29 July 2019

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John Pierce
Chair
Australian Energy Market Commission
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By online submission

Dear Mr Pierce

National Electricity Rule change proposal – Future system restart capability

AEMO submits the attached rule change proposal to amend the National Electricity Rules for the purposes of:

- Incentivising the provision of both system restart and restoration support capabilities from a range of different technologies.
- Facilitating more extensive testing to verify the viability of system restart paths, increasing the level of assurance that system restoration will succeed.

AEMO is proposing these changes to maintain reliable and sustainable capability to restart the NEM power system as it transitions rapidly away from the traditional synchronous generation and load centres that characterised the grid when the current SRAS framework was introduced.

Queries on the proposal can be directed to James Lindley, Group Manager - Systems Capability, at James.Lindley@aemo.com.au or 07 3347 3906.

Yours sincerely

Peter Geers
Chief Strategy & Markets Officer

Attachments: Rule Change Proposal: Future System Restart Capability

ELECTRICITY RULE CHANGE PROPOSAL

FUTURE SYSTEM RESTART CAPABILITY

July 2019

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NEW SOUTH WALES QUEENSLAND SOUTH AUSTRALIA VICTORIA AUSTRALIAN CAPITAL TERRITORY TASMANIA WESTERN AUSTRALIA

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1. SUMMARY

AEMO requests the AEMC to make a Rule to amend the system restart ancillary services (SRAS) provisions of the National Electricity Rules (NER) and to provide for co-ordinated network-level testing of system restart paths for the national electricity market (NEM) power system.

The proposed changes are part of a series of measures AEMO is investigating, aimed at preserving and improving the capability to restart a power system in transition. The NEM is moving rapidly away from the traditional synchronous generation and load centres that characterised the grid when the current SRAS framework was introduced. It has been observed that this shift has adverse consequences for the ability to restart the power system using existing SRAS-capable generation in the event of a major supply disruption (a black system), and subsequently to progressively restore supply. In particular:

- Ageing, market withdrawal or retirement of some traditional SRAS generation means that fewer reliable sources of black start capability are available to meet the system restart standards. In some NEM regions there is little or no competition for SRAS contracts.
- Other, non-SRAS synchronous plant that has previously been relied on to support the subsequent system restoration is less frequently online, while the increasing penetration of grid-scale intermittent asynchronous plant has neither black start capability nor active capability to support restoration in the early stages of the process.
- This changing generation mix is starting to restrict the viable restart paths and means that they may be less effective.
- Very large quantities of small-scale distributed energy resources make it challenging to identify enough stable loads to keep the power system balanced and stable during restoration.

This rule change proposal focuses on the first three issues. It proposes changes to the SRAS definitions and framework that are intended to support the continued acquisition of services with a greater degree of confidence that they will be effective to restart the power system if necessary. This would be achieved primarily by:

- Incentivising the provision of both system restart and restoration support capabilities from a range of different technologies.
- Facilitating more extensive testing of restart paths into transmission networks.

This proposal does not specifically seek to address:

- The issues for stable system restoration caused by the presence of significant concentrations of distributed energy resources. In partnership with industry bodies, AEMO's DER program is exploring how to minimise the adverse impact of DER during system restoration, and how to best utilise the contribution that can be provided by these resources. This program is expected to inform recommendations for regulatory changes across several areas, including the role and performance of distributed energy resources in a black system and subsequent restart situation.
- The need for network service providers (NSPs) to invest in the upgrade and development of equipment to facilitate the provision of voltage control and assist restoration, in remote areas in particular. This is likely to include settings upgrades on primary and secondary network assets used in network control and protection schemes, and the installation of additional protection relays. AEMO intends to work with NSPs and the Australian Energy Regulator (AER) to determine whether the regulatory framework presents any barriers to this type of investment where necessary.

The remainder of this proposal sets out:

- Context for this proposal (section 2): the current SRAS framework, its shortcomings for the transforming power system, why and how the framework needs to change, and relevant international experience in those areas.
- Statement of issues (section 3): the specific rules (or absence of rules) that inhibit the development of the identified changes.
- How the proposal will address the issues (section 4): a description of the NER changes proposed, and how AEMO considers they will address the issues identified in section 3 to meet the needs outlined in section 2, the changes AEMO will need to make to its SRAS Guideline, and initial feedback from NSPs on extended network testing.
- How the proposed rule is consistent with the national electricity objective (section 5).
- The expected or potential costs and benefits of the proposed rule (section 6).
- The proposed rule drafting (Appendix A).

