEMO, [Final] *SRAS Agreement Proforma*, December 2017, p. 25, 28.

301 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, December 2017, p. 23.

302 AEMO, [Final] *SRAS Guideline* (marked-up), December 2017, p.12-13.

303 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, 15 December 2017, p. 23.

304 Ibid.

4.15 Findings, recommendations and AER actions

4.15.1 Arising from 4.4: SRAS deployment during the System Restoration period

Findings

Origin met the requirements for SRAS deployment under the NER.

During the System Restoration period, Origin was required to comply with a number of obligations including that it follow AEMO's instructions, and comply with the relevant provisions of its SRAS Agreement and its LBSP. On review of Origin's actions, we consider Origin did fulfil such obligations under clauses 3.11.1(d), 3.11.9(d), 4.8.14(b) and 4.9.3A(d).

While Mintaro was also not available during the System Restoration period, we note that the likely cause of this was lightning damage[305] and AEMO's advice that Mintaro was neither needed nor called upon. We have therefore not explored further whether Synergen could have taken additional steps to comply with its obligations under its SRAS Agreement.

No further recommendations or actions are proposed in relation to these clauses.

4.15.2 Arising from 4.6: SRAS Procurement

Findings

The obligations arising from SRAS procurement for both AEMO and ElectraNet were complied with in the period prior to and during the System Restoration period.

For the initial 2015 NEM-wide procurement for South Australia, AEMO met the procurement objective of reasonable endeavours to procure SRAS in accordance with the NER and AEMO's SRAS procurement guidelines (2014) in compliance with clause 3.11.4A(b) and 3.11.5(a1).[306] AEMO also produced compliant SRAS Guidelines in accordance with clauses 3.11.4A(c) to (f) and 3.11.5(b).[307]

In 2016, AEMO was again required to procure SRAS to meet the System Restart Standard but under a different rule requirement.

The procurement of Mintaro SRAS in addition to the existing Quarantine SRAS could meet both components of the System Restart Standard. Given the limited availability of SRAS facilities and the process AEMO undertook to assess potential options, we consider AEMO has used reasonable endeavours to acquire appropriate SRAS to meet the System Restart Standard at least cost in the circumstances. We therefore assess that AEMO has complied with the obligations under clause 3.11.7(a1) of the NER.[308]

With regards to ElectraNet's obligations to negotiate in good faith with, and facilitate the testing of, prospective SRAS providers (in this case Origin), we conclude there is no evidence to suggest ElectraNet did not comply with clause 3.11.5(f).

While all relevant parties complied with the requirements of the NER, the procurement process presented an opportunity to identify the need for a soft start requirement of QPS5 and for this to be communicated to all the relevant parties. We considered that improvements to AEMO's SRAS Guidelines could ensure relevant technical requirements were identified in future procurement processes.

The AER made a submission to AEMO's 2017 consultation on the revised SRAS Guidelines, recommending AEMO provide greater clarity and guidance of the roles and responsibilities of parties during the procurement process.

The submission recognised that the NER framework for procurement changed since the 2014/15 procurement process (see appendix A below). Relevantly, a new obligation was imposed pursuant to clause 3.11.7(b) requiring AEMO to consult with the NSP to identify and resolve issues in relation to the capability of any SRAS proposed to be provided by a prospective tenderer. We consider that this obligation will elicit new information that comes to light during the procurement of SRAS. By exchanging any such information between the relevant NSP and AEMO, there is an opportunity for the parties to address any issues that may compromise the NSP's ability to ensure SRAS can successfully be delivered under black start conditions. This is then relevant to the development of System Restart SSPs.

We also noted that the SRAS Guidelines are no longer required under the NER to direct that a NSP or other Registered Participant should assist a prospective SRAS tenderer to identify and resolve, where possible, issues that would prevent the delivery of SRAS.[309] The obligation on a NSP to negotiate in good faith with a prospective tenderer, however, remains, pursuant to clause 3.11.9(i)(2).

We consider the revised SRAS Guideline (2017) goes some way towards clarifying AEMO's expectations of NSPs interactions with the prospective SRAS provider and AEMO.

305 AEMO, Final Report, p. 80.

306 In accordance with the applicable version of the NER, Version 71.

307 In accordance with the applicable version of the NER, Version 64.

308 In accordance with the applicable version of the NER, Version 79.

309 As previously required by NER clause 3.11.5(b) under Version 64 (in effect when AEMO published the SRAS Guidelines).

With regards to more detailed guidance on the process for TNSP involvement in the SRAS Guideline, AEMO stated it "remains open to the development of protocols with the TNSP with the benefit of experience".[310]

AEMO also adopted our recommendations[311] to include in the new SRAS Guideline (2017):

- an explicit requirement that the SRAS Provider, in consultation with any relevant third party (eg. SRAS equipment owner where they are not the SRAS Provider), the TNSP or DNSP (as the case may be), proactively identify any issues with the proposed SRAS provision internal to the delivery point and identify any technical requirements in providing the proposed SRAS, and
- that it is AEMO's role, with the assistance of the NSP, to identify any issues with the proposed SRAS provision external to the delivery point.

We also recommended that AEMO provide more guidance regarding the type of technical information to be elicited by prospective SRAS Providers during the procurement process and for this to be explicitly set out in the SRAS Agreement. On balance, we consider the new SRAS Guideline and pro forma SRAS Agreement go a material way towards ensuring that technical information about a SRAS is clear. AEMO could also consider include requiring plant specific technical requirements to be specified, in addition to the location and components of SRAS equipment, in the pro forma SRAS Agreement. This could then be cross-checked with the applicable LBSPs.

In light of the changes made in the SRAS Guideline (2017), no further recommendations or actions are proposed in relation to the procurement process.

4.15.3 Arising from 4.8: Fulfilment of SRAS testing requirements

Findings

Both Origin and AEMO complied with their SRAS testing requirements.

AEMO complied with its obligation to develop and publish guidelines for undertaking the physical testing of SRAS, under clause 3.11.4A(e)(2) of Version 64 of the NER, which were in effect at the time AEMO published the SRAS Guidelines (2014).

In addition, Origin undertook annual SRAS testing in accordance with its SRAS Agreement obligations. Origin completed the most recent SRAS test on 21 May 2016. It successfully demonstrated that it could meet the capability and deliverability requirements specified in its SRAS Agreement.

Despite this, a lack of understanding among the relevant participants about the required switching procedures for QPS5 undermined the availability of QPS5 during the System Restoration period.

We consider that, to ensure the SRAS test closely reflects the actual use of the service, the SRAS test should simulate as closely as possible a real black system event. The SRAS test procedure and SSP are to be as similar as possible to those to be applied in the event of a real black system event.

QPS5 was unique because that generating unit utilised an internal network. AEMO notes that "no other SRAS procured in the NEM involves an internal network within the contracted generating system". This unique feature has now been modified so that soft start is no longer necessary.

It is clear from comments made to us by AEMO, Origin and ElectraNet that there were variations in understanding of the requirement to implement a soft start of QPS5. It is our assessment that ElectraNet was at the very least 'involved' in the process of preparing QPS to provide SRAS. AEMO notes that "TNSPs are not involved in the commercial aspects of AEMO's SRAS procurement, but they do provide input to the technical assessment AEMO conducts as part of the process". AEMO concludes that ElectraNet appeared not to "realise the significance of the gradual energisation (or 'soft start') of the feeder to QPS5 that ElectraNet had prepared for SRAS tests".

More broadly, our review of the testing arrangements for QPS5 highlighted differences in understanding as to the roles and responsibilities of the SRAS provider, the NSP, the SRAS equipment owner (where applicable) and AEMO in the SRAS testing. This, in addition to our view there ought to be greater cross linking between test switching arrangements and those planned to be used in a real life event, was the subject of our submisson to AEMO's SRAS Guideline consultation.

AEMO adopted our recommendations[312] to include in the new SRAS Guideline (2017):

- a requirement for formal approvals by the TNSP and SRAS equipment owner of test procedures that would form part of the evidence of satisfactory completion of the SRAS test requirements, and
- test procedure should set out any differences between the SRAS test SSP and switching arrangements to be used in a major supply disruption [i.e. the System Restart SSP] and the basis for the difference.

310 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, p. 25; https://www.aemo.com.au/Stakeholder-Consultation/Consultations/SRAS-Guidelines-2017

311 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, pp. 25, 29.

312 AEMO, *SRAS Guideline and NSCAS Tender Guidelines Final Report*, December 2017, p. 23.

The AER also recommended in its SRAS Guidelines submission that AEMO, as the party responsible for final approval of the SRAS test procedures, should ensure that the approval process is rigorous, standardised and consistently applied. In particular we recommended AEMO independently review the implications and risks associated with differences identified by the SRAS Provider/NSP/third party between the test switching arrangements and those to be used during a major supply disruption.

AEMO stated in the SRAS Guidelines (2017) it did not intend to independently review the test procedures beyond a checklist exercise that the relevant parties have provided the requisite approvals.[313]

The AER notes that the revised SRAS Guideline significantly addresses the potential for misalignment in information associated with the SRAS procurement and testing steps. In addition, while we acknowledge that the arrangements which existed at QPS5 may be somewhat unusual, we nevertheless consider that processes could be strengthened so that any differences or unusual configurations are identified and addressed in testing and are made known to the relevant participants including AEMO. We consider AEMO's requirement to compare black start testing arrangements with those to be utilised in a real life scenario, ought to be captured in the NER.

We also agree with AEMO's view that there is merit in strengthening the applicability of the SRAS process (including procurement, testing and provision) to NSPs, particularly as NSPs are not parties to SRAS Agreements. The NER applicable at the time SRAS was procured in South Australia did not require an NSP to conduct testing of SRAS with an SRAS Provider. The most a NSP had to do was "participate in, or facilitate, testing of" SRAS[314] and assist a *prospective* tenderer of SRAS to identify and, if possible, resolve issues that would prevent the delivery of SRAS[315].

This raises a concern about the term "prospective" in respect of an SRAS Provider, which is now found in NER cl 3.11.9(i). We consider the obligations imposed on an NSP to use its reasonable endeavours to support the effective delivery of SRAS should apply both to testing of prospective SRAS (which we take to mean prior to the entry into a SRAS Agreement), and to SRAS already the subject of an SRAS Agreement (e.g. periodic testing to confirm ongoing viability). Most importantly, this should apply during a major supply disruption when AEMO is actually deploying SRAS to meet the System Restart Standard.

A range of misunderstandings and information asymmetries undermined the efficacy of system restoration on 28 September 2016 as evident from the following points:

- ElectraNet stated '[a]t no time before 28 September 2016 was ElectraNet aware that Origin were not expecting 'hard starting' their generator during actual system restart as per the system restart procedure. …'.
- Origin had provided some information during the procurement and testing processes regarding its soft start requirements but it was unclear whether the full implications were understood.
- AEMO stated that neither AEMO staff nor Origin staff involved in the SRAS testing were aware that the System Restart switching procedures developed in June 2016 were different from those of the SRAS May 2016 test for QPS.[316]

This indicates that there is a need in the NER for an encompassing obligation on NSPs to be involved in testing, endorsement and delivery of SRAS before and after the SRAS Provider and AEMO enter into a formal SRAS Agreement, and on deployment of SRAS in a major supply disruption.[317]

Proposed AER actions:

4.1 AER to propose a rule change to clarify the TNSP's involvement in SRAS process beyond procurement. This involvement to extend to facilitating ongoing testing of SRAS to ensure that SRAS continues to be capable of being delivered and the actual deployment of SRAS during system restoration. This includes complying with applicable requirements in the SRAS Guideline.

4.2 AER to propose a rule change to amend clause 3.11.7(d) of the NER to specify that the SRAS Guideline sets out that the testing of SRAS is to include a comparison with the arrangements planned to be utilised during a major supply disruption.

313 Ibid.

314 NER, clause 3.11.5(f) (Version 71).

315 NER, clause 3.11.5(b)(4) (Version 71).

316 AEMO, Final Report, p. 79.

317 The obligation for NSPs to assist prospective SRAS providers exists in NER clause 3.11.9(i). Other obligations to assist AEMO during a major supply disruption are contained in subordinate instruments, namely the Instruments of Delegation for TNSPs and AEMO's System Restart Plan.

4.15.4 Arising from 4.9: Local Black System Procedures

Findings

All parties have complied with their obligations in relation to the development of LBSPs. AEMO complied with its obligations under clauses 4.8.12(e) and (g) of the NER by developing and publishing its Guidelines for Preparing LBSPs on 30 March 2015. Origin, Synergen and ElectraNet all provided LBSPs that were consistent with the LSBP Guidelines, thereby fulfilling NER clause 4.8.12(d).

AEMO relies upon information prepared by each Generator and NSP as a major input in developing its regional Restoration Options[318] and the content of LBSPs must be "sufficient" to allow AEMO to effectively implement the System Restart Plan.

The relevant provisions of the NER allow AEMO to exercise its discretion at to what amounts to sufficient information to effectively implement the System Restart Plan. We recognise that AEMO may assess the content of the LBSPs to be sufficient when considered alongside the other information available to AEMO, for example, information set out in the SRAS Agreement.

But while all relevant parties complied with the requirements of the NER, the purpose of the LBSPs and the way in which that purpose is intended to be achieved, are not expressly set out in the Rules. As set out in the Implications for the Regulatory Framework chapter, we consider the AEMC should review this area of the legal framework with a view to providing clearer guidance to all participants.

Furthermore, based on our review of certain LBSPs, we consider there to be a risk that participants could understand the requirements of the LBSPs differently. We consider this risk could be alleviated by AEMO providing additional guidance in its Guidelines for Preparing LBSPs. We accept that providing guidance can, at times, unintentionally cause participants to not include all relevant information (as they limit their response to the examples or scenarios discussed). We also note that many NEM participants are well established and experienced operators and therefore in a good position to understand what type of information AEMO is seeking to elicit. However, given the number of new, smaller participants entering the market with various technologies, we consider there to be a heightened risk LBSPs will not elicit the required information in a consistent manner.

Lastly, further to measures already undertaken by AEMO to tighten its procedures around sharing LBSPs with TNSPs, we consider the sharing arrangements should be included in the communication protocols required under 4.8.12(j) (Recommendation 4.4).

Recommendation

4.3 AEMO, during its next review of the LBSP Guidelines, consult with Generators and NSPs on providing more detailed content in the LBSPs and on the level of guidance provided in the LBSP Guidelines. This will assist and guide the growing number of new, smaller participants who will be required to develop LBSP.

4.15.5 Arising from 4.10: System restart plan

Findings

We have found AEMO complied with the NER requirements, and accept that responsibility for the plan should rest with AEMO.

Prior to the Black System Event, AEMO was required to comply with a number of obligations relating to the preparation of a System Restart Plan for the South Australian electrical sub-network. On review of AEMO's actions, we consider that AEMO fulfilled its obligations under clauses 4.8.12(a) and 4.8.12(c).

We consider that, in line with AEMO's subsequent rule change request, the dissemination of the System Restart Plan is a key aspect of participants understanding their respective roles under the plan. In our AER action 4.4, we propose that the communication protocols be extended to cover any preparations for major supply disruption, not just those protocols to apply during a major supply disruption. In extending those protocols, consideration should be given to setting out the role of the SRWG in assisting AEMO.

4.15.6 Arising from 4.11: Development of the System Switching Programs for the System Restart Plan

Findings

ElectraNet was compliant with the Rules relevant to TNSPs when developing the system switching programs for the System Restart Plan.

We assessed ElectraNet complied with its obligation under 4.10.2(b) to observe the requirement to undertake switching functions set out in AEMO's System Restart Overview procedure. We also assess ElectraNet did not breach

318 AEMO, *Guidelines for Preparing Local Black System Procedures*, version 2.1, p. 4, *inter alia*.

relevant obligations as System Operator to undertake certain functions delegated to ElectraNet by AEMO in accordance with the delegation instrument and the NER and to keep AEMO fully and timely informed in relation to power system security issues under clauses 4.3.3(d) and (e) of the NER.

Despite this, we found that:

- there was a lack of a clear understanding as to who was responsible for sharing the System Restart SSP with the SRAS Provider
- there was no established practice for ensuring that the System Restart SSP was checked, and
- there was no established practice for identifying and exploring any difference between the System Restart SSP and the SRAS test SSP.

We note the new SRAS Guideline (2017) materially addresses this shortcoming as all parties involved in testing (namely the SRAS Provider, any asset owner and the TNSP) must provide formal approval of the test procedure and provide advice to AEMO regarding differences between test arrangements and those that will be used in a major supply disruption.[319]

In light of our findings, we made recommendations to AEMO as part of its consultation on its SRAS Guidelines, in particular:

- establishing a clear understanding of the roles and responsibilities with respect to the development, sharing and checking of the System Restart SSP, and
- identifying the existence of any differences between the SRAS test SSP and the System Restart SSP.

We considered whether additional steps were warranted, namely that the parties with equipment involved in the System Restart SSP review and endorse the SSP developed by the TNSP. AEMO may also play a role in this process by actively confirming that these steps have been undertaken. AEMO considered that the changes to the SRAS Guidelines (2017) satisfactorily addressed this issue and no further review of the System Restart SSP was required. Regarding AEMO approval of System Restart SSP, AEMO noted that the expertise to develop switching programs sits with TNSPs and AEMO was not in a position to provide formal approval of those plans.

We consider AER actions 4.1 and 4.2 relating to NSP involvement in SRAS and SRAS testing, in addition to our proposed action below regarding communication protocols, will provide additional assurance.

4.15.7 Arising from 4.12: Communication protocols for sharing information

Findings

The communication protocols in the System Restart Overview and the System Restart Plan for South Australia, although high level, met the requirements of the NER. As such, AEMO and ElectraNet complied with their obligation to establish the protocols.

We note that the intent of clause 4.8.12(j) is to cover communication at the time that an event occurs and the system restart plan needs to be implemented.

While AEMO has ultimate responsibility, it is the NSPs that carry out the switching which results in restoration of supply to customers. For this reason, AEMO and NSPs must have a common understanding and agreement for the implementation of the System Restart Plan. Therefore it is appropriate that they jointly develop the communication protocols for giving effect to the System Restart Plan.

While we agree with AEMO that what occurred was what is required under the NER provision, we find that the protocols could be improved by including more detailed guidance and facilitating the exchange of information as part of any planning for a system restart, not only at the time of a system restart.

We consider that improvements to the communication protocols would assist all participants involved in a system restart. Any such changes should fully reflect participants obligations and align with other of our findings and recommendations that a TNSP should be required to facilitate ongoing testing and the role of the SRWG should be formalised. In coming to this view, we found observations made by NEMMCO in its rule change submission informative.

319 AEMO SRAS Guideline (2017); clause 4.2. We also note that the inclusion of this process into the new SRAS Guideline is consistent with AEMO's Recommendation 13 in the AEMO Final Report.

AER action

4.4 AER to propose a rule change to require AEMO and NSPs for each region to jointly prepare written communication protocols which set out the timing of and manner in which information will be exchanged and between which parties, both in preparation for and during a major supply disruption specifically, and the nature of that information including:

- AEMO to liaise directly with all TNSPs and generators, including through the dissemination of LBSPs to other parties where appropriate and the SRWG
- TNSPs to liaise directly with:
  - DNSPs and customers connected to their transmission network regarding the nature of connection point and load characteristics
  - Generators regarding connection point characteristics and the nature of switching that may need to be conducted during the process of system restoration
- DNSPs to liaise directly with parties (including embedded generators) connected to their distribution network regarding the nature of connection point and load characteristics.

We note that the exchange of information may include information that is confidential or protected and that any communication protocol will need to address such matters in accordance with the relevant legal requirements and powers.

4.15.8 Arising from 4.13: Reasonable endeavours to assist AEMO

Findings

ElectraNet complied with the NER by using its reasonable endeavours in respect of its broad obligation to cooperate and assist AEMO with system restoration.

ElectraNet, in its capacity as a NSP, is required under clause 4.3.4(a) to use its reasonable endeavours to assist AEMO to discharge its power system security responsibilities. We have considered whether ElectraNet has met this broad obligation in relation to the delivery of SRAS.

While this obligation was met, there were possible additional steps ElectraNet could have taken, namely, to have consulted with AEMO and/or Origin on the change to the System Restart SSP.

We consider AER actions 3.1 and 3.4 will establish an obligation on TNSPs to take such steps.

4.15.9 Arising from 4.14: AEMO's power system security responsibilities

Findings

AEMO met both its broad and specific responsibilities under the NER to use reasonable endeavours to manage power system security.

We are satisfied that AEMO has met the obligations associated with its powers under the NEL and NER, and in compliance with clause 4.3.2(a), to:

(d) ensure that *high voltage* switching procedures and arrangements are utilised by *Network Service Providers* to provide adequate protection of the *power system*

(g) ensure that all *plant* and equipment under its control or co-ordination is operated within the appropriate operational or emergency limits which are advised to AEMO by the respective *Network Service Providers* or *Registered Participants*

(h) assess the impacts of technical and any operational *plant* on the operation of the *power system*

(o) utilise resources and services provided or procured as *ancillary services* or otherwise to maintain or restore the *satisfactory operating state* of the *power system*

(p) procure adequate *system restart ancillary services* in accordance with clause 3.11.9 to enable AEMO to coordinate a response to a *major supply disruption*, and[320]

(w) ensure that each *System Operator* satisfactorily interacts with *AEMO*, other *System Operators* and *Distribution System Operators* for both *transmission* and *distribution network* activities and operations, so that *power system security* is not jeopardised by operations on the *connected transmission networks* and *distribution networks*.

This finding does not lead to additional recommendations or actions beyond those relating to specific aspects of the system restoration process detailed above.

320 The NER clause 4.2.6(e) principle mirrors the NER clause 4.3.1(p) power system security obligation, requiring: 'Sufficient system restart ancillary services should be available in accordance with the system restart standard to allow the restoration of power system security and any necessary restarting of generating units following a major supply disruption'.

Appendix A—Legal framework

The versions of the NER that applied to the conduct we are examining are set out in the following section.

Relevant versions of the NER

When assessing compliance with the NER, we are required to assess the conduct against the version of the NER in effect at the relevant time.

The majority of our compliance assessment is focused on:

- the procurement and testing of the specific SRAS which were in place on the date of the Event—these were obtained by AEMO in 2015-2016, at which time AEMO was subject to the SRAS Guidelines (2014) and various versions of the NER, and
- the key system restoration activities which occurred on the date of the Event, at which time Version 82 of the NER was in effect.[321]

From 1 July 2015 there was a material change to the NER relating to SRAS, including changes to AEMO's objectives and obligations in the procurement of SRAS. After 1 July 2015, AEMO could undertake a more flexible approach to procuring SRAS as opposed to the previous requirements. Obligations for other participants, particularly NSPs and SRAS Providers, also changed. The SRAS Agreement by which SRAS was provided by Origin (involving Quarantine) was entered into prior to these changes taking effect.