2. CONTEXT – SYSTEM RESTART NEEDS

2.1 Current framework

As part of its power system security responsibilities (NER clause 4.3.1(p)), AEMO acquires SRAS from generators with black start capable facilities to enable AEMO to coordinate a restoration process in the event of a major supply disruption in all or part of the power system. A major supply disruption includes a voltage collapse leading to a black system. Black start capable generation can start up or continue operating without drawing power from the network, and in turn re-energise other generation and the transmission network.

In acquiring SRAS under the NER, AEMO is required to apply the SRAS procurement objective: to meet the system restart standard at the lowest cost. The system restart standard is a procurement standard set by the Reliability Panel for each electrical sub-network. It specifies a quantity of supply (generation and transmission) that the SRAS acquired by AEMO should be capable of restoring within a specified timeframe and with a specified level of reliability.

The concept of SRAS envisages that the services are capable of starting a process that leads to full supply and load restoration. While load restoration is not part of the system restart standard, SRAS is of limited value if the process cannot be continued to a point where supply is sufficient and stable enough to restore mass load.

A series of events resulting in a black system could occur at any time and in any range of network outage, demand and supply conditions. In consultation with transmission network service providers (TNSPs), AEMO prepares system restart plans, incorporating the SRAS contracted by AEMO, to cover the most plausible alternative paths (generally two to four) that could be used to progressively restore supply and stabilising load in each NEM region.

The system restart plans, including the identity of contracted SRAS generating units, are confidential information under the NER. To support this rule change proposal, AEMO has provided the AEMC with specific examples of the issues canvassed in this proposal, which are already manifesting in some NEM regions.

2.2 Issues for future system restart capability

2.2.1 Decline of effective SRAS sources and supporting resources

Over recent SRAS procurement cycles AEMO has observed that there are fewer traditional sources of SRAS in some regions, and those that remain are potentially less capable of reliably restoring generation and transmission to a point from which load can ultimately be restored within a reasonable timeframe.

AEMO has undertaken extensive studies and advanced power system modelling since the South Australian (SA) black system in September 2016 and as part of the 2017-18 SRAS procurement process. These studies have shown that historically-procured SRAS sources may no longer be able to contribute significantly to restoration, and there are fewer and different viable restart paths that can be used while maintaining a stable system. The most important contributors to this change are:

- High penetration of asynchronous, intermittent grid-connected generation with no black start capability and currently no active capability to support grid stability during restoration.
- Synchronous generating plant has traditionally provided both the MW and the system support needed to continue the restoration process after initial restart. In parallel with the growth of asynchronous installations:
  - The large, synchronous units historically assumed to be available and ready to be energised to support system restoration are becoming less reliable as they age, with some indefinitely mothballed or retiring.
  - Many of the synchronous generators that remain in service are increasingly offline for commercial reasons. At best this would mean a cold start, adding several hours to the restoration process. At worst, there may be insufficient fuel supply or available staff for the plant to provide any support at all.
- Fewer static loads (i.e. not connected via power electronic inverters) available for grid stabilisation, combined with a very high uptake of distributed energy resources, making it increasingly difficult to restore supply in a stable manner.

In less than three years since the SA black system, the amount of asynchronous and distributed generation in the grid has continued to grow exponentially. As at January 2019[1] the NEM had around 7.4 GW of installed grid-scale wind, solar and battery facilities, a further 6.3 GW considered as committed and around 42 GW at earlier stages of planning and development. About 2,700 additional MW of coal and gas plant is due to be withdrawn from the NEM within three to four years[2], and market conditions could accelerate withdrawals of synchronous plant going forward.

2.2.2 Incentives are needed for alternative sources of restart and support

The SRAS contract market does not provide enough incentive for generators, energy storage providers or other types or combinations of plant to invest in black start capability. Although it is possible in theory for AEMO to underwrite the development of new SRAS capability by contracting for SRAS in advance, in practice the SRAS procurement objective is a significant hurdle to this outcome. If the system restart standard does not materially change and the existing sources remain sufficient to meet the standard, they will almost certainly remain the lowest cost options and AEMO must continue to acquire them (and no more) in order to meet the SRAS procurement objective. In the meantime, developers of new generation are unlikely to make additional investments in black start capability with no assurance of making a return

[1] AEMO Generator information page, as at 21 January 2019
[2] AEMO Generator information page, as at 21 January 2019

on it. Potential opportunities to develop new system restart sources will therefore go begging until it is too late to avoid falling short of the system restart standard.