The following versions of the NER are relevant to our assessment of compliance with the various stages of procurement, testing and implementation of SRAS in South Australia to restore the system after the Black System Event:

Event and date	NER version in force
Black System—28 September 2016; deployment of SRAS to restore network	NER Version 82
Procurement of QPS5 (June 2015)	NER Version 71
Procurement of Mintaro (April 2016)	NER Version 79

The new SRAS rules came into effect from 1 July 2015.[322] At the same time, the AEMC implemented transitional provisions[323] which required AEMO to develop and publish new SRAS Guidelines after the Reliability Panel published its updated System Restart Standard. The new Guidelines reflect the new version of the NER. Revised SRAS Guidelines[324] were ultimately published in December 2017 and apply to SRAS implemented from 1 July 2018.

In the interim period, the AEMC stated that:

> *"any reference in an existing SRAS contract to a document published by AEMO under old clause 3.11.4A is taken to be a reference to the relevant provision of that document as in effect immediately before the Commencement Date. The clause clarifies that where contracts for the provision of restart services have been negotiated on the basis of existing SRAS Guidelines documents, those earlier versions continue to apply to the contract, regardless of whether AEMO has developed subsequent versions of the SRAS Guidelines."*[325]

Further detail on how the rule obligations changed can be found in the relevant sections of our compliance assessment.

Reasonable endeavours

Our approach to assessing 'reasonable endeavours' is set out in the Legal Framework section of the Pre-Event AEMO chapter. As set out in previous chapters, AEMO's power system security responsibilities under Chapter 4 are wide ranging and to be achieved in accordance with the power system security principles set out in NER cl 4.2.6. The first of those principles qualify its responsibilities to securely operate the power system "[t]o the extent practicable".[326]

Principle 4.2.6(e) is fundamental to AEMO's role in the provision of SRAS. It provides that "Sufficient *system restart ancillary services* should be available in accordance with the *system restart standard* to allow the restoration of *power system security* and any necessary restarting of *generating units* following a *major supply disruption."* This should be understood in light of AEMO's power system security

321 Version 83 of the NER commenced on 29 September 2016. We note that version 83 did not amend the clauses relevant to our assessment.

322 NER, Version 72, effective from 1 July 2015.

323 AEMC, *National Electricity Amendment (System Restart Ancillary Services) Rule 2015 No. 5*, 2 April 2015.

324 AEMO, *SRAS Guideline published 15 December 2017* (Version 1.0).

325 AEMC, *Rule Determination, National Electricity Amendment (System Restart Ancillary Services) Rule 2015*, 2 April 2015 at p. vi.

326 NER, clause 4.2.6(a).

responsibilities relating to SRAS,[327] which is to procure adequate SRAS:

- "in accordance with clause 3.11.4A" of the NER applicable at the time that AEMO entered into the SRAS Agreement for Quarantine[328], and
- "in accordance with clause 3.11.9" of the NER applicable at the time that AEMO entered into the SRAS Agreement for Mintaro.[329]

Clauses 3.11.4A of Version 71 of the NER and 3.11.9 of Version 79 of the NER are key to how AEMO was required to undertake this responsibility in accordance with this principle. While these versions of this provision are similar, they differ in detail. These differences are reflected in our assessment.

In its coordinating role, AEMO relies to a large extent upon the technical information provided by Generators and NSPs. AEMO's powers and obligations sit alongside the obligations imposed upon other participants including the obligation on a NSP to use reasonable endeavours to exercise its rights and obligations in relation to its networks so as to cooperate with and assist AEMO in the proper discharge of the AEMO power system security responsibilities.[330] AEMO is also to use reasonable endeavours to ensure that each System Operator satisfactorily interacts with AEMO to avoid jeopardising power system security.[331]

Importantly, under clause 4.3.2(b), AEMO is also required to exercise reasonable endeavours in fulfilling other obligations under Chapter 4 where AEMO is to arrange or control any act, matter or thing or to ensure that any other person undertakes or refrains from any act.

We consider if AEMO had an obligation to arrange or control, or at least to coordinate, the disclosure of switching procedures, including test switching procedures, between the relevant participants. If so, but AEMO did exercise reasonable endeavours despite failing to meet certain of its obligations, it will not have breached those obligations.[332]

Our assessment of whether AEMO used reasonable endeavours includes considerations such as the following:

- the nature of the powers available to AEMO and the extent to which AEMO used the powers available to it to carry out its responsibilities
- the nature of Origin's and ElectraNet's obligations and whether they may have contributed to the failure by Origin QPS5 to deliver SRAS during the System Restoration period by failing to meet those obligations
- the circumstances which led to the switching procedures employed on the day differing from the test switching procedures, and
- the extent to which there was regulated access to SRAS technical information under the NER.

We have also considered the reasonable endeavours standard which applies to NSPs in assisting AEMO and to certain of Origin's obligations under its SRAS Agreement with AEMO.

327 NER, clause 4.3.1(p).
328 NER, Version 71.
329 NER, Version 79.
330 NER, clause 4.3.4(a).
331 NER, clause 4.2.6(w).
332 NER, clause 4.3.2(c).

Market suspension compliance assessment

5. Market suspension compliance

5.1 Summary

In the period following the Black System Event, we found AEMO and SA Market Participants were committed to, and achieved, the safe restoration of power. They were also committed to the ongoing stability of South Australia's electricity system during the market suspension period that extended from 28 September 2016 until the resumption of the spot market late on 11 October 2016.

This is particularly notable given that market suspension is rare, having only occurred once before,[333] and involves specific rules and procedures that had limited precedents. Further, AEMO also had to navigate operating the power system under unprecedented circumstances.

The lengthy period of the market suspension, 13 days, posed a number of challenges for AEMO, including in respect of the administration of market suspension pricing as well as the dispatch of generators and managing power system security.

As such, in assessing AEMO's compliance with its market suspension obligations and management of power system security during the spot market suspension period in South Australia, issues we considered include:

1. The decision to suspend and restore the market—whether AEMO followed proper processes and whether Market Participants had adequate understanding of the process.
2. The administration of market suspension pricing, including impacts on other regions.
3. AEMO's management of power system security, including when it reclassified wind farms, how it intervened in the market, as well as the publication of market notices.

Consistent with our role of reviewing compliance with the NEL and NER, we examined the actions of SA Market Participants as well as AEMO. This included the review of information and documents, including call recordings between the relevant parties.

We identified key issues regarding clarity of communications and transparency on the part of AEMO. At a high level, the specific areas of non-compliance with the NER are:

1. AEMO failed on several occasions to issue market notices when there were foreseeable circumstances that may have required AEMO to intervene in the market through clause 4.8.9 directions. While AEMO did issue a market notice in regard to the direction to AGL, we assess that it was not sufficiently immediate. AEMO also did not issue a market notice at all prior to the direction to ENGIE.
2. AEMO's operating procedures did not fully reflect the legislated principles as required in respect of clause 4.8.9 directions.

Our analysis also identified a key issue regarding AEMO's use of quick energy constraints on an individual generator which we found to have varied the generator's dispatch, but was not taken to be a clause 4.8.9 direction. While we did not make any compliance finding, it did raise questions about the means by which AEMO manages emerging power system security issues without formally directing Market Participants.

In summary, AEMO's strategies and communications at times were not as clear as they could have been and may have been open to interpretation. It is evident from the call recordings, as well as from our discussions with generators, that there was confusion as to whether or not they were being formally directed by AEMO.

Our recommendations therefore regard transparency through the publication of timely market notices as well as clarity of verbal communications.

Clear communication, including through issuing timely market notices, gives Market Participants the best opportunity and ability to make informed decisions to respond to circumstances. This should result in more efficient outcomes for consumers.

Finally, we note that most Market Participants prioritised social responsibility above commercial considerations during the market suspension period. This extends from generators agreeing to operate without being formally directed, although this meant operating at a loss, through to gas transportation charges to generators being waived by the gas pipe line operators.[334]

We have made recommendations in relation to our findings. These are summarised in the table on the next page.

333 The first market suspension occurred on 8 April 2001 for a period of two hours affecting all regions of the NEM following a market systems (IT system) failure.

334 For example, AGL has stated that it incurred substantial losses when it was instructed by AEMO to run its Torrens Island Power Station during the market suspension period for which it was not entitled to compensation. Source: AGL, Submission to Inquiry into State-wide blackout of Wednesday 28 September 2016, 14 February 2017, pp. 18–21 and 22, https://www.parliament.sa.gov.au/Committees/Pages/Committees.aspx?CTId=3&CId=335.

Table 1: Summary of recommendations

Assessment of market suspension period		Recommendation
Dispatch of generation and power system security during the market suspension period.	5.1	Improved training for AEMO operators regarding the specific language used to ensure operators clearly state whether they are making a request, issuing instructions, or otherwise issuing clause 4.8.9 directions.
Dispatch of generation and power system security during the market suspension period.	5.2	AEMO ensures that it publishes market notices, without delay, after it becomes aware of any foreseeable circumstances that may require AEMO to implement an intervention event and that it updates its procedures and guidelines accordingly.
AEMO formal intervention—clause 4.8.9 directions.	5.3	AEMO ensures that its procedures more closely align with what is prescribed in the NER particularly regarding directions (clause 4.8.9) and market notices (clause 4.8.5A).

5.2 AER approach to assessing compliance

As stated above, market suspension is rare, and had never been in effect for such a lengthy period prior to the Black System Event. As AEMO has reported:

> *"The length of the market suspension period was unprecedented and the market suspension regime was not designed to be in place for such an extended time."*

The AER closely examined how the NER operated as well as AEMO's approach to compliance during these unprecedented circumstances. Dispatching the market and the management of power system security was also challenging during this period. Participants and AEMO highlighted the collaborative approach to navigating these issues, particularly in the period immediately following supply restoration. While participants commended AEMO's general approach to keeping them informed through daily update teleconferences, several participants stated that there was still confusion about how AEMO was dispatching generators to ensure power system security requirements were being met towards the end of the market suspension period.

In addition to reviewing AEMO's approach to dispatch during the market suspension, the AER also closely reviewed participants' compliance with 4.8.9 directions issued by AEMO during the period. Directions are a crucial tool for AEMO in meeting its power system security and reliability obligations; hence the imperative for participant compliance with those directions.

Our inquiries have identified a key area of divergence between the AER and AEMO regarding the market operation and system security rules framework during market suspension. In response to our assessment, AEMO has stated that when the market is suspended, the rules are only specific about pricing (clause 3.14.5). AEMO also points to clause 3.14.4(e)(1) which states if AEMO has declared that the spot market is suspended AEMO may issue directions to participants in accordance with clause 4.8.9, and, to the extent possible, rules 3.8 and 3.9 (subject to clause 3.14.5): "Otherwise, [according to AEMO] *the suspension provisions do not specifically mandate compliance with any market operation rules.*"

In contrast to AEMO's position, we note that the High Court has previously found that *"[a] market will continue to exist even though dealings in it be temporarily dormant or suspended."*[335]

The AER considers that in the absence of an explicit provision to the contrary, obligations in the NER apply, given all the facts and circumstances. Our view is that, if AEMO's interpretation is taken to its logical conclusion, generators, for example, would have not have to comply with the various obligations under rule 3.8 regarding generation dispatch offers.

We also differ with AEMO in our interpretation of certain obligations in Chapter 4 of the NER. The key point of difference is in respect of requirements under clause 4.8.5A to issue notices of any foreseeable circumstances that may require AEMO to intervene in the market. We consider that Chapter 4 obligations continue to operate during market suspension;[336] accordingly our view is that the requirement for AEMO to keep participants fully informed is mandatory as prescribed.[337]

In relation to clause 4.8.5A,[338] AEMO has stated that the "*application of the obligations to publish notices under clause 4.8.5A in a suspended market is not clear*". AEMO's view is that:

> *"AEMO observes that the primary concern of Chapter 4 is management of power system security. AEMO*

335 Queensland Wire Industries v BHP (1989) 167 CLR 177, 196 per Deane J.

336 For example, AEMO's explicit authority to issue dispatch instructions is set out in clause 4.9.2.

337 Aside from AEMO's compliance to clause 4.8.5A, which is assessed in this chapter, we also point to clauses 4.3.1(m), 4.3.2(a) and 4.8.3(a). All of these clauses are discussed further within the final chapter "Implications for the Regulatory Framework".

338 Clause 4.8.5A(a) states: AEMO must immediately publish a notice of any foreseeable circumstances that may require AEMO to implement a AEMO intervention event.

interprets the rules to be that AEMO's primary responsibility is to address the unfolding issue."

Further, AEMO has also stated that it sought to "*apply a common sense approach during the market suspension, meaning it applied the NER to the extent it considered practical and reasonable to do so*."

In those extraordinary circumstances where either AEMO and/or a Registered Participant, is unable to simultaneously comply with an obligation critical to market operations or system security and a more administrative obligation, it is appropriate that the more critical obligation is prioritised. We do not consider, however, this means that compliance with the administrative obligation is not required. Rather, all of the facts and circumstances must be assessed to determine whether administrative requirements in the Rules should have been followed and, if so, these will be relevant considerations for the AER as the enforcement agency in determining what compliance or enforcement action, if any, is to be taken.

We also considered whether clause 4.8.7(b) applied. As discussed in section 5.6.1, clause 4.8.7(b) requires AEMO to follow the procedures in clause 4.8.9 in the context of contingency events and potential electricity supply shortfalls. The AER and AEMO disagreed about the 'contingency event' element of clause 4.8.7(b) as to whether AEMO was managing the continuing effects of the contingency events that resulted in the system black condition and/or was managing the risk of a further contingency event. However, we found that the second key element of clause 4.8.7(b) did not apply. This element of the clause appears to be in respect of AEMO being required to intervene in respect of *supply* shortfalls (in regard to reliability) and is not relevant to AEMO managing power system security and potential inertia shortfalls, the latter of which was relevant towards the end of the market suspension period of the Black System Event.

We also disagreed with AEMO as to whether it was altering dispatch in its use of quick energy constraints on an individual generator at times. Clause 3.8.21(i) appears to indicate that altering the dispatch algorithm outcome occurs in the context of AEMO intervening via clause 4.8.9 directions. However, for the reasons discussed in section 5.6.1 it was not apparent that AEMO had formally intervened with these quick energy constraints, though AEMO did state that these particular constraints were utilised to meet its power system security obligations in respect of maintaining sufficient inertia.

AEMO contends that our report indicates that the rules around AEMO intervention do not work well when intervention is required for power system security. As AEMO has stated: "*what was originally contemplated as a very rare event is becoming commonplace, and the rules need to evolve in response*." AEMO considers more flexibility is warranted so as to adapt to new risks and extremes. We note that, where the Rules provide parties such as AEMO with the flexibility to apply judgment and expertise, this power is frequently accompanied by obligations to establish a decision making framework or principles in consultation with participants as well as obligations regarding notification and transparency of decisions. This is in recognition that participants require certainty and transparency around decisions which can fundamentally impact their investment and operational decisions, as well as the overall efficiency of the market.

For example, we note in the AEMC's review into the coordination of generation and transmission investment in the NEM[339] that AEMO itself has submitted that the planning process of the Integrated System Plan must be governed by a number of objectives including transparency. AEMO has specified that this includes the provision of information via disclosure of criteria, assumptions and data underlying the plan to all relevant stakeholders.[340]

More broadly, the basis of having overarching rules such as the NER is that the stakeholders, in this case, AEMO and participants alike, are aware of the governing framework in which they operate. As a broad principle, if there is doubt as to how the Rules ought to be applied in a particular set of circumstances, this ought to be resolved to provide clarity both to the person(s) on whom the obligation is imposed and to other affected participants.

While the relevant NER interpretation and broader framework issues are referenced in this market suspension chapter, they are discussed in greater detail in in the final chapter 'Implications for the Regulatory Framework".

5.3 Background

5.3.1 What is market suspension?

Market suspension refers to when AEMO declares the spot market to be suspended in a region. AEMO may declare the spot market suspended if any of the following occur:

- the power system has collapsed to a 'black system'
- AEMO has been directed to suspend the market by a participating jurisdiction, or

339 The AEMC website in regard to this review states that the COAG Energy Council asked the AEMC to undertake biennial reporting on a set of drivers that could impact on future transmission and generation investment. The AEMC has stated that its review is considering options for how to make the Integrated System Plan developed by the Australian Energy Market Operator an actionable strategic plan. Source: https://www.aemc.gov.au/markets-reviews-advice/reporting-on-drivers-of-change-that-impact-transmi.

340 AEMO, Coordination of Generation and Transmission Investment Options Paper—AEMO Submission [to the AEMC review], 19 October 2018.

- AEMO has determined it cannot operate the spot market in accordance with the NER.[341]

These abnormal circumstances mean that the ordinary operation of the NEM is not possible, hence the market is suspended.

According to AEMO, the declaration of a market suspension serves two primary roles:

- *It allows AEMO to suspend central dispatch if necessary, and determine market prices in accordance with the NER clauses relating to the market suspension, while the underlying cause is being resolved.*
- *It informs the market participants of a significant issue occurring in the market and provides some price control where necessary, allowing participants to work with AEMO to manage operational issues and to invoke risk management strategies.*[342]

Although market suspension is a major event impacting the market, there are relatively few obligations in Chapter 3 of the NER explicitly governing how the market should operate during market suspension. AEMO therefore has some discretion, and it is open to manage the market suspension as it considers appropriate, subject to being in accordance with any applicable rules. The NER, as it was at the time of the event,[343] set out three key obligations as follows:

- Clause 3.14.3—sets out the circumstances in which AEMO can suspend the spot market and requires AEMO to review and report on the market suspension.
- Clause 3.14.4—sets out the high-level process for declaring a market suspension and AEMO's ability to issue clause 4.8.9 directions and to set pricing in accordance with clause 3.14.5. It also reiterates the requirement for AEMO to report on the market suspension.
- Clause 3.14.5—sets out how AEMO was to determine spot market prices during market suspension, including high-level requirements for AEMO to follow the procedures in the rules for PASA[344] and dispatch requirements of rules 3.8 and 3.9 where practically and reasonably possible (which are the provisions detailing how the spot market is to be dispatched and prices determined when the market is not suspended).

Following the collapse of the power system, AEMO suspended the spot market in SA with effect from the trading interval commencing at 16:00 hrs on 28 September 2016, with the market being suspended until 22.30 hrs on 11 October 2016[345] as follows:

Table 2: Key stages regarding market suspension

Start time	Event issue	Market
28/9/16 16:25 hrs	Collapse of the power system to a Black System.	Suspended[a]
29/9/16 18:25 hrs	Black System condition removed, but AEMO at this time still did not have adequate information that the original cause had been eliminated.	Suspended[b]
29/9/16 20:39 hrs	AEMO directed to suspend the market in SA by Ministerial direction under the *Essential Services Act 1981 (SA).*	Suspended
6/10/16 15:05 hrs	SA Government advised AEMO that the Ministerial direction to maintain suspension is extended by a further seven days	Suspended
11/10/16 17:48 hrs	SA Ministerial direction revoked.[c]	Suspended[d]
11/10/16 22:30 hrs	Market resumed.	Normal

a. AEMO suspended the spot market in SA with effect from the trading interval commencing at 16:00 hrs on 28 September 2016.

b. Until the original cause of the market suspension has been eliminated or sufficient steps have been taken to exclude its influence on market processes, the market must remain suspended.

c. Notably on 4 October 2016 AEMO had informed the SA Minister that AEMO was satisfied that the NEM could resume.

d. AEMO issued market notice 55343 at 18:26 hrs which advised of the revocation and that the market would resume at 22:30 hrs.

Source: Derived from table 16 of the AEMO Final Report, p. 83.

Market suspension in the NEM is rare, having occurred on only one other occasion since the commencement of the NEM in 1998,[346] hence, as stated above, many of the relevant rules and AEMO procedures had never been put to the test.

The lengthy period of the market suspension (13 days) posed additional challenges for AEMO, including the administration of market suspension pricing as well as the dispatch of generators and managing power system security.

341 NER, clause 3.14.3(a).

342 AEMO, Market Suspension Rule Changes, 25 July 2017, p. 4.

343 The relevant Rules were version 82 and 83 during the relevant period. AEMO subsequently requested expedited rule changes in regard to market suspension pricing arising from issues it faced in respect of the Black System event—AEMO, Market Suspension Rule Changes, 25 July 2017. These rule changes are further discussed within this chapter (see box 2 below). See also AEMC Rule Determination: National Electricity Amendment (Pricing during market suspension) Rule 2017, 10 October 2017.

344 Projected Assessment of System Adequacy.

345 When all three criteria for market suspension were no longer met (system black, jurisdictional direction or unable to operate the spot market).

346 The first market suspension occurred on 8 April 2001 for a period of two hours affecting all regions of the NEM following a market systems (IT system) failure.

5.3.2 Relevant features of power system operation

Central dispatch

Under normal market conditions AEMO, as the market operator, coordinates a central dispatch process by which the wholesale spot market is run for every five-minute dispatch interval. The process assesses generator supply offers against demand in real time and determines a mix of generators that should be dispatched to meet that demand, subject to network and power system security requirements. The NEM dispatch engine (NEMDE)[347] then issues instructions to each of these generators to produce the required quantity of electricity to meet that demand. This is to ensure the central dispatch process maximises the value of trade subject to the various constraints and so as to maintain the technical security of the power system. To determine which generators are dispatched, AEMO stacks the offers of all generators in ascending price order for each dispatch interval. It dispatches the cheapest generator bids first, then progressively more expensive offers until enough electricity is dispatched to satisfy demand. This results in demand being met at the lowest possible cost.[348] The highest priced offer needed to meet demand then sets the dispatch price. The spot price paid to generators is the average dispatch price over the 30-minute trading interval.

When the market is suspended some of the normal central dispatch mechanisms may not be able to operate, though this will not always be the case. There may be times when the market is suspended and NEMDE is not operational (as occurred from 30 September to 4 October 2016). Alternatively, there may be times when the market is suspended but NEMDE does operate and dispatches generation (as occurred from 5 October to 11 October 2016). The key difference is that at times of market suspension, prices are determined differently to times of normal operation.

As indicated in section 5.2 above, AEMO has stated that when the market is suspended, the rules are only specific about pricing (clause 3.14.5). AEMO has also pointed to clause 3.14.4(e)1 which states if AEMO has declared that the spot market is suspended AEMO may issue directions to participants in accordance with clause 4.8.9, and, to the extent possible, rules 3.8 and 3.9 (subject to clause 3.14.5). AEMO's view appears to be that the market suspension provisions do not otherwise specify a requirement for compliance with any market operation rules.

Given the issues surrounding dispatch and AEMO's requirement to meet power system security (to be discussed later in this chapter), this highlights the issue that the market suspension regime within the NER was not designed with an extended period of market suspension in mind, as there was following the Black System Event.

However, notwithstanding AEMO's view, our view is that during market suspension, AEMO must still comply with a number of principles and obligations even though it retains some degree of discretion as to how it dispatches generators.

We conclude that the NER provides that AEMO can either: 1) issue a dispatch instruction in the normal course, or 2) issue a direction to a Market Participant if it is required to meet its power system security obligations. When AEMO notifies generators of output requirements, AEMO must do so in accordance with the relevant provisions of the NER, including clause 4.3.1(i).[349]

We also consider that although the NER explicitly refers to 'market suspension' in only a handful of clauses, this does not necessarily preclude the application of clauses where 'market suspension' is not explicitly referenced, even when those clauses contemplate 'the market'.

Power system security

Clause 4.3.1 sets out AEMO's responsibility regarding power system security. It stipulates, among other things, AEMO's obligation to maintain power system security and to ensure that the power system is operated within the limits of the technical envelope (which is defined under clause 4.2.5). The NER requires AEMO to use reasonable endeavours to maintain power system security.

The power system is secure when technical parameters such as voltage and frequency are maintained within defined limits and will remain so following the occurrence of a credible contingency event.[350]

AEMO's obligations to maintain power system security are unchanged during times of market suspension.

Following the Event, on 4 October 2016, AEMO determined that the technical envelope would include a requirement to maintain three thermal generating synchronous units (each

347 The NEM dispatch engine (NEMDE) is the software developed and used by AEMO to ensure the central dispatch process maximises value of trade subject to network and power system security requirements.

348 Specifically, clause 3.8.1 states that AEMO must operate a central dispatch process to dispatch generating units in order to balance power system supply and demand, using its reasonable endeavours to maintain power system security and to maximise the value of spot market trading on the basis of dispatch offers and dispatch bids.

349 Noting clause 4.3.1(i) states that the AEMO power system security responsibilities are: to arrange the dispatch of scheduled generating units, semi-scheduled generating units, scheduled loads, scheduled network services and ancillary services (including dispatch by remote control actions or specific directions) **in accordance with the Rules**, allowing for the dynamic nature of the technical envelope; "(emphasis **added**).

350 The AER notes that maintaining frequency and voltage is not relevant to the balance of this discussion and is only two of the parameters to be maintained.

of not less than 100 MW installed capacity) online at any given time to manage power system security.[351] Relevant to the technical envelope during this same period was the reclassification of 10 wind farms, constraining their output down, as well as a SA Government Ministerial direction directing AEMO to maintain the expected Rate of Change of Frequency (RoCoF) of the South Australian power system to within +/- 3Hz/s in relation to the non-credible coincident trip of both circuits of the Heywood Interconnector. These issues are discussed in further detail below.

Market Notices

AEMO issues market notices through its Market Management System. AEMO's website states they are updated in real time to notify Market Participants about events that impact the market. These include advising of low reserve conditions, status of market systems, over-constrained dispatch, price adjustments, constraints, market directions, market interventions, and market suspensions.[352]

As part of AEMO's responsibilities and obligations in managing power system security, it must publish as appropriate, information about the potential for, or the occurrence of, a situation which could significantly impact, or is significantly impacting, power system security.[353] As we discuss later in this chapter, we conclude that the NER requires AEMO to issue notices to Market Participants in these circumstances, even when the market is suspended.

The purpose of market notices is aligned with the market design principles of the NEM, which include the principle of maximising market transparency.[354] This transparency helps to facilitate a market response as needed. Even when the market is suspended, generators need to make fully informed decisions, notwithstanding that pricing is set by the Market Suspension Pricing Schedule, noting that generators each have different short run marginal costs when they are required to operate.

Part of our assessment relates to AEMO's failure to issue market notices as required, either by not publishing a notice or not doing so with sufficient immediacy. This issue arose towards the end of the market suspension period when AEMO was managing the technical envelope, including its requirement to maintain three synchronous units on at all times to manage power system security. AEMO managed its power system security requirements during the market suspension period following the Black System Event by issuing formal clause 4.8.9 directions, and by invoking constraints on individual generators which meant they were dispatched out of merit order. Both directions and constraints are discussed below.

Constraints

The central dispatch process operated by AEMO is subject to numerous inputs, including generators' offers and technical plant parameters, as well as the technical envelope of the power system (which includes network limits).

Network limits are managed through constraint equations in which NEMDE determines the optimal dispatch of generators based on their offers up to the maximum allowable flows on specific transmission lines (and other transmission equipment). These "network constraints" determine the maximum allowable output of multiple generators in proportion to the impact of each generator on the flow on the relevant transmission element that the constraint is managing as variables in the one constraint equation.[355] AEMO's ability to utilise network constraints is predominantly set out in clause 3.8.10.

Sometimes, however, a constraint can be applied to a single generator to determine that generator's output. This mechanism can be used even if a generator has not been formally directed. Typically, these "quick energy constraints" (using AEMO's terminology) are used when a generator fails to respond to a dispatch instruction and is deemed to be "non-conforming" (and are to ensure that dispatch outcomes correctly account for the generator's likely behaviour).[356] Otherwise, a quick energy constraint will be used when a generator is issued a formal clause 4.8.9 direction to ensure that the generator is dispatched consistent with the direction, noting that the generator offer may mean that it would not normally be dispatched. When a generator is directed this results in its dispatch being out of merit order and it may be compensated for any financial loss it incurs. AEMO's explicit authority to modify or override dispatch outcomes in these two situations is set out in clause 3.8.21(i).

As indicated above, it was AEMO's use of quick energy constraints on an individual generator, out of merit order (where the generator was constrained on at an output level *above* the output level it had offered to be dispatched at, a particular price), towards the end of the market suspension period, and without issuing clause 4.8.5A notices prior, that is the subject of our compliance assessment.

351 From 4 October 2016 onward, as per AEMO's temporary operating advice.

352 AEMO, Events and Reports—https://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Market-notices-and-events.

353 NER, clause 4.3.1(m).

354 NER, clause 3.1.4.

355 Another common type of constraint is a Frequency Control Ancillary Services (FCAS) constraint, which ensures that sufficient FCAS is procured to maintain the frequency standard under a variety of power system security situations (i.e. system normal or outage conditions).

356 NER, clause 3.8.23.

Directions

Under clause 4.8.9 of the NER, AEMO may issue directions to Registered Participants[357] where it is necessary to do so to maintain or return the power system to a secure or reliable operating state. These are most likely to be:

- a direction to a scheduled generator to achieve a particular output level to the extent that this is physically possible and safe to do so, or[358]
- a clause 4.8.9 instruction to a network service provider to disconnect load.[359]

Generators must comply with all clause 4.8.9 directions.[360] When the market is not suspended, and where a direction affects a whole region, intervention or 'what if' pricing would be required. Under 'what if' pricing, the spot price is determined as if the direction had not occurred. Directions also have a direct cost for consumers since both directed participants and other participants affected by a direction may be eligible to seek compensation, the costs of which are ultimately recovered from consumers.[361]

According to AEMO's public operating procedures in effect during the market suspension period, when AEMO considers that it might have to intervene in the market by issuing a clause 4.8.9 direction, it will:[362]

- publish a market notice of the possibility that AEMO might have to issue a clause 4.8.9 direction so that there is an opportunity for a market response to alleviate that need
- determine and publish the latest time for intervention
- determine which Registered Participant should be the subject of a clause 4.8.9 direction
- issue a clause 4.8.9 direction verbally to the relevant Registered Participant, confirming whether it is a clause 4.8.9 direction
- issue a market notice advising that AEMO has issued a direction or clause 4.8.9 instruction, and
- revoke the direction or clause 4.8.9 instruction as soon as it is no longer required.

Differences between a direction, a constraint and a dispatch instruction

There are fundamental differences between a direction, a constraint and a dispatch instruction.

A dispatch instruction is a product of the automated processes of NEMDE to achieve an efficient dispatch of all generation.[363]

A constraint is an obligation or restriction applied by AEMO that alters the normal NEMDE processes/outcomes for relevant generators for technical reasons to manage the power system.

A direction is a formal intervention in the market by AEMO to a Market Participant which alters normal market outcomes for that generator, typically for reliability or security reasons, and for which Market Participants may be eligible to claim compensation.

Additionally, a constraint that requires a generator to run in circumstances where it otherwise would not under normal NEMDE processes is only affected by that constraint where a generator has made a bid at a particular price level in respect of a particular dispatch interval but has not been selected by NEMDE "in merit".

A generator that has bid itself "unavailable" is not able to be constrained on by AEMO in this manner. In that sense, a generator has some measure of control over whether it is subject to this kind of constraint, as opposed to when it receives a direction.

During the market suspension period, some participants advised that there was confusion as to whether they were being directed by AEMO under clause 4.8.9 or being asked by AEMO to follow dispatch instructions which were a result of the constraints used to maintain sufficient inertia to manage power system security.

5.3.3 What is market suspension pricing?

Clause 3.14.3(a1) of the NER, as it was at the time,[364] stipulates that if AEMO suspends the spot market, prices must be set in accordance with clause 3.14.5 for that region.

Clause 3.14.5, sets out a hierarchy of four possible pricing options as follows:

357 Where used in this report, the term 'Registered Participant' includes generators, market customers and loads, ancillary services providers, and network service providers.

358 Directions only apply to scheduled plants or a market generating unit.

359 AEMC, Issues Paper: Reliability Frameworks Review, 22 August 2017, pp. 97–98.

360 However, a generator does not have to comply with a direction or clause 4.8.9 instruction if to do so would be a hazard to public safety, materially risk damaging equipment, or contravene any other law as per clause 4.8.9(c). Directions can also be made under section 116 of the NEL.

361 AEMC, Issues Paper: Reliability Frameworks Review, 22 August 2017, p. 98.

362 AEMO, SO_OP_3707 – Intervention, Direction and Clause 4.8.9 Instructions, dated 11 September 2014, p. 6.

363 Dispatch instructions can also happen manually by telephone, although as discussed in section 5.6 this is somewhat unusual.

364 Rule changes regarding market suspension pricing came into effect on 1 December 2017 and are discussed below in box 2. The market suspension pricing rules discussed here are about those rules in effect during the relevant period, being NER version 83 and are referred to in present tense.

- Normal dispatch pricing [clause 3.14.5(c)]:
  – Spot prices and FCAS prices in the suspended region continue to be set in accordance with rule 3.9[365] where AEMO considers it practical and reasonably possible to do so, and central dispatch is continuing under rule 3.8.[366]
- Pricing based on a neighbouring pricing region [clause 3.14.5(e)], provided that:
  – Dispatch pricing in the suspended region is not possible.
  – Dispatch pricing continues in a neighbouring region.
  – There is an unconstrained interconnector between that neighbouring region and the suspended region.
  – There are no local FCAS requirements in the suspended region.
- Pre-dispatch pricing [clause 3.14.5(h)], provided that:
  – Dispatch pricing or neighbouring-region pricing have already been used during the market suspension.
  – Dispatch pricing and neighbouring-region pricing are no longer practical.
  – A current pre-dispatch schedule exists for the suspended region.
- Pricing based on the market suspension pricing schedule [clause 3.14.5(j)], provided that dispatch pricing, neighbouring-region pricing, and pre-dispatch pricing are not (or are no longer) practical.[367]

As implied above, the options in the NER at that time were sequential, such that once one option was no longer available, AEMO was obligated to use the next option.

5.4 Suspending the market

As a result of the Event, AEMO suspended the spot market in SA with effect from the trading interval commencing at 16:00 hrs on 28 September 2016.[368]

AEMO promptly issued market notices advising that "*a Black system condition exists in the South Australia region*" and the "*SA power system separated from the NEM and became black*."[369]

For the period 18:25 hrs 29 September 2016 until 23:46 hrs 3 October 2016, although the Black System condition had been removed, AEMO advises it was not confident that it could sustainably resume market operations in SA in accordance with the NER for the following reasons:

- *Continuing bad weather in the region slowed survey efforts by ElectraNet.*
- *The underlying cause of the Black System was not fully understood.*
- *Taking these factors into consideration, AEMO was not confident that its then network constraint formulation sufficiently represented the system in its then current state, or that it would be sufficient to prevent a reoccurrence of a system black if normal operations resumed.*

AEMO also states that its understanding of the causes of the Black System Event steadily improved during the period, so that by 23:46 hrs on 3 October 2016, AEMO was able to reclassify the coincident loss of specific generating units (a number of wind farms) in SA to be a credible contingency event. This reclassification enabled AEMO to manage power system security for the risk of those wind farms tripping simultaneously. AEMO states that at this point, it was satisfied that the network constraint formulation was sufficient to return to normal market conditions. On 4 October 2016, AEMO notified the SA Minister accordingly.

However, in the interim, at 20:39 hrs on 29 September 2016, AEMO was directed to suspend the market in SA by Ministerial direction under the *Essential Services Act 1981 (SA)*. The SA Government Ministerial direction was extended on 6 October 2016, notwithstanding the advice from AEMO that it was satisfied that the network constraint formulation was sufficient to return to normal market conditions.

5.4.1 Relevant NER provisions and assessment

In suspending the market, we consider that AEMO fulfilled all relevant obligations. We have set out below our analysis of these obligations.

Clause 3.14.3(a)—Suspension of the spot market

Subject to clause 3.14.3(b), AEMO may suspend the market if at least one of three criteria applies:

1. a black system event has occurred
2. it is directed to do so by a jurisdiction under a state of emergency, or

365 Rule 3.9 specifies the 'usual practice' of price determination, detailing how prices are determined when the market is not suspended, or as the initial option during market suspension where AEMO considers it practical and reasonably possible to do so.

366 Rule 3.8 is about the 'usual practice' of central dispatch and spot market operation, detailing how generation is centrally dispatched and the spot market is operated when the market is not suspended, or as the initial option during market suspension where AEMO considers it practical and reasonably possible to do so.

367 AEMO, Market suspension change proposals—discussion paper, April 2017, p. 9.

368 AEMO, *Black System South Australia 28 September 2016—Final Report*, published March 2017 ("AEMO, Final Report"), p. 82.

369 Market Notice 54985 issued at 16:24 hrs followed by Market Notice 54994 issued at 16:50 hrs (market time).

3. it assesses that the spot market is inoperable in accordance with the provisions of the NER, for example due to IT failures or following a power system emergency.

The NER defines a black system as an absence of voltage on the transmission system affecting a significant number of customers. AEMO usually considers a significant number of customers to be affected if the voltage collapse results in the loss of 60% of forecast customer load in a NEM region.[370] Due the Black System Event, AEMO suspended the spot market in SA with effect from the trading interval commencing at 16:00 hrs on 28 September 2016.[371]

We therefore find that AEMO complied with clause 3.14.3(a)(1) of the NER, in which AEMO may suspend the market if a black system event occurs.

Regarding AEMO being directed to suspend the market in SA by Ministerial direction under the *Essential Services Act 1981 (SA)*, we also find that AEMO complied with its obligations under clause 3.14.3(a)(2).

Clause 4.8.3—AEMO's advice on power system emergency conditions

Clause 4.8.3 states AEMO must publish all relevant details promptly after AEMO becomes aware of any circumstance with respect to the power system which in the reasonable opinion of AEMO could be expected to materially adversely affect supply to or from Registered Participants.

AEMO promptly issued market notices advising that "*a Black system condition exists in the South Australia region*" and the "*SA power system separated from the NEM and became black*."[372] The notices were published in accordance with clause 4.8.3. We find that AEMO complied with clause 4.8.3.

Findings

We conclude that AEMO complied with clause 3.14.3(a)(1) and clause 4.8.3 in regard to its actions in suspending the market and issuing the relevant notices.

5.5 Reclassification of wind farms

Following the collapse of the system on 28 September, AEMO undertook a series of enquiries relating to the cause of the Event. A key component of AEMO's assessment was the sequence of events immediately prior to the system's collapse. AEMO identified that certain South Australian wind farms had tripped immediately prior to the Black System Event. The timeline in relation to AEMO's assessment of the wind farms and subsequent reclassification process is in box 1 on the next page.

370 AEMO, Power System Security Guidelines: SO_OP_3715, Version 78, 29 August 2016, p. 14.

371 AEMO, Final Report, p. 82.

372 Market Notice 54985 issued at 16:24 hrs followed by Market Notice 54994 issued at 16:50 hrs (market time).

Box 1: Timeline of events regarding the reclassification of wind farms

- By the end of 30 September 2016 AEMO had requested all available information from ElectraNet on metered power flows within the SA network. AEMO also collected the majority of generators' network metering data.
- By the morning of 3 October 2016, based on the analysis conducted in the days prior, AEMO compiled a list of SA wind farms that had tripped immediately before the Event. At this stage, none of the listed wind farms had provided AEMO with an explanation for why the units unexpectedly went offline.
- Due to the uncertainty about why these units went offline, AEMO issued a market notice[373] at 11:46 hrs on 3 October 2016 stating that the loss of the identified wind farms[374] was considered a credible contingency in the event of a single credible contingency occurring.
- This reclassification resulted in a constraint being placed on the listed wind farms to limit their output to ensure there was sufficient capacity on the Heywood Interconnector to meet any sudden reduction in output from these wind farms.
- In the days following that market notice, correspondence with the identified wind farm operators and the turbine manufacturers highlighted the common cause of the wind farms reducing output immediately prior to the event.
- By the end of 5 October 2016, AEMO had been notified by all the wind farm operators of a low voltage ride through (LVRT) setting as the most likely cause of the units tripping prior to the event.
- AEMO then undertook a more detailed investigation into the particular LVRT settings for each wind farm generating unit. AEMO subsequently removed wind farms from the reclassification issued on 3 October 2016, when the operators provided evidence that the units could avoid tripping as a result of similar number of voltage disturbances.
- Two of the wind farms had their reclassifications removed on 10 October and a further three on 11 October (meaning that they were removed from the relevant constraint).
- The final four wind farms had their reclassifications removed on 24 December 2016, as the settings responsible for the generating unit trips had been addressed.[375]

5.5.1 Relevant NER provisions and assessment

Following AEMO's identification of the wind farms that tripped immediately prior to the Event, the decision to reclassify the loss of these units as credible following a contingency event was a prudent approach. In accordance with the NER, we consider it was open to AEMO to take these steps given the uncertainty around the cause of the units tripping.

We note that the constraint set enlivened at the time of the reclassification continued to remain in place following the determination of the LVRT issue. The decision to preserve the reclassification and constraints appears to be a careful approach to the preservation of network security. The decision to preserve the reclassification until AEMO is satisfied that the risk was mitigated is consistent with AEMO's procedures and guidelines.

Clause 4.2.3A(g)—AEMO power to reclassify contingency events

If AEMO considers that the existence of abnormal conditions make the occurrence of a non-credible contingency event reasonably possible, clause 4.2.3A(g) requires AEMO to reclassify a contingency event from non-credible to credible and notify the market as soon as practicable.

As noted above, we consider AEMO's decision to reclassify the loss of multiple wind farms in SA on 3 October was timely and appropriate given the information available at the time. At the time there was significant uncertainty surrounding the cause of the wind farms tripping. In accordance with clause 4.2.3A(g), AEMO acted on these abnormal conditions by putting in place additional measures to deal with the heightened risk that multiple generators could trip again.

Our conclusion is based on the assessment of email correspondence between AEMO, ElectraNet and the relevant wind farm operators immediately following the Event.

Clause 4.2.3A(h)—reclassifying contingency events

Clause 4.2.3A(h) provides that after reclassifying a non-credible contingency event, if AEMO considers that the relevant facts and circumstances have changed so that the occurrence of the credible contingency is no longer

373 Market Notice 55161, 3 October 2016 11:46 hrs. Note: Market Notice 55168, an amendment of listed wind farms at 4 October 2016 05:16 hrs.

374 Wind farms affected: Bluff WF, Clements Gap, Mt Millar, Hallett Hill, Hallett, Snowtown, Hornsdale Wind Farm 1, Snowtown 2 South, and Snowtown 2 North, North Brown Hill.

375 See Market Notices 55328 (10 October 2016), 55336 (11 October 2016) and 56434 (24 December 2016).

reasonably possible, AEMO may reclassify that credible contingency event to be non-credible.

With the assistance of the wind farm operators, AEMO promptly identified that certain LVRT trip settings were the likely cause of the wind farms tripping on 28 September. Each wind farm was removed from the constraint once the operator satisfied AEMO that the relevant setting had been adjusted such that it was no longer a risk to the network. In accordance with the clause 4.2.3A(h) AEMO can return the classification to non-credible at its discretion. We consider AEMO's decision to preserve the reclassification was a careful one given the knowledge that the above settings were the cause of the generation units tripping.

Findings

We conclude that AEMO complied with clauses 3.2.3A(g) and 3.2.3A(h) in its reclassification decisions surrounding the loss of multiple wind farms.

5.6 Dispatch of generation and power system security during the market suspension period

Certain generators raised concerns with us about how AEMO had been managing power system security, particularly towards the end of the market suspension period. These generators claimed that AEMO, by its actions, was in effect directing participants.

By contrast AEMO has stated it issued only two formal directions.[376] As already discussed, participants who are formally directed under clause 4.8.9 may be eligible to seek compensation.

As part of our review and assessment of these matters, we met with AEMO and SA Market Participants, followed by written requests for information and documents, including call recordings between AEMO and SA Market Participants.

We subsequently received 211 call recordings from generators alone, which we transcribed and analysed. We also considered additional phone calls provided by AEMO for context.[377]

Our analysis identified practices of concern that specifically affected Origin towards the end of the market suspension period. This is particularly from 7 to 11 October 2016, through the circumstances in which AEMO invoked "quick energy constraints" on Origin's Quarantine 5 unit (QPS5).

To assess these issues, we divided the Event and the subsequent market suspension period into three key stages:

AEMO's management of the power system—28 to 29 September (Black System stage)

As indicated in table 2 (above, section 5.3.1), the Black System stage is defined as the period from 16:18 hrs on 28 September 2016, when the SA power system went black, until clearance was given to restore the last load block at 18:25 hrs on 29 September 2016.

Regarding such an event, clause 4.8.12 requires AEMO to prepare a system restart plan for the purpose of managing and coordinating system restoration activities during any major supply disruption. AEMO's system restart plan for SA has subsequently been nominated by AEMO to be the power system operating procedures under clause 4.10.1(a)(5) of the NER. Relevantly, clause 4.10.2(b) requires generators to comply with the requirements of the power system operating procedures, and clause 4.8.14(d) requires generators to comply with AEMO's directions or clause 4.8.9 instructions regarding the restoration of the power system. AEMO's System Restart Overview, being the relevant overarching procedural document, specifies that all participants have a responsibility to assist AEMO in the restoration process.

While AEMO issued no formal directions during this stage, given AEMO's obligation to manage power system security and generators' obligations to assist with the restoration process pursuant to the specific system restart plan, we find that none of the calls analysed during this stage raised concerns about how AEMO dispatched generation.

AEMO's management of the power system—30 September to 4 October (No NEMDE stage)

During the period of 30 September to 4 October AEMO manually dispatched generators by telephone instead of its usual electronic NEMDE system. This was unusual, but we note that both clause 3.8.21(e), as well as AEMO's System Operating Procedure for 'Failure of Market or Market Systems', specify AEMO will issue dispatch instructions via telephone if in AEMO's reasonable opinion normal processes are not available. Clause 4.9.2(a) gives AEMO the power to instruct, with clause 4.9.5 providing a description of the essential elements that constitute dispatch instructions.[378] AEMO has stated that NEMDE was not being used during this stage because AEMO lacked confidence in NEMDE's pre-dispatch and dispatch outcomes.[379]

376 AEMO, Final Report, p. 85. Particularly, to: 1) ENGIE (Pelican Point) on 9/10/16 and 2) AGL (Torrens Island "TIPS") on 11/10/16.

377 Not all calls have been referenced in the text for a number of reasons including due to volume.

378 For example, *dispatch instructions* must include specific references to the generating unit, desired outcome (i.e. required action), and timing.