At the same time, the capability to support the grid during a restart process – for example by providing voltage control, frequency control and fault current – is neither required nor valued under the current NER under conditions of major supply disruption. This is because these are inherent properties of the large synchronous generating units that have characterised the NEM power system since its inception. However, these properties are not inherently provided by inverter-connected generators under conditions when very little synchronous generation is online. As the generation mix is shifting, changes are needed to ensure this restoration support capability remains available. Without it, black start capability itself is of little or no value.

Solutions that are sustainable for the long term will need to involve the asynchronous generation fleet and other inverter-connected resources, with additional support from network equipment and control schemes.

Inverter-based black start capability

None of the existing installed asynchronous generation has black start capability sufficient to energise the adjacent transmission network and other generation. Almost all installed generation has a 'grid-following' inverter type that cannot establish its own voltage source and may require a sufficient number of nearby synchronous machines in the system before stable operation can be established. However, 'grid-forming' inverter technologies are currently being developed and deployed by some battery manufacturers. These devices will exhibit similar performance to that of a synchronous generator from a system restoration perspective and could be capable of restarting the power system.

System restoration support

Large, transmission connected synchronous generation has the capability to provide system support during a restoration, if the generating system remains normally available.

There is potential for some currently installed asynchronous generation to support the progressive restoration of the power system by providing other services, such as voltage support (reactive power) or frequency control required for stable operation. However, changes to asynchronous generator controls and settings might be necessary in order to provide this type of support under islanded, system restart conditions. This could be achieved through the use of different control modes of operation or different settings for the same control mode. Automatic gain reduction is a control mode which has been applied and utilised in static var compensators (SVCs) for several years, and could enable inverter-based technologies to be deployed under extreme operating conditions with lower system strength.

While this capability may already exist, or be capable of utilisation with settings modifications,[3] there is no requirement or incentive for generators to enable or maintain it, and no basis for AEMO to test its effectiveness under extreme operating conditions.

International experience

Although the vast majority of black start sources worldwide are synchronous generators, several wind turbine, solar inverter and battery inverter manufacturers have successfully demonstrated black start capability, often requiring the use of diesel generators or batteries. Additionally, the use of grid forming inverters has proven successful in black starting microgrids and islanded power systems in the order of several tens of MW, including in Australia[4]. This technology would not require any diesel generators or other synchronous sources to initiate the restoration process.

[3] Experience with recent transmission outages in Victoria has shown that the control systems of most inverters are tuned for system intact conditions and may not operate stably under prior outage (N-1-1) conditions. A black system would present much more extreme conditions.

[4] ABB public library, accessed at: https://library.e.abb.com/public/68b1b939c6ce1cdf83257dc500370bf8/54-60%204m480_EN_72dpi.pdf

The use of inverter-based resources to *support* system restoration has been already widely deployed in international grids. For example, voltage source converter (VSC) HVDC links have been successfully tested for providing black start capability in Ireland[5] and Denmark[6]. A VSC HVDC has very similar control principles to those used in wind turbines, solar and battery inverters, all being VSC based devices.

Improved capability of modern inverter-based resources in providing steady-state and dynamic voltage and frequency control along with enhanced withstand capability and stability under low system strength conditions allows for their increased use to support system restoration, even if they cannot initiate the restoration.

While the use of inverter-based resources to support system restoration is currently very limited worldwide, existing frameworks for system services in some countries would permit such an application. For example, in the UK provision of reactive power is divided into obligatory reactive power service (ORPS) and enhanced reactive power service (ERPS), where enhanced capability is the capability beyond that set out in ORPS[7]. ORPS could be considered analogous to automatic access standards in the context of the NER, while ERPS could be either additional reactive power capability to that agreed in the generator's performance standards, or capability in more extreme conditions than those accounted for in performance standards, e.g. lower system strength during system restoration conditions.

More broadly, grid operators including the UK's National Grid Company are recognising the possibility that a range of facilities can provide system restart services in addition to different generation types, including interconnectors and combined service offerings involving multiple facilities.[8]

2.2.3 More extensive testing of restart paths is necessary

The ongoing transformation of the NEM power system makes it increasingly difficult to establish by modelling alone whether the SRAS acquired by AEMO is effective for system restart. Testing of the restart paths therefore assumes greater importance for power system security than in previous years.