379 AEMO, Final Report, p. 86.

On 30 September 2016, AEMO implemented an operational strategy for generation dispatch during market suspension. AEMO issued a key market notice[380] on this date which advised of the operational strategy, including that AEMO would use constraint equations where possible to manage system security.

Regarding the operational strategy, AEMO states: "*this provided the operational framework to manage SA's network while the market was suspended to ensure that the system remained secure and stable*".[381] AEMO also states[382] that this operational strategy was developed by AEMO and shared with affected Registered Participants at industry teleconferences.

Other key elements of the operating strategy were:

- *AEMO intended to move towards a situation where the central dispatch system was more reflective of how the system was being operated and generation was dispatched.*
- *AEMO's first priority in the dispatch of generation was to ensuring* [sic] *system security and stability.*
- *AEMO would dispatch all available scheduled generation at its minimum load*.[383]

We also note that AEMO issued an internal temporary operating advice to its staff during this period in four iterative versions. It stated amongst other things that:

- AEMO would maintain a minimum of three thermal synchronous generator units, (each of not less than 100 MW installed capacity), in-service at all times. If required, AEMO would issue directions to maintain this level of synchronous plant in service.
- If necessary for system security purposes, AEMO would direct generating units that are uneconomic for dispatch but available for direction, following the rules directions process.

As stated above, on 3 October AEMO issued a market notice[384] reclassifying the loss of nine generating units (specifically wind farms) in SA to be a single credible contingency until further notice.[385] AEMO also held an industry conference on 3 October to discuss the reclassification of the windfarms.[386] On 4 October AEMO issued a further market notice (55168) reclassifying 10 wind farms in total.[387] This effectively constrained the total output of the reclassified wind farms—a total capacity of 675 MW.[388]

On 4 October 2016 there was a SA Government Ministerial direction under section 4 of the *Essential Services Act 1981* (SA) directing AEMO to *"take all reasonable actions, utilising a best endeavours approach, to maintain the expected Rate of Change of Frequency [RoCoF] of the South Australian power system* [to within +/- 3Hz/s in relation to the non-credible coincident trip of both circuits of the Heywood Interconnector]."

We received one specific query regarding the clarity of communications between AEMO and generators during this period. In particular, ENGIE[389] questioned whether or not it had been directed on 30 September 2016. Our assessment did not find any concerns, as we consider AEMO's language was unambiguous. There otherwise did not appear to be a pattern of conduct during this period, as it is evident that AEMO was easily able to maintain its strategy of keeping at least three thermal synchronous generator units on at any given time,[390] with generators likewise confirming that AEMO dispatched during this period by keeping numerous units on at minimum load. This is understandable, particularly given that at that time, AEMO could not rely on NEMDE and still did not know the root cause for the power system collapse. We therefore consider that none of the calls analysed during this stage raise concerns about how AEMO managed the power system and dispatched generation.

AEMO's management of the power system—5 October to 11 October (NEMDE stage)

On 5 October AEMO issued a market notice[391] notifying the market of an update to the SA operating strategy. The change was intended to assist in managing power system security through the use of network constraint equations and to move towards a situation where the central dispatch

380 Market Notice 55072.

381 AEMO, Final Report, p. 86.

382 Ibid.

383 Market Notice 55072.

384 Market Notice 55161.

385 Two of the wind farms had their reclassifications removed on 10 October and a further three on 11 October, as the cause of the generating unit trips had been addressed.

386 Held at 10.00pm AEST.

387 Also see figure 31 of AEMO's Final Report, p. 89.

388 AEMO, Final Report, p. 89

389 ENGIE Australia has two subsidies with plant in South Australia, Synergen Power P/L and Pelican Point Power Ltd. For ease of reference, we use ENGIE throughout this report rather than the individual corporate entities.

390 AEMO, Final Report, p. 90, table 19.

391 Market Notice 55230.

system was more reflective of how the system was being operated and generation was dispatched.

Key points were:

- *Where possible, dispatch instructions would be issued by the standard methods.*
- *Unless otherwise instructed by AEMO, all SA scheduled and semi-scheduled generators had to follow dispatch targets issued by NEMDE.*

This means that, during this period, generators were making bids, NEMDE was automatically determining a merit order and dispatch instructions were issued by NEMDE to Market Participants. However, AEMO was still also telephoning generators about dispatch. It did this to manage power system security and stability. Prices at this stage were still being set by the Market Suspension Pricing Schedule.

From our analysis of the telephone calls between AEMO and generators, we consider that issues of clarity of communications and transparency arose during this period in particular. This appears to be because, as indicated above, AEMO was advising generators of the level of power required to be produced via both NEMDE and verbally. It is evident from the calls, as well as from our discussions with generators that this was causing confusion as to whether or not they were being formally directed. The calls to generators and consequent confusion appear to stem from AEMO's strategy of keeping three synchronous generators on at any given time, so as to manage system inertia. We note that the actual output from generation is available in real time to all participants, so the actual numbers of online synchronous generators is known at all times. AEMO has stated that power system inertia in SA is a direct function of synchronous unit commitment in SA, so it was considered appropriate, at a minimum, to ensure that system inertia did not fall below the levels seen immediately prior to the Event.

AEMO also managed system inertia partially because the SA Minister directed AEMO to "*take all reasonable actions*" to maintain RoCoF, and manage power system security.

As indicated above, this strategy appears to have most affected Origin, through AEMO's use of quick energy constraints, particularly during the period 8 to 11 October 2016. We note that there were three types of quick energy constraints invoked by AEMO during this period:

1. Constraints invoked on Origin's QPS5 unit, which led to dispatch that was not in accordance with its dispatch offers[392] (the key issue we examined)
2. Constraints invoked on ENGIE's Pelican Point power station and AGL's Torrens Island power station, but consistent with their dispatch offers, and
3. The constraint invoked on ENGIE's Pelican Point power station in respect of the formal clause 4.8.9 direction.[393]

AEMO states in its Final Report of March 2017 that the constraints invoked on generators were to ensure they did not generate *below* a certain level.[394] We note that the use of these types of constraints is unusual and was associated with prices being set according to the market suspension schedule, not by NEMDE. Typically, generators manage targets through their offers.

AEMO states that the constraints were put in place to ensure:

> *"that the generators that were required to run to meet the conditions imposed on AEMO under direction from [the] SA [Government] were not being damaged by being dispatched below their technical minimum, for example at times where demand was low and wind generation high."*

Directly related to this, AEMO also states the constraints were due to an issue whereby pricing was at the floor and NEMDE was issuing targets below the minimum acceptable generation level of those units.[395]

There is some evidence of constraints being issued to Origin to ensure its QPS5 unit would not be dispatched below its minimum generation levels which would damage the unit. For example, there are calls where Origin acquiesces and agrees to be constrained on, but is receiving targets below the unit's minimum generation level. Nonetheless, some of the constraints binding Origin to dispatch were not in accordance with its initial dispatch offers (where all of its capacity was offered at the market cap price), and were not implemented as a result of a formal clause 4.8.9 direction.

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392 That is, the offer prices were close to the price cap, and the generator was not forecast to be dispatched above zero.

393 Noting that a constraint was not issued in respect of AGL's clause 4.8.9 direction as the direction was revoked before it came into effect due to the subsequent lifting of the market suspension condition.

394 AEMO, Final Report, p. 90. AEMO has stated this was due to an issue whereby pricing was at the floor and NEMDE was issuing targets below the minimum acceptable generation level of those units. The constraints were therefore ensuring that those units would not be dispatched below their minimum generation levels which would damage the units' combustors.

395 Ibid.

AEMO implementation of constraints on Origin's QPS5 unit

As shown in table 3 below, it appears that AEMO easily maintained its policy of keeping three synchronous generating units[396] in service at all times up to and including 5 October 2016. This was due to the strong commitment by SA Market Participants to ensure the ongoing stability of SA's electricity system. AEMO also states that actual load levels and the wind and solar levels at the time also contributed.

Table 3: Synchronous generating units on-line

DATE	Number of large synchronous generators on-line
28-Sep-16	0
29-Sep-16	4
30-Sep-16	8
01-Oct-16	6
02-Oct-16	6
03-Oct-16	6
04-Oct-16	5
05-Oct-16	4
06-Oct-16	3
07-Oct-16	3
08-Oct-16	3
09-Oct-16	3[a]
10-Oct-16	3
11-Oct-16	3[b]
12-Oct-16	4

a. At 20:54 hrs a direction was issued to Pelican Point to come on-line.

b. Market suspension lifted 11 October at 22:30 hrs.

Source: Table 19 of the AEMO Final Report, p. 90.

However, it is clear that from 6 October 2016 onwards, it became more difficult for AEMO to maintain three synchronous generators on-line to manage power system security.

Specifically, we note that from 6 October onwards AEMO began calling generators seeking cost information,[397] an action AEMO usually undertakes after a clause 4.8.5A notice but before it formally issues clause 4.8.9 directions.[398] For example on 6 October, AEMO called AGL to seek cost information. AGL's call log indicates that AEMO had been considering a direction and had sought cost information, but nonetheless AGL decided that it could offer the unit without a direction. AGL's log states that "[AEMO] *require[d] [AGL] to run the unit at min load*".

By 7 October 2016 the market had been suspended for 9 days. Several generators have advised us that having been subjected to low market suspension pricing and subsequent financial losses during this period, they made a commercial decision from this point onwards that they would not operate plant contrary to their bids unless formally directed.

As part of our consideration of events during the market suspension period, we listened to and assessed more than 150 telephone calls between AEMO and Origin, and about 20 calls directly related to the ENGIE and AGL formal directions. We found numerous issues arising from 8 October to the end of the market suspension period on 11 October. In summary we note these key points based on our understanding of the calls:

- AEMO invoked constraints on Origin's QPS5 unit to meet its power system security requirement to maintain a minimum of three synchronous generators in service for the following periods:
  - 8 October from 1:30–16:00 hrs.
  - 9 October from 2:30–3:05, 3:05–6:35, 6:35–14:35, 14:35–0:00 hrs (the next day).
  - 10 October from 17:45–7:25 hrs (the next day).
- At times it was not clear to the Origin trader whether Origin was being directed.
- AEMO's communications were not always clear to Origin, though we note Origin's acquiescence to having the constraints invoked upon it. Constraints were at times extended by AEMO prior to obtaining Origin's agreement—though again, we note that Origin would ultimately acquiesce.
- On 9 October, after Origin had run voluntarily for a number of periods, it advised AEMO that it had become energy constrained. Consequently, AEMO then formally directed ENGIE's Pelican Point power station.
- After a market notice was issued advising that a direction to a Market Participant (ENGIE) had been cancelled on 10 October, a phone call between Origin and AEMO in relation to this market notice took place. Upon our assessment of the phone call, we consider the Origin representative was confused as to why another participant had been directed and Origin had been operating from an understanding AEMO was not directing any Market Participants during market suspension.
- On 11 October there were several conversations between AEMO and Origin about AEMO applying a security constraint to QPS5 to ensure that the unit generated. Origin queried on two occasions whether it was a

396 Each of not less than 100 MW installed capacity.

397 AEMO has advised us that it was also seeking cost information the previous week to support its manual dispatch instructions.

398 Per clause 4.8.5A(e)(3) in which AEMO may request estimates of relevant costs when it considers it reasonably likely a Scheduled Generator will be subject to a direction.

direction and was advised it was not. After being subject to the constraint for a period of time, Origin notified AEMO that QPS5 was being bid unavailable due to commercial reasons. AEMO subsequently spoke to both Origin and AGL to obtain cost information; AEMO issued a direction to AGL to synchronise its Torrens Island B2 unit.[399]

- On at least one occasion, circumstances appear to indicate that Origin may not necessarily have been the most economic option but was constrained on nonetheless.[400]

AEMO advises:

> *"AEMO held multiple briefings with SA generators, NSPs and officials throughout the market suspension period. SA generators were informed of AEMO's requirements for online synchronous generation, and were aware that AEMO would need to issue directions in the event that insufficient synchronous generating units remained available for dispatch. This message was conveyed to South Australian participants in the industry conference on 3 October. AEMO was also in regular contact with each of the large synchronous generators (including Origin) at a management and operational level."*

We formed a different view as to whether there was at all times a shared understanding between AEMO and generators regarding AEMO's approach to dispatching the market. We formed this view by listening to hundreds of phone calls and reviewing material from a number of generators, including written responses and contemporaneous trading and operational logs.

5.6.1 Relevant NER provisions and assessment

In managing the power system towards the end of the market suspension period of the Black System Event, we consider that AEMO did not comply with all of its obligations.

While we appreciate the difficulty AEMO had in managing power system security towards the end of the market suspension period, we are concerned that AEMO's approach at times did not appear to be as open and transparent as it could have been. We consider that AEMO could have been clearer in its communications.

We note that AEMO has relied on its issuance of the earlier market notices of 30 September and 5 October, as well as key industry conferences (held on 30 September, 3 and 4 October 2016) to support its view that there was sufficient transparency. However, we conclude that AEMO should have also issued more timely (contemporaneous) notices, between 7 and 11 October, which dealt specifically with its concerns that it would not be in a position to comply with the technical envelope. Regarding the 3 October industry conference, AEMO advised us that its records do not indicate specifically who received the invitation or attended. We also note that Origin was not listed as an attendee to the industry conference of 4 October 2016. AEMO should also at times have been clearer and more open in its phone calls with Origin.

This is evident in Origin's written response to our inquiries in which it states that it was under the impression that everyone was operating in a similar manner to Origin and working as hard as they could to assist the market to get back to normal conditions. This is significant because it was not always in Origin's financial interest to run when constrained on and it appears that it did not bid itself unavailable because it made a high level decision to provide system support.

We acknowledge that AEMO was endeavouring to manage power system security in challenging circumstances. However, there is scope for AEMO to improve its practices and procedures regarding clear communications as well as transparency and disclosure.

We conclude that AEMO did not issue market notices seeking a market response on a number of occasions as required under the NER. Likewise, it is apparent that AEMO's discussions with Origin could at times have been clearer.

Our recommendations are therefore in regard to transparency through the publication of contemporaneous market notices for instances that *may* require AEMO to implement an intervention event[401] as well as clarity in its verbal communications.

Clause 4.8.9—AEMO's power to issue directions

A *direction* is defined as having the meaning given in clause 4.8.9(a1)(1) which states if AEMO requires a Registered Participant to take action as contemplated by clause 4.8.9(a) or section 116 of the NEL in relation to a scheduled plant, AEMO is taken to have issued a direction.

- Clause 4.8.9(a) states notwithstanding any other provision of rule 4.8 AEMO may require a Registered Participant to do any act or thing if AEMO is satisfied that it is necessary to do so to maintain or re-establish the power system to a secure operating state, a satisfactory operating state, or a reliable operating state.

399 Due to the lifting of the market suspension condition, the direction was subsequently cancelled.

400 AEMO has stated this was on the basis that QPS5 was bid available and others required direction.

401 That refers to specific circumstances giving rise to a need to potentially intervene, in addition to, or in opposed to, a general overall message to the market, as indicated in clause 4.8.5A.

- Clause 4.8.9(b)(5) states AEMO must develop procedures for the issuance of directions. These procedures must reflect certain principles including the principle that AEMO must expressly notify a Directed Participant that AEMO's requirement is a direction.
- Section 116 of the NEL states AEMO may, if it considers that it is necessary to maintain power system security, direct a Registered Participant to take one or more relevant actions.[402] These relevant actions include calling equipment into service, commencing operation and maintaining, increasing or reducing active or reactive power output.

We consider that the definition of a *direction* at clause 4.8.9(a1)(1) allows for an interpretation that AEMO constructively directed Origin at times during the period 8 to 11 October. This is because AEMO specifically *required* a *Registered Participant* (Origin) to *take action* (to commence operation or maintain) in relation to a *scheduled plant* (QPS5) to maintain power system security.

However, there is also evidence that suggests AEMO's conduct does not amount to a direction. In particular, AEMO's advice to Origin that it was not being directed and that it was open to Origin to bid itself unavailable if it did not want to generate (for whatever reason), notwithstanding that it appears to us in some of the calls that Origin appeared confused at times. However, Origin's status as a large and experienced Market Participant and its decision to bid itself unavailable on 10 October supports a conclusion that AEMO was not 'requiring' it to do an act or thing in the context of 4.8.9(a)(1).

In these circumstances, we could not conclude that the use of quick energy constraints represented a formal direction to Origin. Despite this, as the following sections explain we have formed the view that by virtue of the circumstances at the time, AEMO was required to issue clause 4.8.5A notices. We have also considered the applicability of clause 4.8.7(b) which requires AEMO to follow the procedures in clause 4.8.9 in the context of contingency events and potential electricity *supply* shortfalls.

Clause 4.8.7(b)—Managing a power system contingency

Clause 4.8.7(b) states that AEMO must follow the procedures outlined in clause 4.8.9 (regarding formal directions) when *contingency events* lead to potential or actual electricity *supply* shortfall events.

In analysing this clause, we consider the relevant contingency events to be those that caused the collapse of the power system to a Black System on 28 September 2016.[403]

While the Black System condition was removed at 18:25 hrs on 29 September, we consider that AEMO was still managing system security issues (in particular rate of change of frequency and inertia stemming from the relevant contingency events) until the end of market suspension on 11 October.

As AEMO has stated in its Final report, from 4 October onwards it had reclassified 10 wind farms in total to be a single credible contingency, and that:

> *"Due to AEMO's inability to determine the cause of the Black System in the short term, it was not possible to ascertain the exact generation requirement to ensure AEMO was meeting its obligations to maintain power system security. However, as it was suspected that inertia and system strength may have played a role in the system collapse, AEMO determined that the level of synchronous generation on-line should not fall below the level on-line prior to the Black System."*[404]

We also note AEMO's market notice on 4 October[405] when it reclassified the wind farms stated:

> *"At 1618 hrs Wednesday, 28th September 2016 the South Australia power system separated from the remainder of the NEM interconnected power system following a number of events, including the trip of multiple generating units, resulting in a black system condition in South Australia.*
>
> *Based on AEMO's analysis to date, it is not satisfied that the trip of multiple generating units following a single credible contingency event is unlikely to re-occur."*

Along with the wind farm reclassification constraint, other network constraints binding during the market suspension period include:

- Constraint to keep the Heywood Interconnector at zero export from SA to Victoria to manage suspension pricing impacts.
- Constraint limiting Heywood interconnector flows where necessary to maintain the rate of change of change of frequency in SA to +/- 3 Hz for a non-credible trip of both interconnector circuits.

402 As described in section 116(6) of the NEL.

403 Namely, the loss of a double circuit transmission line and the loss of multiple generating units (the relevant wind farms).

404 AEMO, Final Report, pp. 88 and 89.

405 Market Notice 55168.

We further note that AEMO's use of these network constraints align with AEMO's Power System Security Guidelines in respect of "Contingency Management".

The AER and AEMO differ in their interpretation of clause 4.8.7(b) as to whether AEMO was managing the aftermath of contingency events and/or was managing the risk of a further contingency event.

However, in all the facts and circumstances, we agree with AEMO's view regarding the second element in clause 4.8.7(b) as to whether AEMO was managing potential *supply* shortfalls.

We considered whether inertia shortfalls could also be captured by 4.8.7(b), i.e. whether a supply shortfall includes a shortfall in supply of services (such as inertia) required to ensure power system security. Ultimately we found that AEMO was not managing potential supply shortfalls from a reliability of supply perspective. We instead found that it was a matter of AEMO managing power system security and potential *inertia* shortfalls. We interpret clause 4.8.7(b) to require AEMO to follow the procedures outlined in clause 4.8.9 (regarding formal directions) in respect of potential or actual supply shortfalls related to reliability, and not inertia.

Clause 3.8.21(i)—when AEMO modifies the dispatch outcome

Clause 3.8.21(i) states:

> *(i) AEMO may modify or override the dispatch algorithm outcome in accordance with the requirements of clause 4.8.9 or due to plant not conforming to dispatch instructions and in such circumstances AEMO must record the details of the event and the reasons for its action for audit purposes.*

To ensure units remained on-line, semi-scheduled generation typically bid all energy at the market price floor, whereas scheduled generation bid reflective of the suspension pricing schedule, with smaller quantities at the market price floor. As a result of tie-breaking limitations in NEMDE, units with larger quantities at the market price floor were dispatched to higher targets. This resulted in scheduled generating units being dispatched below their minimum load, even when the units were required on-line for power system security. AEMO undertook constraint action when required, such that units would not be dispatched under their operational minimum.

It appears from AEMO's internal operating advice NEMDE would use quick constraint equations set by AEMO control room staff in these situations. This interpretation is consistent with the narrations set out in an internal AEMO constraint spread sheet provided to us by AEMO.

However, we consider there were instances where the constraints were used for a purpose beyond ensuring units were not dispatched below their minimum safe operating level (which had been bid in at the price floor). The AER considers that, where Origin only made QPS5's capacity available to the market at the price cap in its dispatch offer, the use of a quick constraint would result in a dispatch instruction being issued to Origin that may not accord with its offer. Any failure on the part of Origin to comply with that dispatch instruction would be a contravention of clause 4.9.8(a), which is a civil penalty provision.

AEMO's authority to issue (energy) dispatch instructions is derived from clause 4.9.2.[406][407] Clause 4.9.2 requires AEMO to issue dispatch instructions in accordance with clause 4.9.5, which in turn requires AEMO to comply with 3.8.21. Clause 3.8.21 deals with the online dispatch process and specifies AEMO may modify or override the dispatch algorithm outcome in accordance with the requirements of clause 4.8.9 (formal directions).[408]

The AER considers therefore that it is not clear whether the use of quick energy constraints on an individual generator to vary the generator's dispatch (where the generator is constrained on at an output level *above* the output level it had offered for dispatch at a particular price) would constitute a clause 4.8.9 direction or a dispatch instruction.

AEMO has provided its view to this issue as follows:

- "*Quick constraints were used to ensure QPS5's dispatch offer was scheduled to meet the system security requirement (notwithstanding its high price [capacity bid]), and that for those purposes the unit would be dispatched at or above its operational minimum (80MW as advised by Origin at the time). Subsequent quick constraints were to keep the unit at its minimum load during periods where the requirement applied*."
- "*AEMO considers it did follow normal dispatch processes. A quick constraint was necessary to ensure QPS5 would be dispatched by NEMDE at a level sufficient to meet the power system security requirement*."
- "*AEMO is unaware of any provision to indicate the use of constraints in this way was not permitted by the Rules*."
- "*Clause 3.8.1(b) provides for the central dispatch process to be subject to matters including power system security requirements*."

406 Dispatch instruction is defined under the NER as an instruction given to a Registered Participant under clauses 4.9.2, 4.9.2A, 4.9.3, 4.9.3A, or to an NMAS Provider under clause 4.9.3A.

407 We note that the words 'direction' and 'instruction' are not italicised in clause 4.9.2; when the NER refers to clause 4.9.8 directions the word 'direction' is italicised.

408 NER, clause 3.8.21(i). This clause also enables AEMO to modify or override the dispatch algorithm outcome due to plant not conforming to dispatch instructions.