The generator level testing currently carried out on contracted SRAS sources is only sufficient to validate the simulated response of SRAS generators to deliver electricity to a defined point and sustain stable output for a period. These tests cannot be used to validate the interactive and inter-dependent response of the SRAS source and the wider network to which it is connected.

As the power system and generation mix diverge further from previously-seen operating conditions, emerging new phenomena can reduce the level of confidence in modelling outcomes unless validated against actual test results involving the wider network. This is because the performance of individual power system equipment and their interactions would differ from outcomes in system normal and credible contingency conditions. The risk of not identifying these unknowns in advance could be a complete failure of the restoration path(s) for an SRAS generator, or introducing a significant delay in restoration as several attempts might need to be made.

Extending the testing beyond the SRAS delivery point will help to validate the restart plans and assist in identifying and resolving unexpected issues that could otherwise manifest during an actual restoration event. More specifically, extended testing can assist in:

- Verifying the capability and timeframes to energise nearby large transformers and transmission lines, and connections to downstream distribution loads (with no disruption to customer supply).

[5] CIGRE Study Committee C2 – System operation and control, Power system restoration – World practices & future trends, CIGRE Science & Engineering No. 14, June 2019 p.6

[6] J. B. Kwon, A live Blackstart test of an HVAC network using soft start capability of a voltage source HVDC converter, presented at CIGRE Aalborg Symposium, June 2019.

[7] National Grid UK, accessed at : https://www.nationalgrideso.com/balancing-services/reactive-power-services/enhanced-reactive-power-service-erps?technical-requirements

[8] National Grid ESO, Operability Strategy Report 2019 Summer Update, pp31-32 at: https://www.nationalgrideso.com/document/146506/download

- Identifying any unknown control, protection or communication scheme arrangements that could affect restoration but may otherwise not be discovered until a blackout occurs.
- Identifying other equipment interactions (such as those experienced during the SA black system event) that are not generally modelled and can only be uncovered by staged testing.

Real world tests also provide a unique opportunity for all involved stakeholders to prepare for and rehearse the restoration process, significantly increasing operator situational awareness and reducing the likelihood of error if a black system occurs.

Historically, network level testing for system restart preparedness in the NEM was conducted in New South Wales (for example, Colongra to Vales Point[9]) and in Victoria (Jeeralang to Loy Yang A). Although the power system and rules framework have changed since then, this precedent demonstrates that extended network testing is achievable if properly co-ordinated between willing parties.

Some TNSPs, with the concurrence of the affected generators, have conducted a limited amount of more extensive network testing voluntarily, but given the regulatory uncertainty identified by several NSPs and the level of work required to coordinate other parties with varying priorities, continuing or expanding this limited network testing in future is a highly uncertain prospect without clear regulatory obligations to support this need.

Going forward, to achieve the validation required to have a reasonable level of confidence in the integrity of restart paths as the power system and generation mix changes, there will be an increasing need to include distribution network assets in the tests, at the interface with the transmission system.

International experience

The extended level of testing proposed by AEMO is not unique. International power system experts have identified that a lack of testing and verification of black start capability and system restoration plans has been a key contributor to other system black events, including blackouts in Northeast USA/Canada on 14 August 2003, Mid-West and South Brazil on 10 November 2009, and Northeast Brazil on 4 February 2011.[10]

A number of system operators have undertaken network level testing of system restoration capability within and between interconnected power grids in recent years. These include Italy, Switzerland, Italy-Switzerland, and Italy-France[11] and Sweden.[12] The total length of the restart paths energised in each of the Italian, Swedish and Italian-interconnected system tests were in the range of 940-1450 km, indicating coverage of a large part of the relevant networks.

One of the most recent large scale European network level restoration tests, conducted by the Italian system operator Terna in April 2017, was the subject of a CIGRE paper in 2018[13] demonstrating the values of the test over simulated modelling. The Italian test restoration path covered over 1400 km from southern France to Southern Italy, shown on the map below.

[9] At the time both power stations were owned by the same Generator, and the entire path was a contracted SRAS.
[10] CIGRE Study Committee C2 – System operation and control, Power system restoration – World practices & future trends, CIGRE Science & Engineering No. 14, June 2019 p.7
[11] ibid, pp. 12-14
[12] H Fendin et al, Black Start Test of the Swedish Power System, presented at 2011 IEEE Trondheim Power Tech
[13] CIGRE C2-105 Field test results of an Italian 380 kV top-down Restoration strategy from neighbouring power systems supplying very long restoration path, 2018

Figure 1 Restoration path under test by Terna Rete Italia, 9 April 2017[14]

Reports on these system level tests indicate that they yielded positive benefits in terms of the unique opportunity they present, in a controlled environment, to:

- Verify the technical feasibility of preparing and energising identified restart paths.
- Provide a reliable estimate of the time required to accomplish certain steps during restoration.
- Monitor and assess the operation and interoperation of assets, equipment and protection devices in emergency conditions.
- Identify and adjust for shortcomings, faults, incorrect assumptions and unexpected interactions in the restart sequence.
- Provide operator experience and training in the coordination required between organisations and teams involved.