Clause 4.8.5A—Publication of market notices

Clause 4.8.5A of the NER provides for the "*Determination of the latest time for AEMO intervention*" and states that:

a. *AEMO* must immediately *publish* a notice of any foreseeable circumstances that may require *AEMO* to implement an *AEMO intervention event*.[409]

b. A notice referred to in paragraph (a) must include the forecast circumstances creating the need for the *AEMO intervention event*.

c. *AEMO* must, as soon as reasonably practicable after the *publication* of a notice in accordance with paragraph (a), estimate and *publish* the latest time at which it would need to intervene through a *AEMO intervention event* should the response from the *market* not be such as to obviate the need for the *AEMO intervention event*.

We assess that aside from the formal clause 4.8.9 directions issued to ENGIE's Pelican Point and AGL's Torrens Island power stations respectively (which are considered in a separate section below), there were multiple occasions in which there were foreseeable circumstances that *may have* required AEMO to implement an AEMO *intervention event*.

Below are specific instances which we consider to be such foreseeable circumstances that may have required AEMO to implement an AEMO intervention event, but in which it did not publish the required 4.8.5A notice:

- The occasion when AEMO had been considering a direction and had sought cost information, but nonetheless AGL decided that it could offer the unit and operate without a direction.
- The constraint issued on Origin on 8 October from 1:30 hrs–16:00 hrs.
- The constraints issued on Origin on 9 October from 02:30 hrs–3:05 hrs, 3:05 hrs–6:35 hrs, 6:35 hrs–14:35 hrs, 14:35 hrs–0:00 hrs (the next day).[410]
- The constraint issued on Origin on 10 October from 17:45 hrs–7:25 hrs (the next day).

More broadly, we consider that in each instance where AEMO was seeking costs from generators and/or was at risk of not meeting its strategy of keeping three synchronous generators on, that it was foreseeable that it *may have* been required to implement an AEMO intervention event. This is notwithstanding that AEMO did not direct on those occasions—but it was clear AEMO *may have* had to intervene had Origin and AGL not agreed to operate contrary to their dispatch offers. We consider that AEMO must issue market notices in these circumstances. We therefore find that AEMO was non-compliant with clause 4.8.5A on each such occasion.

AEMO's response

AEMO in a response to a request for information states that it does not consider a constraint to be an *AEMO intervention event*, therefore clause 4.8.5A (regarding the publication of market notices) does not apply. AEMO further states: "*If system security constraints will be effective to manage power system security issues, AEMO will use them in order to minimise the impact on the market.*"

We consider that the use of the constraints in the circumstances was clearly indicative that AEMO *may have* had to intervene. In fact, AEMO was required to formally direct other Market Participants when Origin bid itself as unavailable. Further, we observe that AEMO's use of constraints whilst pricing during market suspension was set by another means, (i.e. the market suspension pricing schedule), does not mean there was no market impact. This is also our view about the later stages of the market suspension period. When AEMO constrained Origin on—out of merit order—AEMO was changing dispatch outcomes of:

- some SA generators, and/or
- flows over the interconnector—i.e. the dispatch outcomes of some generators in adjoining regions.

As stated above, it is AEMO's view that the constraints invoked on Origin fall within the principle of "dispatch". It also pointed to Origin's acquiescence in agreeing to the constraints. AEMO also relies on the market notice[411] of 5 October 2016 (as well as the earlier 30 September notice) notifying the market of an update to the SA operating strategy which mentions managing power system security by using network constraint equations. AEMO has also stated:

> *"Both the event and the duration of the suspension were unprecedented, as were the lengths AEMO went to in order to keep participants informed. AEMO is not surprised that towards the end of the suspension period some generators withdrew their capacity and made themselves available only under direction. The fact that some did so before others does not indicate there was any confusion; only that AEMO was, very deliberately, seeking to ensure that bidding decisions were made solely by the participants themselves, and not influenced by AEMO in any way."*

We also acknowledge AEMO's view that in all cases the relevant generators had dispatch offers in NEMDE indicating they were *available* for dispatch. This is in contrast with our

409 Noting that an AEMO "intervention event" is defined in the NER as an event where AEMO intervenes in the market under the NER by issuing a direction in accordance with clause 4.8.9 (which is relevant for the purposes of this analysis), or in respect of the exercising of the reliability and emergency reserve trader (which is not relevant here).

410 These constraints are also related to when AEMO ultimately directed ENGIE and also when the participant notice was issued to ENGIE at 21:59 hrs.

411 Market Notice 55230.

view that some of the constraints caused the dispatch of Origin's QPS5 unit to be not in accordance with its initial dispatch offer (in which all of its capacity was offered at the market cap price). That is, Origin's offer of availability was structured in such a way as to minimise the likelihood of being dispatched during certain periods of the market suspension pricing schedule (which would have been known in advance). AEMO states that the "*reason AEMO was continually calling the thermal generators was to ensure their dispatch offers remained reflective of their intentions*."

AEMO has also stated: "*once AEMO resumed the operation of dispatch through NEMDE from 5 October, no generator was constrained on (i.e. dispatched out of merit order) unless it had either submitted a valid dispatch offer for that capacity or been issued with a direction*."

We do not share the same observation of the calls and interpretation of the offers of capacity and availability as AEMO.

In contrast to AEMO's view, we note the following comments on the transparency and communication issues raised by generators, including from the Market Suspension Working Group minutes that were attached in the supplementary documents to AEMO's Market Suspension Compensation Rule change request to the AEMC. For example:

- *"Market transparency issues during SA system black need to be addressed (eg operational strategy discussion was not open to all market participants)"*[412]
- "*During the SA market suspension, one wind farm thought that AEMO was directing them rather than requesting they following [sic] dispatch instructions. AEMO should clarify the difference between operating under suspension and directing*".[413]

Similarly, while Origin considered that AEMO's operation during the period was generally good, Origin nonetheless identified a number of areas for improvement:

- "*AEMO's contact lists were out of date and they did not do a good job of updating them during the event. Origin would have preferred that AEMO take the risk of over-contacting companies rather than making choices about which contacts to advise of Industry Conferences*."
- "*Origin would have appreciated greater clarity about how AEMO chose to dispatch units as on several occasions Origin was not asked to run units in response to higher prices during the day but was asked to run at lower prices overnight*."

Our review of internal AEMO procedures indicated that AEMO may not have sufficiently emphasised the mandatory nature of the requirement in the Rule to issue market notices. AEMO also identified in its Final Report that there was a lack of detailed procedures on how to operate the power system during extended periods of market suspension.

AEMO, faced with challenging circumstances to manage power system security and reliability, was working with many of these rules and procedures for the first time. However, our assessment has highlighted a need for AEMO to improve the clarity and transparency of its practices, procedures and communications during market suspension.

Better transparency and issuing of market notices should ensure participants have clarity about when they can make commercial decisions to operate plant as opposed to when they are *required* to be dispatched to a level to ensure power system security. This would also ensure symmetrical information is being provided to all generators without delay.

In conclusion, if AEMO is not giving timely and sufficient notice of a *possible* intervention, it does not give Market Participants the opportunity to meet AEMO's concerns with a market-based solution. Efficient market outcomes, particularly in terms of the dispatch of generation, are an important element of the market design. We consider that, even in circumstances where the market is suspended, sufficient notice of possible intervention, as required by the NER, enables participants to determine the most efficient outcome.

Regarding the issue of constraints, we note the AEMC has since recognised, with the introduction of its "Inertia Rule", the need for a specific obligation on TNSPs to procure minimum required levels of inertia to manage power system security and associated requirements around the dispatch of generators providing inertia.[414]

412 AEMO, Participant compensation following market suspension rule change request; "Supplementary information: Market Suspension change proposals discussion paper, April 2017", Working Group feedback—19 Apr 2017, (PDF) p. 8.

413 AEMO, *Participant compensation following market suspension rule change request*; "Supplementary information: Market Suspension change proposals discussion paper, April 2017", Minutes to the AEMO Market Suspension Technical Working Group Meeting #2 from Friday, 8 May 2015, (PDF) p. 20.

414 The obligations arising from that rule change commenced from 1 July 2018: AEMC, *National Electricity Amendment (Managing the rate of change of power system frequency) Rule 2017 No. 9* (Inertia Rule).

Findings

We conclude that aside from the formal clause 4.8.9 directions issued to ENGIE's Pelican Point and AGL's Torrens Island power stations respectively (which are considered in a separate section below), there were multiple occasions in which there were foreseeable circumstances that *may have* required AEMO to implement an AEMO *intervention event*. We therefore find that AEMO was non-compliant with clause 4.8.5A on each such occasion. Our findings are notwithstanding that the market was suspended.

Our recommendations in relation to dispatch of generation and power system security during the market suspension period are fully discussed in section 5.10 Findings, recommendations and AER actions at the end of this chapter.

5.7 AEMO formal intervention—clause 4.8.9 directions

As stated above, for the most part of the Black System Event period, AEMO implemented an operational policy of maintaining three synchronous units online at any given time to manage power system security. There were two separate directions issued by AEMO towards the end of the market suspension period to stay within that technical envelope. AEMO directed ENGIE's Pelican Point power station and AGL's B2 unit of the Torrens Island power station on 9 and 11 October respectively.

As part of our review and assessment of these matters, we have considered numerous sources of information and documents. This includes information provided by AEMO in response to AER requests, AEMO's System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions",[415] AEMO market notices, as well as transcripts of telephone calls between AEMO and Market Participants particularly towards the end of the market suspension period (8 to 11 October 2016) when the two directions were issued.

5.7.1 Relevant NER provisions and assessment

In formally intervening on two occasions by issuing clause 4.8.9 directions during the market suspension period of the Black System Event, we find that AEMO did not fully comply with its obligations.

We also consider that AEMO may not have complied with its own procedures and that its procedures for issuing a clause 4.8.9 direction do not fully reflect the intent in the NER.

Turning to the compliance of ENGIE and AGL being formally directed, we consider that ENGIE complied with the direction from AEMO. We otherwise note that AEMO cancelled the direction to AGL before full compliance became necessary.

Clause 4.8.5A—Publication of market notices

Clause 4.8.5A of the NER sets out a process for AEMO to follow when it may need to intervene in the market, including the timely publication of market notices. It also applies to this assessment as follows:

ENGIE Pelican Point

On 9 October 2016 there were six phone calls between ENGIE and AEMO, with AEMO publishing three market notices relevant to the direction to Pelican Point.
On 10 October 2016, there was one call and three market notices.

We conclude that it was first foreseeable that AEMO may have been required to implement an intervention event as early as 19:00 hrs on 9 October. However, AEMO did not publish any notices anticipating an intervention during this time or any time on 9 October prior to first contacting ENGIE. It is reasonably practical to publish a market notice within the space of one hour and 50 minutes.

In its public report, regarding both directions, AEMO states:

> *"The one exception [of compliance], which was the absence of a Market Notice on 9 October 2016 prior to the issue of the direction, was inconsequential as AEMO had already explored all feasible options for a market response."*[416]

AEMO's statements suggest that the issuing of a market notice would have been unnecessary and would not have elicited a response from the market. While this may have been the case, clause 4.8.5A(a) does state that a notice *must* be published and does not provide AEMO with any discretion either on the basis of necessity or effectiveness. Therefore we conclude that by not publishing a notice on 9 October, AEMO did not comply with clause 4.8.5A(a),[417] although we note that AEMO states that it had already explored all feasible options for a market response.

AGL Torrens Island

On 11 October 2016 there were 15 calls between AGL and AEMO, with AEMO publishing six market notices relevant to the direction to Torrens Island.

415 AEMO, System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions", Version 19, dated 11 September 2014.

416 AEMO, *NEM Event—Directions to thermal synchronous generators during South Australia market suspension*—9 and 11 October 2016, published 26 April 2017, p. 10.

417 And therefore did not comply with clauses 4.8.5A(b) and (c).

Early on 11 October 2016, AEMO contacted AGL to enquire about the availability of generating units at the Torrens Island power station. More than six hours later, AEMO issued market notice 55334 forecasting an intervention event and seeking a market response from synchronous generating units. It can be inferred that AEMO was anticipating an intervention event and did not issue a market notice for more than six hours. We assess that this length of time is not sufficiently immediate[418] to be compliant with clause 4.8.5A(a).

Clause 4.8.9(c2)—Participants must not contribute to causing a direction

In assessing the conduct of both ENGIE (Pelican Point) and AGL (Torrens Island), clause 4.8.9(c2) of the NER states that a Market Participant must not by any act or omission, whether intentionally or recklessly, cause or significantly contribute to the circumstances causing a direction to be issued, without reasonable cause.

As discussed above, following the Event, AEMO had a technical envelope which required it to maintain three synchronous units on to manage power system security. The directions to both ENGIE Pelican Point and AGL Torrens Island were issued to maintain that technical envelope. Given that the originating circumstances which required the directions were due to the network conditions and the loss of multiple generating units, the requirement could be met by several different generating units and that ENGIE or AGL did not knowingly contribute to the need to issue a direction to them, we consider that neither ENGIE nor AGL caused or contributed to the directions being issued to them, in relation to these particular facts and circumstances.

Clauses 4.8.9(b)—AEMO must develop procedures for the issuance of directions

Clause 4.8.9(b) of the NER states that AEMO must develop, and may amend from time to time, in accordance with the NER consultation procedures, procedures for the issuance of directions which reflect the prescribed principles.

AEMO developed procedures titled System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions" prepared by AEMO as required by clause 4.8.9(b).[419]

The following is our assessment of AEMO's procedures against its conduct and against the NER, as well as AEMO's conduct against the principles outlined in clause 4.8.9(b) of the NER upon which the procedures are based.

The reason why we have also assessed AEMO's conduct against the principles is because we consider AEMO's procedures do not fully reflect the principles. We note that clause 4.8.9(b) states that the procedures *must* reflect the principles.

Procedures SO_OP_3707—AEMO's procedures when issuing clause 4.8.9 directions

We conclude that AEMO's System Operating Procedure SO_OP_3707 regarding the issuing of clause 4.8.9 directions does not reflect all the principles prescribed in clause 4.8.9(b) of the NER. Further, AEMO did not follow all the steps outlined in section five of the procedures in respect of "AEMO actions when issuing a direction or clause 4.8.9 instruction".[420]

The procedures do not reflect the principles contained in clauses 4.8.9(b)(1) and (3) which are regarding the consideration of costs and reliability panel guidelines, respectively. AEMO has referred to its 2009 'Guidelines for management of electricity supply shortfall events' as being the guidelines for clause 4.8.9(b)(3), which are not explicitly referenced within AEMO's System Operating Procedure SO_OP_3707. While the 2009 supply shortfall guidelines AEMO points to appear only to be in relation to load shedding, we have not discussed clause 4.8.9(b)(3) in any further detail as part of this assessment, as load shedding was not relevant during the market suspension period. We conclude AEMO complied with clause 4.8.9(b)(4) in that its procedures reflect its obligations concerning sensitive loads.[421] Clause 4.8.9(b)(5) NER, which requires AEMO to *expressly* notify participants that they are being directed, appears comparatively passive in AEMO's procedures at paragraph 5(4) where it discusses AEMO *confirming* that the verbal instruction or direction to the participant is indeed an instruction or direction. This issue is discussed below.

The sections of the procedures[422] that AEMO did not completely satisfy in our assessment of when it formally directed are 5(1) and consequentially 5(2), which require anticipatory market notices**.** We consider there is insufficient information to ascertain whether AEMO followed section 5(7) regarding the timeliness of the revocation of the direction on 9 October, and therefore cannot comment as to whether the direction could or should have been cancelled earlier.

418 We consider "immediate", as used in this context, to mean 'without delay'. Once AEMO becomes aware of circumstances that *may* require it to implement an intervention event then it should publish a notice of these foreseeable circumstances 'without delay'. We consider that the term 'immediately' in the NER would have been included to ensure that the market is given the maximum available time to respond. This is consistent with the extrinsic material that accompanies the 2008 rule change.

419 AEMO, System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions", p. 3, (V 19).

420 AEMO, System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions", section 5, p. 6, (V 19).

421 AEMO, System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions", section 5.2, p. 7, (V 19).

422 AEMO, System Operating Procedure SO_OP_3707: "Intervention, Direction and clause 4.8.9 instructions", section 5, p. 6, (V 19).

Clause 4.8.9 (b)(1)—AEMO must use reasonable endeavours to minimise costs

We assess that the procedures do not reflect the principle outlined in clause 4.8.9(b)(1) which states:

> *AEMO must use its reasonable endeavours to minimise any cost related to directions and compensation to Affected Participants and Market Customers pursuant to clause 3.12.2 and compensation to Directed Participants pursuant to clauses 3.15.7 and 3.15.7A.*

This is because AEMO procedures do not reference this principle outlined in clause 4.8.9(b)(1) at all.[423] The principle of considering costs as part of AEMO's procedures is fortified by clause 4.8.5A(e)(3) which states:

> *The information that AEMO may request in accordance with paragraph (d) may include, but is not limited to: estimates of the relevant costs to be incurred by the Scheduled Network Service Provider, Scheduled Generator or Market Customer should it be the subject of a direction, but only if AEMO considers it reasonably likely that such Scheduled Network Service Provider, Scheduled Generator or Market Customer will be subject to a direction.*

In assessing whether AEMO did use its best endeavours to minimise costs, we reviewed several telephone calls. These indicate that AEMO made inquiries about costs and therefore turned its mind to the cost implications of any proposed direction.

Given these circumstances, we conclude that there is nothing to suggest that AEMO did not use its best endeavours to minimise costs.

AEMO's response

AEMO has acknowledged that its System Operating Procedure SO_OP_3707 could better reflect the principles on minimising costs of directions, although AEMO points to paragraphs 5(3)[424] and 5(7)[425] within those procedures as having cost considerations.

AEMO in its response also notes (and as we have observed in our assessment) that in practice AEMO does seek cost information from generators under clause 4.8.5(e) and factors that into its decision-making.

AEMO states that it will review the procedure in this regard.

Clause 4.8.9 (b)(5)—AEMO must expressly notify the directed participant that the requirement is a clause 4.8.9 direction

We assess that AEMO's procedures do not fully reflect the principle outlined in clause 4.8.9(b)(5) of the NER which states:

> *AEMO must expressly notify a Directed Participant that AEMO's requirement or that of another person authorised by AEMO pursuant to clause 4.8.9(a) is a direction.*

Specifically, we assess that AEMO's procedures at paragraph 5(4) could go further to ensure clear and unambiguous communication and therefore better reflect the principle in the rules. We note that the NER requires that AEMO "*expressly* notify" a Market Participant that its requirement is a direction. As currently drafted, AEMO's procedures require AEMO to "confirm" a verbal communication. From our analysis of the phone calls regarding the constraints issued on Origin and its confusion at times as to whether it was being directed (as discussed above), as well as ENGIE similarly seeking explicit confirmation from AEMO that Pelican Point was in fact subject to a direction (discussed below), it is apparent that clarity of communication is paramount. We do note however that AEMO did issue a reasonably clear participant notice albeit 65 minutes following the verbal direction.

Assessment of the phraseology of the verbal directions

We find the form of words used to direct Pelican Point and Torrens Island to be markedly different. Specifically, AEMO's approach in the ENGIE Pelican Point direction did not use the formal explicit language used in the AGL Torrens Island direction. By way of background, in assessing the formal AEMO directions we have also considered the surrounding calls for context.

ENGIE Pelican Point Direction (9 October)

We note in our assessment of the ENGIE Pelican Point direction telephone call ENGIE had to prompt AEMO to confirm that the Pelican Point direction was indeed a direction.

We note in a call leading up to the ENGIE direction, AEMO asked whether Pelican Point was available to come on any earlier. While ENGIE had indicated they would be able to operate earlier, they also specified it would be if they were

423 Although we note that that AEMO's procedures do state: "*[i]f there is any inconsistency between this Procedure and the NER, the NER will prevail to the extent of that inconsistency*." (Per section 1c) on page 6). Nonetheless clause 4.8.9(b) does not give AEMO discretion for its procedures to not reflect the relevant prescribed principles as described in clauses 4.8.9(b)(1) to 4.8.9(b)(5).

424 Paragraph 5(3) of AEMO's System Operating Procedure SO_OP_3707 (to paraphrase) refers to '*if reasonably practicable*', the determination of which Registered Participant is to be directed will aim to minimise the effect on interconnector flows and minimise the number of Affected Participants, (V 19).

425 Paragraph 5(7) of AEMO's System Operating Procedure SO_OP_3707 is in regard to revoking the direction or clause 4.8.9 instruction as soon as it is no longer required, (V 19).

directed to do so. AEMO's response in that earlier call was that AEMO would get back in touch with ENGIE if they needed to go down that path—indicating that ENGIE being directed was not a *fait accompli*.

Nonetheless, we consider the manner in which Pelican Point was verbally directed meets the requirements of expressly notifying Pelican Point that the requirement was a direction, as per clause 4.8.9(b)(5). While the direction to Pelican Point also complies with AEMO's procedures (which only require confirmation), we consider that overall, AEMO could have been clearer, instead of having to be prompted to confirm that the requirement to operate was indeed a formal direction.

AGL Torrens Island Direction (11 October)

In contrast, AEMO's approach to the AGL Torrens Island direction was more express, noting that AEMO was not prompted to indicate that the AGL generator was being directed and that AEMO advised AGL of the powers which AEMO was invoking to require AGL to take action.

Summary

It is important that AEMO communicates clearly to the participant being directed. Clarity of communication is paramount for several reasons. Firstly, AEMO may be implementing clause 4.8.9 directions during high risk situations where confusion about the basis of AEMO's requirement could cause unnecessary delay in participants complying with the direction. Participants need to understand that they *must* follow the direction. This contrasts with quick constraints where the participant needs to understand that they *do* have the choice to avoid the constraints by bidding their capacity as unavailable to the market due to opportunity costs. Secondly, when AEMO intervenes in the market it can have a distortionary effect, and therefore should be a last resort. Finally, a direction can give rise to an entitlement for compensation.

Assessment of other AEMO internal training material

We assessed relevant AEMO training material regarding "Directions" and we found some deficiencies. Specifically, we found instances in the training material that implied that market notices are subject to an element of discretion and could be issued where possible or if time permitted.

Further to the administration of directions, we are aware that AEMO has since clarified the way it communicates directions by developing a standard script to be used when it issues a clause 4.8.9 direction.[426]

AEMO's response

AEMO states that its primary concern is management of system security and events. The circumstances of the emergency may not allow time to elicit a market response. AEMO interprets that the intent of the rules is that AEMO would not allow a system security or reliability issue to unfold and occur whilst it is busy issuing market notices and waiting for a market response.

AEMO has also acknowledged that it has "*identified an opportunity to sharpen its verbal communications and notices with regard to directions and instructions, and market notices more broadly*." AEMO has further stated that "*[t]his is considered an improvement initiative, not a compliance issue.*"

426 AEMC, Issues Paper: Reliability Frameworks Review, 22 August 2017, pp. 98–99.

Findings

In formally intervening on two occasions by issuing clause 4.8.9 directions during the market suspension period of the Black System Event, we find that AEMO did not fully comply with its obligations.

We conclude that that AEMO did not fully comply with the NER in regard to the publication of notices.[427] AEMO did not publish any notices anticipating that it may have to intervene prior to directing ENGIE's Pelican Point power station. In respect of its obligation to publish such a notice in relation to its direction to AGL, it appears that AEMO failed to comply with the temporal requirements in clause 4.8.5A. This requires that AEMO must publish the notice "immediately". We note that the earlier a notice is issued, the more time the market has to respond. In turn, if the market has longer to respond, it may mean the need for AEMO intervention can be avoided.[428]

We also conclude that AEMO may not have complied with its own procedures and that its procedures for issuing a clause 4.8.9 direction do not fully reflect the intent in the NER.

As in the issue of constraints invoked on Origin discussed earlier, we find that this is an opportunity for AEMO to improve its transparency and clarity of communications, both when dealing with individual generators, as well as the market as a whole.

Turning to the compliance of ENGIE and AGL being formally directed, we consider that ENGIE complied with the direction from AEMO. We otherwise note that AEMO cancelled the direction to AGL before full compliance became necessary.

Our recommendations in relation to AEMO's formal intervention during the market suspension period are fully discussed in section 5.10 Findings, recommendations and AER actions at the end of this chapter.

5.8 Market suspension pricing, spot price impacts on other NEM regions, and FCAS management[429]

Market suspension pricing

As described in section 5.3.3 above, clause 3.14.3(a1) of the NER stipulates if AEMO declares the spot market to be suspended, prices must be set in accordance with clause 3.14.5 for that region. Clause 3.14.5 sets out a hierarchy of four possible pricing options, with the options in the Rules at that time being sequential. This means that once one option is no longer available, AEMO is obligated to use the next option, without being able to go back to the previous option.

Following the hierarchy of pricing that AEMO should move through, as prescribed by the NER, and as applicable as the market suspension unfolded, AEMO set the market suspension prices in accordance with clause 3.14.5(j).

Spot price impacts on other NEM regions

In accordance with NER clause 3.14.5(m), when energy flows from other NEM regions towards a suspended region, energy prices in those regions must be capped to ensure negative settlements residue does not accrue.

Prices in those regions must not exceed the SA suspension price, scaled by the average loss factor applicable to energy flow from their region towards SA.

Accordingly, for the full suspension period 28 September to 11 October, AEMO revised prices downwards, capping prices in the Victorian, Queensland and New South Wales regions over a number of dispatch intervals.[430]

However, as stated in AEMO's Final Report, AEMO concluded that Tasmanian prices should not have been capped during the period of market suspension.[431] As AEMO stated in its Final Report:

> *"In accordance with clause 3.14.5(o) when determining the average loss factor applicable to determine the capped prices in other regions, AEMO must reference the inter-regional loss factor relating to the relevant regulated interconnector. Since Basslink is not a regulated interconnector, Tasmanian prices were not capped."*[432]

427 In respect of clause 4.8.5A of the NER.

428 It is clear from clause 4.8.5A that the purpose of a clause 4.8.5A notice is to elicit a market response from a Market Participant so 'as to obviate the need for the AEMO intervention event'. The intention evident from the drafting is that only at the latest possible time, as a last resort, will AEMO intervene in the market.

429 Rule changes in respect of market suspension pricing came into effect from 1 December 2017, and are discussed in box 2 below. In referencing the relevant rules (NER versions 82 and 83) in this section we have done so in the present tense.

430 AEMO, Final Report, p. 85.

431 Ibid.

432 Ibid.

We consequently sought further information from AEMO as to the basis of how it concluded that Tasmanian prices should not have been capped. AEMO's response and our assessment appear below.

Frequency control ancillary services

We also considered how AEMO managed frequency control ancillary services (FCAS) during the market suspension period following the Black System Event.

AEMO must ensure sufficient FCAS services are enabled so the system can respond effectively to frequency deviations. When all regions are synchronously connected, FCAS can be sourced from any region to meet global (NEM-wide) requirements.[433]

During the market suspension period, AEMO did not acquire global FCAS services from SA participants, even though SA was no longer electrically separated ("islanded") from the rest of the NEM.[434] As part of our inquiries, we note AGL's concerns that it raised with us, as well as in its submission to the relevant SA Parliamentary Inquiry:

> *"AGL notes the high published FCAS raise and lower default prices during the period of market suspension did not reflect the physical requirement or provision of local regulation services in the South Australian market during that time. During the period of market suspension, AGL had contractual FCAS derivative obligations which were unable to be defended by the provision of a physical product."*[435]

AEMO's Final Report notes that the NER does not prevent FCAS from being sourced within a suspended region. We also note that AEMO's Final Report states AEMO's view that the provision of FCAS from a suspended region to support a global FCAS requirement is not workable with market suspension pricing, stating that the central dispatch process cannot co-optimise services across both suspended and unsuspended markets.

AEMO states that consequently, global FCAS requirements were sourced from other NEM regions during this period.[436] AEMO also states that it would still have sourced FCAS from registered ancillary service providers within SA if it became necessary to do so to maintain power system security or reliability. Our assessment of how AEMO managed FCAS during the market suspension period is below.

5.8.1 Relevant NER provisions and assessment

In administering market suspension pricing including the spot price impacts on other NEM regions and FCAS during the market suspension period, we consider that AEMO fulfilled its obligations.

Market suspension pricing

Clause 3.14.5—Pricing during market suspension

Clause 3.14.5 sets out how AEMO should determine spot market and ancillary service prices during market suspension, including high level requirements for AEMO to follow the rules for PASA[437] (physical availability) and dispatch requirements of rules 3.8 and 3.9 where reasonably practical.

AEMO states that on 28 September 2016, it was not possible in its opinion to set the spot prices and FCAS prices in the suspended region in accordance with clause 3.8 and 3.9 because the underlying demand in SA could not be represented nor met due to the Black System condition. AEMO states that the prices could not be set in accordance with clause 3.14.5(d) and (e) because SA was not connected to the rest of the NEM by an unconstrained interconnector. Clause 3.14.5(g) could not be used because neither rule 3.8 or 3.9, nor clause 3.14.5(g), had initially been applied.

Following the hierarchy of pricing that AEMO should move through, as prescribed by the NER, and as applicable as the market suspension unfolded, AEMO states that prices were set in accordance with clause 3.14.5(j). Given this initial condition, clause 3.14.5(k) required that AEMO continue to set the prices in this manner until the market was no longer suspended.

We accordingly conclude that AEMO complied with clause 3.14.5 in how it followed the formulaic hierarchy of pricing as prescribed by the NER at that time.

Spot price impacts on other NEM regions

We now turn to AEMO's decision not to cap Tasmanian pricing. As indicated above, we sought further information from AEMO as to how it concluded that Tasmanian prices should not have been capped.

In response to our inquiries, AEMO advises that it was necessary to apply clause 3.14.5(o) as a prerequisite to the application of clause 3.14.5(m). Clause 3.14.5(o) prescribes how AEMO must calculate the average loss factor applicable to clause 3.14.5(m) when price scaling in unsuspended regions.

Clause 3.14.5(m) only references regional reference nodes connected by an "*interconnector*". Clause 3.14.5(o), on the other hand, explicitly and exclusively references the "relevant *regulated interconnector*". Unlike clause 3.14.5(o), clause

433 AEMO, Final Report, p. 90.

434 AEMO, Final Report, p. 91.

435 AGL, Submission to Inquiry into State-wide blackout of Wednesday 28 September 2016, 14 February 2017, p. 18.

436 AEMO, Final Report, p. 91.

437 Projected Assessment of System Adequacy.

3.12.5(m) does not specify whether or not the interconnector referred to is regulated. However, AEMO has advised that since clause 3.14.5(o) is required to calculate the average loss factor applicable to clause 3.14.5(m), it is, in its view, logical for it to interpret that paragraph 3.14.5(m) could only apply to cap prices between regions connected by a *regulated* interconnector.

We consider AEMO's interpretation of the reference to an "*interconnector*" in 3.14.5(m) to mean a "*regulated interconnector*" (to correlate with the wording in clause 3.14.5(o)) as reasonable. We conclude that AEMO complied with its obligations.

The rule change that came into effect on 1 December 2017 regarding market suspension pricing clarifies that price scaling in other regions should occur only where the region is connected by a *regulated* interconnector. A brief discussion of that rule change appears below.

Frequency control ancillary services

We note that clause 3.14.5 sets out how AEMO was to determine spot market and ancillary (FCAS) service prices during market suspension. However, we also note that the NER was (and still is) otherwise silent as to how AEMO was and is to operate the FCAS services during market suspension periods.

As stated above, AEMO did not acquire global FCAS services from SA participants during the market suspension period.[438] We consequently sought further information from AEMO for the basis of that decision.

In response, AEMO advises that when satisfying global FCAS requirements, it was not possible to co-optimise the dispatch of local SA FCAS with that in other regions due to the different nature of pricing across regions.[439] AEMO was concerned that SA providers could have bid low to ensure dispatch ahead of units in other regions because they were guaranteed the higher FCAS suspension prices. AEMO advises it addressed this limitation by preventing SA Generators from being dispatched to meet global FCAS requirements until market pricing had resumed. If a local SA requirement had been in effect, SA Generators would have been permitted to bid and meet this requirement via NEMDE.

AEMO's response also indicated that it is also not aware of any requirement to consult on these matters, nor would it consider it appropriate to consult on how AEMO fulfils its responsibility to operate the power system in real time.

We note that AEMO had in fact communicated this approach to Market Participants, for example at the 30 September industry-wide teleconference, as well as in the 30 September market notice attaching the operational strategy for generation dispatch during market suspension. We consider it may otherwise have been appropriate for AEMO to issue further market notices as the market suspension period continued until 11 October.

Nonetheless, given the NER is silent as to how AEMO was to operate the FCAS services during market suspension periods, and that AEMO operated FCAS services to manage potentially perverse market outcomes, we assess that AEMO's approach was reasonable in the circumstances and that it therefore complied.

Findings

We conclude that AEMO fulfilled its obligations in clause 3.14.5 in administering market suspension pricing including in the spot price impacts on other NEM regions and FCAS during the market suspension period.

Further to our findings, we note on 15 November 2018 the AEMC made a final rule establishing a new compensation framework so that certain Market Participants who incur losses during a market suspension event can be compensated. The instigator of this rule change was AEMO in the wake of the market suspension period during the Black System Event. The framework set out in the new rule provides that a scheduled generator or ancillary service provider that provides services during a market suspension pricing schedule period is automatically entitled to compensation if its estimated costs during that period (calculated using the applicable 'benchmark value') exceed the revenue it earnt.[440]

This rule change, along with other market suspension pricing rule changes are discussed below in box 2.

438 AEMO, Final Report, pp. 90–91.

439 Co-optimising the dispatch of local SA FCAS with that of other regions would have been ideal to ensure that the most efficient combination of FCAS across regions (i.e. globally) would be dispatched, however as described above, this was not possible.

440 AEMC, *Rule determination: National Electricity Amendments (Participant Compensation following Market Suspension)*, dated 15 November.

Box 2: Market suspension pricing rule changes

During the September 2016 event, AEMO identified a number of issues with the NER market suspension pricing framework. AEMO's Final Report included recommendations in relation to this framework, including that AEMO review market processes and systems, in collaboration with Registered Participants, to identify improvements and any associated NER or procedure changes necessary to implement those improvements.[441]

AEMO subsequently established a Market Suspension Technical Working Group (MSTWG) to discuss and develop changes to the market suspension pricing framework, including rule changes where appropriate.[442]

In July 2017 AEMO requested an expedited rule change that was informed by those discussions. In October 2017 the AEMC made a final ruling that simplifies the process for setting prices if the spot market is suspended, and establishes a simpler, more workable market suspension pricing framework.

AEMO found that during the Black System event that neighbouring region pricing and pre-dispatch pricing were essentially unworkable and thereby burdensome on AEMO during a time when AEMO's efforts would be best focussed on rectifying the cause of market suspension rather than attempting to manually implement pricing through a series of steps.

The key features of the final rule therefore strip out many of the alternatives (in particular neighbouring region pricing and pre-dispatch pricing) as well as some of the consequential price adjustments required to other regions in order to streamline the process.

The benefit of the rule change is that AEMO will be able to publish prices in real time and give greater certainty to the market.

We note the final rule was largely the same as the proposed rule. The key difference between the final rule and the proposed rule relates to where AEMO has suspended the market in response to a jurisdictional direction. In this case, the relevant jurisdiction must agree to a return to dispatch pricing before AEMO can apply this pricing regime. Under AEMO's proposed rule, an agreement by the relevant jurisdiction was not required.[443]

This Rule commenced operation on 1 December 2017.

In July 2017, AEMO also submitted a rule change request to the AEMC relating to participant compensation following market suspension. The Participant compensation following market suspension rule change request was also informed by discussions at the MSTWG.[444] On 15 November 2018 the AEMC made a final rule establishing a new compensation framework so that certain Market Participants who incur losses during a market suspension event can be compensated.

As AEMO noted in its rule change request, the former framework did not provide for participant compensation due to pricing during market suspension. AEMO stated in its rule change request that it considered the application of the market suspension pricing schedule to be a form of administered pricing, with implications aligned to those arising from the application of the administered price cap. AEMO stated in its rule change request that, on that basis, it would be appropriate to allow Market Participants to seek compensation for losses over the duration of the market suspension. AEMO considered that this would reduce the risk of generators making their units unavailable for economic reasons during a time of acute operation stress, thereby requiring AEMO to issue directions.[445]

As can be seen from our findings, this is what occurred during the last few days of the market suspension period of the Black System event, noting that a number of generators have advised us that they made losses due to their earlier decisions to provide system support not based on commerce. However, having been subjected to low market suspension pricing and subsequent losses over the extended period of market suspension, most made a commercial decision towards the end of the market suspension period that they would not operate plant contrary to their bids unless formally directed.

It appeared that AEMO did not have any alternative but to issue the two directions towards the end of the lengthy market suspension period.

441 See recommendation 17 of AEMO's Final Report: "AEMO to review market processes and systems, in collaboration with Registered Participants, to identify improvements and any associated NER or procedure changes necessary to implement those improvements".

442 The MSTWG comprises representatives from industry and the market bodies, including the AER, and has, at the time of writing, met on five occasions between April and November 2017.

443 AEMC, Rule Determination: National Electricity Amendment (Pricing during market suspension) Rule 2017, 10 October 2017, Summary p. i.

444 AEMC, Rule Determination: National Electricity Amendment (Pricing during market suspension) Rule 2017, 10 October 2017, p. 1.

445 AEMO, Market Suspension Rule Changes, 25 July 2017, p. 6.

5.9 Resumption of the market

The market resumed following the revocation of the SA Ministerial direction on 11 October 2016, meaning that the market was suspended for 13 days in total.

AEMO can only resume the spot market when none of the three conditions apply: That is, there is no longer a system black condition or a jurisdictional direction suspending the market, and AEMO has the IT capabilities to operate the spot market. AEMO must also be satisfied that there is minimal possibility of suspending the market within the next 24 hours due to any of these causes. If the spot market was suspended due to a direction from a participating jurisdiction, then AEMO can only resume the spot market after that participating jurisdiction has revoked the direction. This was the case when, as indicated above, the SA Minister revoked its direction to suspend the market, being under the *Essential Services Act 1981* (SA).

5.9.1 Relevant NER provisions and assessment

We consider AEMO fulfilled its obligations when it resumed the spot market. We have set out below our analysis of these obligations.

Clause 3.14.4—Resumption of spot market

Clause 3.14.4 states among other things that following a declaration by AEMO under clause 3.14.3(a) of market suspension, the spot market is to remain suspended until AEMO declares and informs all Registered Participants:

1. that spot market operation is to resume in accordance with Chapter 3 of the NER, and
2. of the time at which the spot market is to resume.

Further, AEMO must within 10 business days following the resumption of the spot market commence an investigation of that spot market suspension. The investigation must examine and report on the reason for the suspension and the effect that the suspension had on the operation of the spot market. AEMO must make a copy of the report available to Registered Participants and the public as soon as it is practicable to do so.

In assessing whether AEMO has complied with clause 3.14.4, we note that while the NER require AEMO to declare and inform all Registered Participants that the spot market in the suspended region is going to resume, it is silent on the appropriate notice period.

Noting the timeline in table 2 above (denoting key stages regarding market suspension), on 11 October 2016, at:

- 17:48 hrs the SA Ministerial direction was revoked
- 18:26 hrs AEMO issued Market Notice 55343 advising the SA Ministerial direction was revoked and that the market would resume at 22:30 hrs, and
- 22:30 hrs the market resumed.

As part of our inquiries, AEMO has advised that it elected to use a four-hour notice period to ensure sufficient time for:

- participants to update and confirm their market bids and availabilities
- AEMO to revoke any unnecessary suspension related constraint equations and confirm all IT systems were ready to return to normal operation
- several pre-dispatch cycles using the updated bids availabilities, and network constraint equations were necessary to minimise any surprise or shock when the market resumed operation.

We note that AEMO's four-hour notice period is more than the two hours AEMO provides for in its procedures. AEMO's procedures state it will provide a minimum two hours' notice before resuming the spot market to allow an orderly transition to normal pricing, or sooner if the market is suspended due to a failure of AEMO's central dispatch process.[446] We also note there is evidence in the calls of AEMO notifying generators, drawing their attention to the lifting of the market suspension and asking them to rebid their units. We therefore consider that AEMO complied with the relevant provisions.

Finally, we turn to the obligation that AEMO must commence an investigation within 10 business days and make a copy of the report available to Registered Participants and the public as soon as it is practicable to do so.

We note AEMO's compliance with this particular obligation when it issued its 5 October 2016 Preliminary Report.[447] This was followed by a second[448] and third[449] preliminary report as well as the Final Integrated Report.[450]

446 AEMO, System Operating Procedure SO_OP_3706: "Failure of Market or Market Systems", section 11, p.16.

447 AEMO, First Preliminary Report, 5 October 2016.

448 AEMO, Second Preliminary Report, 19 October 2016.

449 AEMO, Third Preliminary Report, December 2016.

450 AEMO, Final Report.

Findings

We consider AEMO fulfilled its obligations when it resumed the spot market.

We note AEMO's transparency and clarity of communications regarding the timeliness of issuing the relevant market notice and in calling the generators requesting them to rebid their units. We subsequently do not make any recommendations about how AEMO handled this aspect of the Black System event.

5.10 Findings, recommendations and AER actions

5.10.1 Arising from 5.4: Suspending the market

Findings

AEMO fulfilled all relevant obligations in suspending the spot market in SA with effect from the trading interval commencing at 16:00 hrs on 28 September 2016.

AEMO promptly issued market notices advising that "*a Black system condition exists in the South Australia region*" and the "*SA power system separated from the NEM and became black*", and as such, complied with NER clause 3.14.3(a)(1).

Regarding AEMO being directed to suspend the market in SA by Ministerial direction under the *Essential Services Act 1981 (SA)*, we also find that AEMO complied with its obligations under clause 3.14.3(a)(2).

AEMO promptly issued market notices advising of the event in accordance with NER clause 4.8.3.

No further recommendations or actions are proposed in relation to these clauses.

5.10.2 Arising from 5.5: Reclassification of wind farms

Findings

We find that AEMO's decision to reclassify the loss of wind farm units as credible following a credible contingency event was a prudent approach and complied with NER clause 4.2.3A(g). We also find that AEMO complied regarding its decision to preserve the reclassification in consideration of clause 4.2.3(h).

In accordance with the NER, we consider that it was open to AEMO to take these steps given the uncertainty around the cause of the units tripping at that time.

No further recommendations or actions are proposed in relation to these clauses.

5.10.3 Arising from 5.6: Dispatch of generation and power system security during the market suspension period

Findings

We found that there were multiple occasions in which AEMO did not comply with NER clause 4.8.5A which requires AEMO to publish a notice without delay when it may need to intervene.

We assess that aside from the formal clause 4.8.9 directions issued to ENGIE's Pelican Point and AGL's Torrens Island power stations respectively that it is clear that there were multiple occasions in which there were foreseeable circumstances that *may have* required AEMO to implement an AEMO *intervention event*.

Better transparency and issuing of market notices should ensure participants have clarity about when they can make commercial decisions to operate plant as opposed to when they are *required* to be dispatched to a level to ensure power system security. This would also ensure symmetrical information is being provided to all generators without delay, giving the market the best opportunity to respond to the circumstances. This should result in more efficient outcomes for consumers.

As indicated in the final chapter—Implications for the Regulatory Framework, the AER anticipates that it will be working with the AEMC regarding questions that AEMO raised regarding the interaction and applicability of the market operation and system security rules, given, but notwithstanding, the suspension of the market.

Recommendations

5.1 Improved training for AEMO operators regarding the specific language used to ensure operators clearly state whether they are making a request, issuing instructions, or otherwise issuing clause 4.8.9 directions.

5.2 AEMO ensures that it publishes market notices, without delay, after it becomes aware of any foreseeable circumstances that may require AEMO to implement an intervention event and that it updates its procedures and guidelines accordingly.

5.10.4 Arising from 5.7: AEMO formal intervention

Findings

We found that there were multiple occasions in which AEMO did not comply with NER clause 4.8.5A which requires AEMO to publish a notice without delay when it may need to intervene.

AEMO's procedures for issuing a clause 4.8.9 direction do not fully reflect the intent in the NER as required by clause 4.8.9(b) and AEMO may not have complied with its own procedures.

In relation to ENGIE and AGL being formally directed, we consider that neither ENGIE nor AGL caused or contributed to the directions being issued to them in compliance of 4.8.9(c2), in relation to these particular facts and circumstances.

In relation to ENGIE and AGL being formally directed, we consider that ENGIE complied with the direction from AEMO. AEMO cancelled the direction to AGL before full compliance became necessary.

AEMO did not publish any notices anticipating that it may have to intervene prior to directing ENGIE's Pelican Point power station. In respect of its obligation to publish such a notice in relation to its direction to AGL, it appears that AEMO failed to comply with the temporal requirements in clause 4.8.5A. This requires that AEMO must publish the notice "immediately". We note that the earlier a notice is issued, the more time the market has to respond. In turn, if the market has longer to respond, it may mean the need for AEMO intervention can be avoided.[451]

Further, we find that AEMO may not have complied with its own procedures and that its procedures for issuing a clause 4.8.9 direction do not fully reflect the intent in the NER.

Recommendations

Our assessment highlights a need for AEMO to improve its practices, procedures and communications, particularly regarding the improvement of a market suspension communication protocol for clarity and transparency.

We note that AEMO has previously identified that there was a lack of detailed procedures on how to operate the power system during extended periods of market suspension, and has since clarified the way it communicates directions by developing a standard script to be used when it issues a clause 4.8.9 direction. We commend this action by AEMO.

Two of our earlier recommendations (regarding when AEMO invoked constraints on Origin when it was indicative that it *may* have needed to intervene)[452] are also applicable to when AEMO issued formal clause 4.8.9 directions (recommendations 5.1 and 5.2, being about improved training for AEMO when issuing clause 4.8.9 directions, as well as ensuring the timely issuing of market notices under clause 4.8.5A).

5.1 Improved training for AEMO operators regarding the specific language used to ensure operators clearly state whether they are making a request, issuing instructions, or otherwise issuing clause 4.8.9 directions.

5.2 AEMO ensures that it publishes market notices, without delay, after it becomes aware of any foreseeable circumstances that may require AEMO to implement an intervention event and that it updates its procedures and guidelines accordingly.

5.3 AEMO ensures that its procedures more closely align with what is prescribed in the NER particularly regarding directions (clause 4.8.9) and market notices (clause 4.8.5A).

451 It is clear from clause 4.8.5A that the purpose of a clause 4.8.5A notice is to elicit a market response from a Market Participant so 'as to obviate the need for the AEMO intervention event'. The intention evident from the drafting is that only at the latest possible time, as a last resort, will AEMO intervene in the market.

452 As well as the occasion when AEMO had been considering a direction and had sought cost information, but nonetheless AGL decided it could offer the unit and operate without a direction.

5.10.5 Arising from 5.8: Market suspension pricing, spot price impacts on other NEM regions, and FCAS management

Findings

AEMO fulfilled its obligations under NER clause 3.14.5 in administering market suspension pricing including the spot price impacts on other NEM regions and FCAS during the market suspension period.

No further recommendations or actions are proposed in relation to these clauses.

5.10.6 Arising from 5.9: Resumption of the market

Findings

AEMO fulfilled its obligations when it resumed the spot market and therefore complied with NER clause 3.14.4.

We note AEMO's transparency and clarity of communications regarding the timeliness of issuing the relevant market notice and in calling the generators requesting them to rebid their units.

We subsequently do not make any recommendations about how AEMO handled this aspect of the Black System Event.

Implications for the Regulatory Framework

6. Implications for the regulatory framework

6.1 Summary

Our compliance assessment into the extensive and unprecedented set of circumstances surrounding the Black System Event has identified areas where changes should be considered to improve the overall effectiveness of the regulatory framework.

This includes providing greater clarity and transparency about roles and responsibilities, not only to address gaps in the framework but also to address areas in which the AER and AEMO disagree about what the framework requires. Our assessment will help inform the AEMC's review of the legislative framework relevant to the Black System Event, which must be completed within six months of this report being published.

Where the Rules provide parties such as AEMO with the flexibility to apply judgment and expertise, this power is usually accompanied by a requirement to establish a decision-making process in consultation with affected participants and by obligations ensuring transparency of decision-making. This recognises that participants require certainty and transparency around decisions that may fundamentally impact their investment and operational outcomes, as well as the overall efficiency of the market.

More broadly, the basis of having rules such as the NER is that the stakeholders—in this case, AEMO and participants alike—are aware of the governing framework in which they operate. If there is doubt about how the Rules should be applied in a particular set of circumstances, this needs to be resolved to provide clarity both to the person(s) on whom the obligation is imposed and to other affected participants.

Whilst we have raised specific aspects of the framework that relate to the Black System Event, we do not consider that the deficiencies outlined in this chapter caused the black out.

We also note that there have been several rule changes and reviews of AEMO guidelines and procedures undertaken since the Black System Event, each designed to improve the framework and operational guidance about rule requirements and implementation. We have taken this into consideration when identifying remaining framework issues and have actively participated in those processes to share our insights throughout the investigation.

6.2 Pre-event

6.2.1 Reclassification framework

The reclassification framework is the main process by which AEMO assesses current and forecast environmental conditions to identify and manage potential risks to the power system which are not factored into the normal management of the system.

As system operator, AEMO plays a central role in assessing how abnormal conditions may pose added risks to the power system, as well as communicating and managing these added risks where appropriate through the reclassification framework. Relevant to the discussion below, the Rules require that AEMO must take all reasonable steps to ensure that it is promptly informed of abnormal conditions, and when abnormal conditions are known to exist, AEMO must:[453]

3. on a regular basis, make reasonable attempts to obtain all information relating to how the abnormal conditions may affect a contingency event, and
4. identify any non-credible contingency event which is more likely to occur because of the existence of the abnormal conditions.

If AEMO identifies that a non-credible contingency event is more likely because of abnormal conditions, it must provide Market Participants with a notification that specifies, among other things, what the abnormal conditions and the non-credible contingency event are, and whether AEMO has reclassified the contingency event or not.[454]

The section below outlines two key issues with the application of this framework. These are: the meaning of a contingency event; and when the market must be notified.

6.2.2 What may constitute a contingency event?

A contingency event is an event affecting the power system which AEMO expects is likely to involve the failure, or removal from operational service, of one or more generating units and/or transmission elements.[455]

As discussed in the investigation report, we consider this definition provides AEMO with sufficient flexibility to deal with risks as they arise, including the simultaneous removal of multiple generating units due to feathering in severe wind conditions. It is an event affecting the power system that involves the removal from operation of multiple

453 NER, clause 4.2.3A(b).

454 NER, clause 4.2.3A(c).

455 NER, clause 4.2.3(a).

generating units (wind turbines) and therefore fits the definition. Determining whether such a contingency event is a credible contingency event will depend on the operating conditions. For example, in normal weather conditions it might be reasonably possible (even if not likely) for multiple generating units connected by one transmission element that are producing up to 260 MW to be removed from service across a particular region due to the loss of that transmission element. The loss of more than 260 MW would be a non-credible contingency event as more than one event would be required to occur simultaneously. However, if a storm front approached with strong wind gusts across a broad area, there may be an additional risk of multiple generating units at multiple wind farms being removed from operational service at the same time. This is additional to the risk of any single transmission element failing. This additional risk may require a reconsideration of what is credible or non-credible while those abnormal conditions persist around those assets.

Conversely, AEMO considers that contingency events are "sudden, completely unpredictable events resulting in an instantaneous imbalance large enough not to be manageable in central dispatch". According to AEMO, intermittent generation-related events and load ramping events do not fit this description, and treating these as contingencies is not workable in the NEM context.

Due to its narrower interpretation of what constitutes a "contingency event", AEMO considers that the current reclassification framework does not provide it with enough flexibility to deal with new and emerging potential security risks. AEMO states:

> *At NEM start, rules were written around the presumption that system security measures only needed to protect against sudden, unpredictable failures of large, centralised generators or transmission links.*

It considers this presumption is no longer valid because of the proliferation of smaller and more distributed energy resources. It proposes that:

> *[a] fit-for-purpose regulatory framework is needed to address the potential system security risks arising in the power system of today and the future, and the increasing potential for more extreme weather events. Using the existing contingency framework to expand contingency sizes comes at a very high cost to consumers, and a potentially unacceptable impact on the reliability of supply… AEMO considers that additional, detailed and accurate information combined with flexible adaptive processes will be central to maintaining a secure and reliable system.*

Following the emergence of new technologies and new ways of engaging with the network, AEMO also notes that currently it does not receive sufficient information to appropriately assess how these new technologies will integrate and interact—including in potentially more extreme conditions triggered by severe climate events.

We note that AEMO has recently submitted a request to the Reliability Panel to have certain non-credible contingency events (including the potential loss of multiple generating units) associated with destructive wind conditions in SA declared as a protected event.[456] AEMO submits that it cannot use forecasts of destructive wind conditions to identify specific non-credible contingency events (e.g. the loss of a specific generator) as reasonably possible and hence cannot sufficiently manage the loss of multiple generating units using the current reclassification framework.[457]

6.2.3 When does AEMO need to notify the market?

Under clause 4.2.3A(c), as soon as practicable after AEMO identifies a non-credible contingency event which is more likely to occur because of the existence of abnormal conditions, AEMO must provide Market Participants with a notification regarding the conditions and the event, as well as whether AEMO has reclassified the event as a credible contingency event or not.

As discussed in the Pre-event (AEMO) chapter, the wording of "more likely", as opposed to "reasonably possible", sets a unique threshold for when AEMO must notify the market pursuant to clause 4.2.3A(c). That is, AEMO must provide the market with a notification even if it has identified that the relevant non-credible contingency event is not yet reasonably possible.

We consider that the obligation to notify the market is enlivened if AEMO identifies a heightened risk that a non-credible contingency event is more likely due to the abnormal conditions, regardless of whether it identifies that the loss of specific assets (such as the loss of particular generating units or transmission lines) is more likely.

We consider that AEMO notifying Market Participants of a heightened risk of a non-credible contingency event occurring is an important medium through which the rules seek to promote transparency and informed market responses. If Market Participants are well informed about abnormal conditions and the information AEMO has relied on in assessing these:

- Market Participants will better understand the relevant threats to power system security

456 AEMO, *AEMO request for protected event declaration: Potential loss of multiple generators in South Australia*, submitted November 2018.

457 Ibid, p. 8.

- Market Participants will have advance notice that there could be a change in the manner in which AEMO will manage the power system while the risk remains, and
- Market Participants will be able to identify information gaps and inform AEMO if there is any additional information that may be relevant to power system security in light of the abnormal conditions and the type of non-credible contingency event identified in the market notice.

AEMO interprets the requirements of clause 4.2.3(c) more narrowly. AEMO considers it must identify a particular asset that is more likely to be at risk due to the abnormal conditions, rather than a heightened general risk of a loss of multiple lines or generating units within a region due to abnormal conditions. AEMO states:

> *A generic notice to the effect that things might happen will not enable market participants to assess whether and how they could take risk mitigation action and is likely only to cause confusion and potential price disruption. If NER 4.2.3A(c) means that AEMO should inform the market of non-specific risks to the power system, AEMO would have to publish a notice whenever abnormal conditions exist. That is not an interpretation that can be discerned from the words of NER 4.2.3A(b)(2) and 4.2.3A(c), nor would it serve any purpose to do so.*

AEMO further states it will review its processes and training to ensure compliance with clauses 4.2.3(c) and (d), but that in most cases, a reclassification decision will be made almost simultaneously with AEMO determining that a particular event is in fact more likely. According to AEMO, usually there will be no reasonable opportunity to inform the market of a "more likely" contingency.

6.3 System restart

6.3.1 Ancillary services framework

As discussed in Chapter 4 of the investigation report, we have found instances where there was a lack of shared understanding of the roles, responsibilities and requirements of AEMO, NSPs, and SRAS Providers. This lack of understanding flowed from procurement stage through to implementing the System Restart Plan during the System Restoration period.

We consider the lack of shared understanding was, in part, caused by gaps within the regulatory framework. The effective and timely implementation of the System Restart Plan depends upon the sharing of information between AEMO, TNSPs, DNSPs, SRAS Providers and other Market Participants, and clarity regarding roles and responsibilities. Communication of pertinent information between all relevant stakeholders needs to occur not only during implementation, but also in the preceding period during which key preparatory measures are undertaken. This should better ensure overall effectiveness of these preparatory measures and ensure that they are fit for purpose.

In our view, the communication protocols that were in place to facilitate the exchange of all information relevant to the roles played by various participants in the implementation of the system restart plan[458] were not sufficiently clear or comprehensive enough. In conjunction with the AEMC considering these issues in the frameworks review, the AER will put forward a rule change proposal to clarify and expand the breadth of the communication protocols.

We have also determined that the role of a NSP should be more formally recognised under the rules to ensure the appropriate exchange of information.

6.3.2 What are the roles and responsibilities for SRAS testing?

We have concluded that there is not a consistent understanding between AEMO, ElectraNet and Origin Energy with respect to the requirements of the SRAS test. This circumstance is further complicated by the fact that, in this case, ElectraNet was both the NSP and an SRAS equipment owner.

This confusion may be partly a result of the legal framework for testing. Most concerning is that the legal framework for SRAS test compliance is largely based on those obligations in the SRAS Agreement between the SRAS Provider and AEMO, and they do not directly apply to a NSP.[459]

We note that AEMO's amendments to its SRAS Guideline go a significant way to clarifying roles and responsibilities, and closing the loop between testing arrangements and real life arrangements. We intend to submit a rule change formalising the requirement for the SRAS Guidelines to set out that SRAS testing must include a comparison with the arrangements planned for use during a major supply disruption.

6.3.3 The role of the NSP in system restoration services

A NSP has certain obligations to assist prospective SRAS providers and AEMO during the procurement phase. AEMO's SRAS Guideline (2017) also sets out expectations around

458 NER clause 4.8.12(j) requires AEMO and NSPs to jointly develop communication protocols to facilitate the exchange of all information relevant to the roles played by AEMO, NSPs, Generators and Customers in the implementation of the system restart plan.

459 'Available' means 'in respect of an SRAS at any time, that the SRAS is capable of being provided at all of the Contracted Levels of Performance by SRAS equipment that meets the Minimum Technical Requirements'.

the involvement of NSPs in SRAS testing of successful SRAS providers.

However, as discussed in the investigation report, there is a gap in the SRAS framework due to the rules limiting responsibility of procurement and testing largely to proposed SRAS and prospective SRAS providers.

The relevant NSP is as central a figure in the procurement, testing and delivery of SRAS as AEMO and the SRAS provider. However, the NER do not explicitly recognise this post the procurement phase.

We consider the obligations imposed on a NSP to use its reasonable endeavours to support the effective delivery of SRAS should apply both to testing of prospective SRAS (which we take to mean prior to the entry into a SRAS Agreement), and to SRAS already the subject of an SRAS Agreement (e.g. periodic testing to confirm ongoing viability). Most importantly, this should apply during a major supply disruption when AEMO is actually deploying SRAS to meet the System Restoration Standard. This would also include complying with the requirements of the SRAS Guidelines.

We agree with AEMO's view that there is merit in strengthening the applicability of the SRAS process (including procurement, testing and provision) to NSPs.

6.3.4 The Local Black System Procedure (LBSP)

We consider the purpose of the LBSP should be clarified and the rules should expressly set out how this purpose is achieved.

Under the Rules, there is an obligation for LBSPs to be consistent with SRAS Agreements[460] and there is an obligation for NSPs and generators to comply with their LBSP as quickly as practicable.[461] This tends to indicate that LBSPs were intended to encompass procedures such as the actions Generators (including SRAS Providers) and NSPs will undertake when a major supply disruption is declared at their local level. The name itself—'Local Black System Procedures'—also tends to indicate that LBSPs were intended to be local level procedures that are consistent with the system restart plan.

AEMO considers the LBSP Guidelines focus on eliciting information to identify the conditions and capabilities of power system assets after a total loss of supply and are not, in fact, procedures. The purpose of the LBSP is to inform AEMO of the likely capability of the asset in re-energising and maintaining a stable operating state.

While we do not dispute the importance LBSPs have in informing AEMO, we consider that the power of AEMO to issue guidelines for the preparation of LBSPs, and to request review and amendment of LBSPs, suggests that the LBSPs could be given a broader scope than the minimum information requirements.

As outlined in the System Restoration chapter, we note the lack of clarity regarding the purpose may be a result of changes to the rules in 2006.

6.4 Market suspension

6.4.1 Interaction of market operation and system security rules

A crucial feature of the NEM is to provide Market Participants with the necessary information and regulatory framework to enable them to make informed decisions about how to engage with the market.

A key area of divergence between the AER and AEMO is in respect of the interaction and applicability of the market operation and system security rules, given, but notwithstanding, the suspension of the market.

In response to our assessment, AEMO states that when the market is suspended, the rules are only specific about pricing (clause 3.14.5). AEMO also points to clause 3.14.4(e)(1) which states that if AEMO declares that the spot market is suspended then AEMO may issue directions to participants in accordance with clause 4.8.9, and, to the extent possible, clauses 3.8 and 3.9 (subject to clause 3.14.5): "*Otherwise, the suspension provisions do not specifically mandate compliance with any market operation rules*."

AEMO also states that during the market suspension period, the regulatory framework afforded them the flexibility to "apply the NER to the extent it considered practical and reasonable to do so".

While this interpretation of the rules may provide AEMO with its desired flexibility during market suspension, the implication of the rules having limited application may result in significant regulatory uncertainty. For example, based on this interpretation, the framework may not require compliance with dispatch instructions unless they are a clause 4.8.9 direction.

The AER holds an alternate view and considers that although the NER explicitly refers to 'market suspension' in only a handful of clauses, this does not necessarily preclude the application of clauses where 'market suspension' is not explicitly referenced, even when those clauses contemplate 'the market'.

Although AEMO has some degree of discretion as to how it dispatches generators during market suspension, AEMO must still comply with a number of principles and obligations.

460 NER, clause 4.8.12(d).

461 NER, clause 4.8.14(b).

While AEMO's overarching responsibility is to maintain power system security, when AEMO notifies generators of output requirements, AEMO must do so in accordance with the relevant provisions of the NER including clause 4.3.1(i), which states AEMO must dispatch generators and ancillary services in accordance with the Rules.

The issues surrounding dispatch and AEMO's requirement to meet power system security as discussed in the Market Suspension chapter highlight the AER's view that the market suspension regime within the NER was not designed with an extended period of market suspension in mind, as occurred in respect of the Black System Event.

Glossary

Term	Description
abnormal conditions	Conditions posing added risks to the *power system* including, without limitation, severe weather conditions, lightning, storms and bush fires.
active power	The rate at which *active energy* is transferred.
AEMO	Means Australian Energy Market Operator Limited (ACN 072 010 327).
AEMO power system security responsibilities	The responsibilities described in clause 4.3.1 of the NER.
AER	The Australian Energy Regulator, which is established by section 44AE of the *Competition and Consumer Act 2010* (Cth).
Ancillary Service Provider	A person who engages in the activity of owning, controlling or operating a *generating unit*, *load* or *market load* classified in accordance with Chapter 2 as an *ancillary service generating unit* or *ancillary service load*, as the case may be.
ancillary services agreement	An agreement under which an *NMAS provider* agrees to provide one or more *non-market ancillary services* to *AEMO*.
applicable regulatory instruments	All laws, regulations, orders, licences, codes, determinations and other regulatory instruments (other than the *Rules*) which apply to *Registered Participants* from time to time, including those applicable in each *participating jurisdiction*, to the extent that they regulate or contain terms and conditions relating to access to a *network*, *connection* to a *network*, the provision of *network services*, *network service* price or *augmentation* of a *network*.
black start capability	A capability that allows a *generating unit*, following its *disconnection* from the *power system*, to be able to deliver electricity to either: (a) its connection point, or (b) a suitable point in the network from which supply can be made available to other generating units, without taking *supply* from any part of the *power system* following *disconnection*.
black system	The absence of *voltage* on all or a significant part of the *transmission system* or within a *region* during a *major supply disruption* affecting a significant number of customers.
Black System Event	The period surrounding the state-wide blackout that occurred on the afternoon of 28 September 2016, specifically from 17:16 hrs on 27 September 2016 until resumption of the spot market in SA at 22:30 hrs on 11 October 2018.
busbar	A common *connection point* in a *power station switchyard* or a *transmission network substation*.
central dispatch	The process managed by *AEMO* for the *dispatch* of *scheduled generating units*, *semi-scheduled generating units*, *scheduled loads*, *scheduled network services* and *market ancillary services* in accordance with rule 3.8.
clause 4.8.9 direction	A direction is defined as having the meaning given in clause 4.8.9(a1)(1) which states if AEMO requires a Registered Participant to take action as contemplated by clause 4.8.9(a) or section 116 of the NEL in relation to a scheduled plant, AEMO is taken to have issued a direction.
clause 4.8.9 instruction	Has the meaning given in clause 4.8.9(a1)(2) of the NER that if AEMO, or a person authorised by AEMO, requires a Registered Participant to take some other action contemplated by clause 4.8.9(a) or section 116 of the National Electricity Law, AEMO is taken to have issued a clause 4.8.9 instruction.
commitment	The commencement of the process of starting up and *synchronising* a *generating unit* to the *power system*.
connect, connected, connection	To form a physical link to or through a *transmission network* or *distribution network*.
connection agreement(s)	An agreement between a *Network Service Provider* and a *Registered Participant* or other person by which the *Registered Participant* or other person is *connected* to the *Network Service Provider's transmission* or *distribution network* and/or receives *transmission services* or *distribution services*. In some *participating jurisdictions*, the *Registered Participant* or other person may have one *connection agreement* with a *Network Service Provider* for *connection services* and another agreement with a different *Network Service Provider* for *network services* provided by the *transmission network*.
connection point	In relation to a network other than an embedded network, the agreed point of supply established between Network Service Provider(s) and another Registered Participant, Non-Registered Customer or franchise customer and includes a parent connection point. In relation to an embedded network, the child connection point, unless otherwise specified.

Term	Description
constrained on	In respect of a *generating unit*, the state where, due to a *constraint* on a *network*, the output of that *generating unit* is limited above the level to which it would otherwise have been *dispatched* by *AEMO* on the basis of its *dispatch offer*.
constraint, constrained	A limitation on the capability of a *network*, *load* or a *generating unit* such that it is unacceptable to either transfer, consume or generate the level of electrical power that would occur if the limitation was removed.
contingency event(s)	An event described in clause 4.2.3(a) of the NER as an event affecting the *power system* which *AEMO* expects would be likely to involve the failure or removal from operational service of one or more *generating units* and/or *transmission elements*.
control centre	The *facilities* used by *AEMO* for managing *power system security* and administering the *market*.
control system	Means of monitoring and controlling the operation of the *power system* or equipment including *generating units connected* to a *transmission* or *distribution network*.
credible contingency event	Defined in clause 4.2.3(b) of the NER as a *contingency event* the occurrence of which *AEMO* considers to be reasonably possible in the surrounding circumstances including the *technical envelope*.
Customer	A person who: 1. engages in the activity of purchasing electricity *supplied* through a *transmission or distribution system* to a *connection point*; and 2. is registered by *AEMO* as a *Customer* under Chapter 2 (NER).
directed participant	A *Scheduled Generator, Semi-Scheduled Generator, Market Generator, Market Ancillary Service Provider, Scheduled Network Service Provider* or *Market Customer* the subject of a *direction.*
direction	Under clause 4.8.9 of the NER, AEMO may issue directions to Registered Participants where it is necessary to do so to maintain or return the power system to a secure or reliable operating state. These are most likely to be: (a) direction to a scheduled generator to increase its output to the extent that this is physically possible and safe to do so; (b) clause 4.8.9 instruction to a network service provider to disconnect load.
disconnect, disconnected, disconnection	The operation of switching equipment or other action so as to prevent the flow of electricity at a *connection point*.
dispatch	The act of initiating or enabling all or part of the response specified in a *dispatch bid*, *dispatch offer* or *market ancillary service offer* in respect of a *scheduled generating unit*, *semi-scheduled generating unit*, a *scheduled load*, a *scheduled network service*, an *ancillary service generating unit* or an *ancillary service load* in accordance with rule 3.8, or a *direction* or operation of capacity the subject of a *reserve contract* or an instruction under an *ancillary services agreement* as appropriate.
dispatch algorithm	The algorithm used to determine *central dispatch* developed by *AEMO* in accordance with clause 3.8.1(d).
dispatch bid	A notice submitted by a *Market Participant* to *AEMO* relating to the *dispatch* of a *scheduled load* in accordance with clause 3.8.7 of the NER.
dispatch instruction	An instruction given to a Registered Participant under clauses 4.9.2, 4.9.2A, 4.9.3, 4.9.3A, or to an NMAS provider under clause 4.9.3A.
dispatch offer	A *generation dispatch offer* or a *network dispatch offer*.
dispatched generating unit	A *scheduled generating unit* which has received instructions from *AEMO* in accordance with a *dispatch* schedule.
dispatched Generator	A *Generator* who has received a *dispatch instruction* from *AEMO*.
Distribution Customer(s)	A *Customer*, *Distribution Network Service Provider*, *Non-Registered Customer*, *franchise customer*, or *retail customer* having a *connection point* with a *distribution network.*
distribution network	A network which is not a transmission network.
Distribution Network Service Provider (DNSP)	A person who engages in the activity of owning, controlling, or operating a distribution system.
distribution system(s)	A distribution network, together with the connection assets associated with the distribution network, which is connected to another transmission or distribution system. Connection assets on their own do not constitute a distribution system.

Term	Description
Distribution System Operator	A person who is responsible, under the *Rules* or otherwise, for controlling or operating any portion of a *distribution system* (including being responsible for directing its operations during *power system* emergencies) and who is registered by *AEMO* as a *Distribution System Operator* under Chapter 2.
Energy	*Active energy* and/or *reactive energy*.
Energy support arrangement	A contractual arrangement between a Generator or Network Service Provider on the one hand, and a customer or participating jurisdiction on the other, under which facilities not subject to an ancillary services agreement for the provision of system restart ancillary services are used to assist supply to a customer during a major supply disruption affecting that customer, or customers generally in the participating jurisdictions, as the case may be.
expression of interest (with reference to System Restoration)	The submission lodged in response to AEMO's Request for EOI. Under the SRAS Guideline (2014), AEMO sought EOI from potential SRAS providers as the first stage in its tender process for securing SRAS to meet the System Restart Standard.
facilities	A generic term associated with the apparatus, equipment, buildings and necessary associated supporting resources provided at, typically: (a) a *power station* or *generating unit*; (b) a *substation* or *power station switchyard*; (c) a *control centre* (being a *AEMO control centre*, or a *distribution* or *transmission network control centre*); (d) facilities providing an *exit service*.
feathering	See the entry for "overspeed".
frequency	For alternating current electricity, the number of cycles occurring in each second. The term Hertz (Hz) corresponds to cycles per second.
generated	In relation to a *generating unit*, the amount of electricity produced by the *generating unit* as measured at its terminals.
generating system	(a) Subject to paragraph (b), for the purposes of the *Rules*, a system comprising one or more *generating units*. (b) For the purposes of clause 2.2.1(e)(3), clause 4.9.2, Chapter 5 and a *jurisdictional derogation* from Chapter 5, a system comprising one or more *generating units* and includes auxiliary or *reactive plant* that is located on the *Generator's* side of the *connection point* and is necessary for the *generating system* to meet its *performance standards*.
generating unit(s)	The plant used in the production of electricity and all related equipment essential to its functioning as a single entity.
generation	The production of electrical power by converting another form of energy in a generating unit.
generation dispatch offer	A notice submitted by a *Scheduled Generator* or *Semi-Scheduled Generator* to *AEMO* relating to the *dispatch* of a *scheduled generating unit* or a *semi-scheduled generating unit* in accordance with clause 3.8.6.
Generator(s)	A person who engages in the activity of owning, controlling or operating a *generating system* that is *connected* to, or who otherwise *supplies* electricity to, a *transmission* or *distribution system* and who is registered by *AEMO* as a *Generator* under Chapter 2. For the purposes of Chapter 5, the term includes a person who is required or intends to register in that capacity or is a non-registered embedded generator (as defined in clause 5A.A.1) who has made an election under clause 5A.A.2(c).
high voltage	A *voltage* greater than 1 kV.
import limit	See the entry for "secure limit".
inertia	Contribution to the capability of the power system to resist changes in frequency by means of an inertial response from a generating unit, network element or other equipment that is electro-magnetically coupled with the power system and synchronised to the frequency of the power system.
interconnection, interconnector, interconnect, interconnected	A *transmission line* or group of *transmission lines* that *connects* the *transmission networks* in adjacent *regions*.
interconnector flow	The quantity of electricity in MW being transmitted by an *interconnector*.

Term	Description
invitation to tender (with reference to System Restoration)	AEMO's document setting out the requirements for potential SRAS providers in order to respond to AEMO's invitation to tender for SRAS. The ITT in 2015 included the schedules, attachments and appendices, which are to be read and interpreted in conjunction with the SRAS Description, SRAS Quantity Guidelines, Boundaries of Electrical Sub-networks, SRAS Assessment Guidelines, and SRAS Tender Guidelines at that time. AEMO sought responses to its ITT from potential SRAS providers as the second stage in its tender process for securing SRAS to meet the System Restart Standard.
Jurisdictional System Security Coordinators	A person appointed by the *Minister* of a *participating jurisdiction* in accordance with section 110 of the *National Electricity Law*.
load	A connection point or defined set of connection points at which electrical power is delivered to a person or to another network or the amount of electrical power delivered at a defined instant at a connection point, or aggregated over a defined set of connection points.
local area/local	The geographical area allocated to a *Network Service Provider* by the authority responsible for administering the *jurisdictional electricity legislation* in the relevant *participating jurisdiction*.
local black system procedures (LBSPs)	The procedures, described in clause 4.8.12, applicable to a *local area* as approved by *AEMO* from time to time.
LBSP Guidelines	Guidelines for preparing local black system procedures, developed and published by AEMO, in consultation with Generators and NSPs, as required by NER cl. 4.8.12(e).
major supply disruption	The unplanned absence of *voltage* on a part of the *transmission system* affecting one or more *power stations* and which leads to a loss of *supply* to one or more *loads*.
market	Any market or exchange conducted by *AEMO*, notwithstanding a period of market suspension.
market ancillary service(s)	A service identified in clause 3.11.2(a) of the NER.
market ancillary service offer	A notice submitted by an *Ancillary Service Provider* to *AEMO* in respect of a *market ancillary service* in accordance with clause 3.8.7A.
Market Customer	A *Customer* who has classified any of its *loads* as a *market load* and who is also registered by *AEMO* as a *Market Customer* under Chapter 2.
market floor price	A price floor on *regional reference prices* as described in clause 3.9.6 of the NER.
market generating unit	A *generating unit* whose *sent out generation* is not purchased in its entirety by the *Local Retailer* or by a *Customer* located at the same *connection point* and which has been classified as such in accordance with Chapter 2.
Market Network Service Provider	A *Network Service Provider* who has classified any of its *network services* as a *market network service* in accordance with Chapter 2 and who is also registered by *AEMO* as a *Market Network Service Provider* under Chapter 2.
Market Notices	Notices published in real time by AEMO through its Market Management System for the purpose of notifying market participants of events that impact the market. These include advance notice of low reserve conditions, status of market systems, over-constrained dispatch, price adjustments, constraints, market directions, market interventions, and market suspensions.
Market Participant(s)	A person who is registered by *AEMO* as a *Market Generator, Market Customer, Market Small Generation Aggregator, Market Ancillary Service Provider* or *Market Network Service Provider* under Chapter 2.
market suspension	Suspension of the *spot market* by *AEMO* in accordance with clause 3.14.3.
Market Suspension period	The Market Suspension period of the Black System Event is defined as the 13 day period from when the power system collapsed into a *black system* at 16:25 hrs (when AEMO suspended the spot market in SA with effect from the trading interval commencing at 16:00 hrs) on 28 September 2016 until the resumption of the spot market in SA at 22:30 hrs on 11 October 2016 following revocation of the SA Government direction.
Minister	A Minister that is a "Minister" under the *National Electricity Law*.
monitoring equipment	The testing instruments and devices used to record the performance of *plant* for comparison with expected performance.
nameplate rating	The maximum continuous output or consumption in MW of an item of equipment as specified by the manufacturer, or as subsequently modified.
National Electricity Law (NEL)	The National Electricity Law set out in the schedule to the *National Electricity (South Australia) Act 1996* (SA) and applied in each of the *participating jurisdictions*.
National Electricity Market (NEM)	The wholesale exchange of electricity operated by AEMO under the NER.

Term	Description
National Electricity Market Dispatch Engine (NEMDE)	The software that calculates the optimum economic dispatch of the NEM every five minutes, subject to a number of constraint equations that reflect additional physical power system requirements. The software co-optimises the outcome of the energy spot market and the frequency control ancillary services market.
National Electricity Objective	The objective stated in section 7 of the NEL which 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.
network	The apparatus, equipment, plant and buildings used to convey, and control the conveyance of, electricity to customers (whether wholesale or retail) excluding any *connection assets*. In relation to a *Network Service Provider*, a *network* owned, operated or controlled by that *Network Service Provider*.
network capability	The capability of the *network* or part of the *network* to transfer electricity from one location to another.
Network Service Provider(s) (NSP)	A person who engages in the activity of owning, controlling or operating a *transmission or distribution system* and who is registered by *AEMO* as a *Network Service Provider* under Chapter 2 (NER).
network support arrangement	An arrangement under which a person agrees to provide one or more *network support and control ancillary services* to a *Network Service Provider*, including *network* support services to improve *network capability* by providing a non-*network* alternative to a *network augmentation*.
non-credible contingency event	Defined in clause 4.2.3(e) of the NER as a *contingency event* other than a *credible contingency event*.
Non-Market Ancillary Service(s) (NMAS)	Any of the following services: (a) *network support and control ancillary services* and other services acquired by *Transmission Network Service Providers* under *connection agreements* or *network support agreements* to meet the service standards linked to the technical requirements of schedule 5.1 or in *applicable regulatory instruments*; and (b) *system restart ancillary services* and *network support and control ancillary services* acquired by *AEMO* under *ancillary services agreements*.
Non-Market Ancillary Service(s) provider	A person who agrees to provide one or more *non-market ancillary services* to *AEMO* under an *ancillary services agreement*.
outage	Any full or partial unavailability of equipment or *facility*.
overspeed	The reduction of output to zero at an individual wind turbine under conditions where average wind speed is consistently high or there are high intensity gusts. This type of output reduction is caused by a wind turbine's control system detecting the high wind speed and adjusting the angle at which the wind turbine blades meet the wind to reduce the aerodynamic load on the machine.
participating jurisdictions	A jurisdiction that is a "participating jurisdiction" under the *National Electricity Law*.
performance standard(s)	A standard of performance that: (a) is established as a result of it being taken to be an applicable performance standard in accordance with clause 5.3.4A(i); or (b) is included in the register of *performance standards* established and maintained by *AEMO* under rule 4.14(n), as the case may be.
plant	In relation to a *connection point*, includes all equipment involved in generating, utilising or transmitting electrical *energy*.
power station	In relation to a *Generator*, a *facility* in which any of that *Generator's generating units* are located.
power system	The electricity power system of the national grid including associated generation and transmission and distribution networks for the supply of electricity, operated as an integrated arrangement
power system security	The safe scheduling, operation and control of the power system on a continuous basis in accordance with the principles set out in Clause 4.2.6 of the NER.
power system security standards	The standards (other than the *reliability standard* and the *system restart standard*) governing *power system security* and *reliability* of the *power system* to be approved by the *Reliability Panel* on the advice of *AEMO*, but which may include but are not limited to standards for the *frequency* of the *power system* in operation and *contingency capacity reserves* (including guidelines for assessing requirements).

Term	Description
Pre-event	The pre-event period of the Black System Event covers the period on 27 and 28 September 2016 up until, but not including, the transmission line faults in SA which occurred from 16:16:46 hrs onwards on 28 September 2016.
Projected Assessment of System Adequacy (PASA)	The medium term and short term processes described in clause 3.7 to be administered by AEMO.
publish/publication	A document is published by the *AER* if it is: (a) published on the *AER's* website; and (b) made available for public inspection at the *AER's* public offices; and (c) in the case of a document inviting submissions from members of the public – published in a newspaper circulating generally throughout Australia. In Part B of Chapter 5, a document is published by the *Distribution Network Service Provider* if it is published on the *Distribution Network Service Provider's* website. Otherwise, a document is published by someone else if it is made available to *Registered Participants* electronically.
QPS5	Origin's Quarantine Power Station unit 5.
Quarantine	Origin's Quarantine Power Station.
reactive plant	*Plant* which is normally specifically provided to be capable of providing or absorbing *reactive power* and includes the *plant* identified in clause 4.5.1(g).
reactive power	The rate at which *reactive energy* is transferred. *Reactive power* is a necessary component of alternating current electricity which is separate from *active power* and is predominantly consumed in the creation of magnetic fields in motors and *transformers* and produced by *plant* such as: (a) alternating current generators; (b) capacitors, including the capacitive effect of parallel *transmission* wires; and (c) *synchronous condensers*.
region, regional	An area determined by the *AEMC* in accordance with Chapter 2A, being an area served by a particular part of the *transmission network* containing one or more major *load centres* or *generation centres* or both.
regional reference node	A location on a *transmission* or *distribution network* to be determined for each *region* by the *AEMC* in accordance with Chapter 2A.
Regional System Restart Procedures	Regional System Restart Procedures consist of five procedures, one for each region. These procedures provide an overview of the general strategy AEMO may use to restart a particular region. These procedures identify a number of possible Restoration Options based on the contracted SRAS Providers and other options AEMO considers viable.

Term	Description
Registered Participant	A person who is registered by *AEMO* in any one or more of the categories listed in rules 2.2 to 2.7. However: (a) in the case of a person who is registered by *AEMO* as a *Trader*, such a person is only a *Registered Participant* for the purposes referred to in rule 2.5A; (b) in the case of a person who is registered by *AEMO* as a *Metering Coordinator*, such a person is only a *Registered Participant* for the purposes referred to in clause 2.4A.1(d); (c) as set out in rule 2.11.1A, for the purposes of rule 2.11 only, *Third Party B2B Participants* (other than *Third Party B2B Participants* who are also *Embedded Network Managers*) are also deemed to be *Registered Participants*; (d) as set out in clause 8.2.1(a1) and 8.2A.2(b), for the purposes of some provisions of rule 8.2 only, *AEMO*, *Connection Applicants*, *Metering Providers*, *Metering Data Providers*, *Third Party B2B Participants* and *B2B Change Parties* who are not otherwise *Registered Participants* are also deemed to be *Registered Participants*; (e) as set out in clause 8.6.1A, for the purposes of Part C of Chapter 8 only, *Metering Providers*, *Metering Data Providers* and *Third Party B2B Participants* who are not otherwise *Registered Participants* are also deemed to be *Registered Participants*; and (f) as set out in clause 4.8.12(a3), for the purposes of Part C of Chapter 8 only, *Jurisdictional System Security Coordinators* are also deemed to be *Registered Participants*.
reliability	The probability of a system, device, *plant* or equipment performing its function adequately for the period of time intended, under the operating conditions encountered.
Reliability Panel	The panel established by the *AEMC* under section 38 of the *National Electricity Law*.
reliability standard	The standard specified in clause 3.9.3C of the NER.
Restoration Option	One or more options for restoring the network in a region after a black system event or major supply disruption developed by AEMO under and in accordance with relevant LBSPs and System Restart Plan, to provide viable approaches to achieve system restoration in various circumstances.
Rules	The rules called the National Electricity Rules made under Part 7 of the *National Electricity Law* as amended from time to time in accordance with that Part.
satisfactory operating state	In relation to the *power system*, has the meaning given in clause 4.2.2 of the NER. Clause 4.2.2 provides that the power system is in a satisfactory operating state if, among other things, various technical requirements are met in relation to frequency, voltage and transmission line flows.
scheduled generating unit(s)	(a) A *generating unit* so classified in accordance with Chapter 2. (b) For the purposes of Chapter 3 (except clause 3.8.3A(b)(1)(iv)) and rule 4.9, two or more *generating units* referred to in paragraph (a) that have been aggregated in accordance with clause 3.8.3.
scheduled load(s)	(a) A *market load* which has been classified by *AEMO* in accordance with Chapter 2 as a *scheduled load* at the *Market Customer's* request. Under Chapter 3, a *Market Customer* may submit *dispatch bids* in relation to *scheduled loads*. (b) For the purposes of Chapter 3 (except clause 3.8.3A(b)(1)(ii)) and rule 4.9, two or more *scheduled loads* referred to in paragraph (a) that have been aggregated in accordance with clause 3.8.3.
scheduled network service	(a) A *network service* which is classified as a *scheduled network service* in accordance with Chapter 2. (b) For the purposes of Chapter 3 (except clause 3.8.3A(b)(1)(ii)) and rule 4.9, two or more *scheduled network services* referred to in paragraph (a) that have been aggregated in accordance with clause 3.8.3 of the NER.
Scheduled Network Service Provider	A *Network Service Provider* who has classified any of its *network services* as a *scheduled network service*.
secure limit	This is the limit for the maximum interconnector flow into a region where the power system can be operated to remain in a satisfactory operating state after the largest credible contingency, allowing for the expected variations in supply and demand that will change actual metered interconnector flows over a 5-minute dispatch interval. It is equal to the satisfactory limit minus the amount of the largest credible contingency minus a small operating margin to account for expected variations in supply and demand.
secure operating state	In relation to the *power system* has the meaning given in clause 4.2.4 of the NER.
Semi-Scheduled Generators	A *Generator* in respect of which any *generating unit* is classified as a *semi-scheduled generating unit* in accordance with Chapter 2.
spot market	The spot market established and operated by *AEMO* in accordance with clause 3.4.1.

Term	Description
spot market transaction	A transaction as defined pursuant to clause 3.15.6 which occurs in the *spot market*.
spot price	The price for electricity in a *trading interval* at a *regional reference node* or a *connection point* as determined in accordance with clause 3.9.2.
substation	A *facility* at which two or more lines are switched for operational purposes. May include one or more *transformers* so that some *connected* lines operate at different nominal *voltages* to others.
supply	The delivery of electricity.
switchyard	The *connection point* of a *generating unit* into the *network*, generally involving the ability to *connect* the *generating unit* to one or more outgoing *network* circuits.
synchronising, synchronisation	To electrically *connect* a *generating unit* or a *scheduled network service* to the *power system*.
synchronous generating unit	The alternating current generators of most thermal and hydro (water) driven power turbines which operate at the equivalent speed of the *frequency* of the *power system* in its *satisfactory operating state*.
System Operator	A person whom *AEMO* has engaged as its agent, or appointed as its delegate, under clause 4.3.3 to carry out some or all of *AEMO's* rights, functions and obligations under Chapter 4 of the *Rules* and who is registered by *AEMO* as a *System Operator* under Chapter 2 of the NER.
System Restart Ancillary Service (SRAS)	A service provided by facilities with black start capability which allows: (a) energy to be supplied; and (b) a connection to be established, sufficient to restart large generating units following a major supply disruption.
SRAS Agreement	An Agreement made between AEMO and an SRAS Provider for the purpose of contracting SRAS for an electrical sub-network. The Agreement sets out the delivery point for the SRAS on the network; the SRAS equipment used to provide the SRAS; the contracted levels of performance in terms of the time to commence delivery of SRAS; the MW export capability; and the minimum availability and reliability of the SRAS.
SRAS Guideline	The guideline developed and *published* by *AEMO* in accordance with clause 3.11.7(c) as in force from time to time and includes amendments made in accordance with clauses 3.11.7(f) and 3.11.7(g).
SRAS Guidelines (2014)	The SRAS Guideline applicable at the time that AEMO obtained the SRAS that were in place on the date of the Black System Event.
SRAS Guideline (2017)	The SRAS Guideline published by AEMO effective from 15 December 2017.
SRAS Objective	The objective for *system restart ancillary services* is to minimise the expected costs of a *major supply disruption*, to the extent appropriate having regard to the *national electricity objective*.
SRAS Procurement Objective	The obligation on AEMO under NER 3.11.7(a1) to use reasonable endeavours to acquire system restart ancillary services to meet the System Restart Standard at the lowest cost.
SRAS Provider	The party contracted by AEMO to deliver the SRAS under an SRAS Agreement.
SRAS Tenderer	A person in receipt of AEMO's Invitation To Tender for SRAS.
SRAS test procedure	A procedure for the purpose of managing and coordinating the testing of the SRAS to demonstrate the deliverability of the contracted SRAS. It consists of a set of high level steps required to demonstrate the deliverability of the contracted SRAS.
SRAS test System Switching Program (SSP)	Detailed switching procedures developed by the relevant TNSP for the purpose of demonstrating the deliverability of the contracted SRAS during SRAS tests.
System Restart Plan	A plan for the purpose of managing and coordinating system restoration activities during any major supply disruption. It sets out the re-energisation pathways and high level steps to be followed by generators, Network Service Providers and AEMO, for restoring energy supply to the affected region.
system restart standard (version 82 NER)	The standard as determined by the Reliability Panel in accordance with clause 8.8.3(aa), for the acquisition of system restart ancillary services.
System Restart System Switching Program (SSP)	Detailed switching procedures intended for use following a major supply disruption which are developed by NSPs in line with the requirements to convert AEMO's broad instructions, as outlined in the Regional System Restart procedures, into detailed switching sequences.
System Restart Working Group (SRWG)	A working group convened by AEMO on matters relating to power system restart and which usually consists of the TNSP, DNSP(s) and scheduled thermal generators in the relevant sub-network.
System Restoration period	Means the period from when AEMO and ElectraNet devised a restoration strategy at 16:30 hrs on 28 September 2016 to when restoration was completed at 18:25 hrs on 29 September 2016.
SSP Restart 2	System Restart SSP developed by ElectraNet and provided to AEMO on 17 June 2016. It converts AEMO's Restoration Option 2 into switching steps.

Term	Description
target flow	In relation to an interconnector, means the flow calculated by NEMDE that the interconnector is expected to reach at the end of a dispatch interval.
technical envelope	The limits described in clause 4.2.5 of the NER meaning the technical boundary limits of the *power system* for achieving and maintaining the *secure operating state* of the *power system* for a given demand and *power system* scenario.
Trader	A person who is registered by *AEMO* as a *Trader* under Chapter 2.
trading interval	A 30 minute period ending on the hour (*EST*) or on the half hour and, where identified by a time, means the 30 minute period ending at that time.
transformer(s)	A *plant* or device that reduces or increases the *voltage* of alternating current.
transient stability	The ability of a power system to quickly return to a stable operating condition after being exposed to a disturbance (for example, a tree falling over an overhead line resulting in the automatic disconnection of that line by its protection systems). A power system is deemed stable if transmission system voltage levels and the rotational speeds of motors and generators return to their normal values in a quick and continuous manner.
transmission	Activities pertaining to a *transmission system* including the conveyance of electricity through that *transmission system*.
transmission element(s)	A single identifiable major component of a *transmission system* involving: (a) an individual *transmission* circuit or a phase of that circuit; (b) a major item of *transmission plant* necessary for the functioning of a particular *transmission* circuit or *connection point* (such as a *transformer* or a circuit breaker).
transmission line(s)	A power line that is part of a *transmission network*.
transmission network	A *network* within any *participating jurisdiction* operating at nominal *voltages* of 220 kV and above plus: (a) any part of a *network* operating at nominal *voltages* between 66 kV and 220 kV that operates in parallel to and provides support to the higher voltage *transmission network*; (b) any part of a *network* operating at nominal *voltages* between 66 kV and 220 kV that is not referred to in paragraph (a) but is deemed by the *AER* to be part of the *transmission network*.
Transmission Network Service Provider(s) (TNSP)	A person who engages in the activity of owning, controlling or operating a *transmission system*.
transmission plant	Apparatus or equipment associated with the function or operation of a *transmission line* or an associated *substation* or *switchyard*, which may include *transformers*, circuit breakers, *reactive plant* and *monitoring equipment* and control equipment.
transmission system	A *transmission network*, together with the *connection assets* associated with the *transmission network*, which is connected to another *transmission or distribution system*.
voltage	The electronic force or electric potential between two points that gives rise to the flow of electricity.