3. STATEMENT OF ISSUES

AEMO has identified a number of current NER provisions that AEMO considers either present a barrier to, or do not adequately incentivise or facilitate, the provision and testing of new sources of system restart and restoration support capability necessary to meet the system restart standard as the NEM transitions to

[14] ibid. p.7

a grid with a high penetration of inverter-based and distributed or remote resources. This section explains how these NER provisions may be contributing to the issues described in section 2.2.

3.1 SRAS definition

The definition of a system restart ancillary service (Chapter 10) specifies that it is provided by facilities with 'black start capability'. This is in turn defined as a capability provided by a generating unit, to deliver electricity to either its connection point or a 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.

Thus, SRAS is by definition only capable of being provided by generating units at present, and the scope of the service is limited to the delivery of electricity to (or energisation of) a particular point on a network. These two limitations in the NER prevent the scope of SRAS services from being expanded to either:

- Include the restoration support services that are increasingly necessary to sustain a successful restoration.
- Increase competition for the provision of these services from an expanded range of facilities.

3.2 SRAS procurement objective

The SRAS procurement objective (clause 3.11.7(a1)) is to acquire system restart ancillary services to meet the system restart standard at the lowest cost. This lowest cost objective replaced the previous version of the SRAS procurement objective as part of the AEMC's last SRAS rule change, effective from 1 July 2015.[15] Previously, AEMO's procurement of SRAS had to be consistent with:

- The SRAS objective – similar to the existing SRAS objective that guides the Reliability Panel in making the system restart standard, which incorporates the national electricity objective.
- Meeting the system restart standard.
- Meeting SRAS needs with 'primary' (higher reliability) restart services[16] where practicable.

The AEMC's intent in amending the SRAS procurement objective was to provide clear and distinct objectives for the Reliability Panel and AEMO respectively in fulfilling their roles in the SRAS framework. At the time, AEMO agreed that it provided a simple and clear focus for AEMO. However, it has become clear that a lowest cost objective does not allow AEMO to take into account non-cost factors that may lead to more efficient outcomes in the long term interests of electricity consumers.

Incentivising long term sustainability and increased competition

In almost all cases, unless appropriate obligations or incentives are applied to encourage initial investment, existing facilities will be able to provide SRAS more cheaply in the immediate term than the cost of developing new capability. Because AEMO must procure sufficient SRAS (if available) to meet the system restart standard at all times, committing additional funds to develop extra capability for future availability makes it difficult to meet the lowest cost objective on terms that are commercially acceptable for the future provider.

While acquiring SRAS only from those currently available sources that meet the system restart standard results in lower costs for the immediate procurement, in some regions it is already a challenge to meet the system restart standard from existing sources. The long term impact on the NEM is less competition from a

[15] *National Electricity Amendment (System Restart Ancillary Services) Rule 2015 No.5*

[16] Before the rule change and subsequent review of the system restart standard, the NER allowed for primary and secondary restart services, which AEMO defined by reference to their assessed reliability levels (primary being 90%). These are now redundant; the system restart standard includes detailed requirements for individual and aggregate reliability of SRAS.

smaller pool of system restart service providers and therefore higher than necessary overall short and long term procurement costs.

Best value over lowest cost

In the same way, the lowest cost objective makes it impossible for AEMO to acquire services with much higher reliability value at a slightly increased cost, or hold a prudent level of SRAS reliability reserve. However, recent experience demonstrates that there may be benefits in doing so.

The causes of a black system are not readily predictable. Although an SRAS may have an assessed reliability of 90%, at the instant when it is needed the plant could be undergoing maintenance or otherwise unavailable. As illustrated by the SA black system event, it might be affected by the conditions that led up to the system collapse, or something could go wrong in a service that requires a complex start-up sequence. AEMO emphasises that there can never be a 100% guarantee of reliability, but some types of service may be inherently more prone to issues because of plant complexity.

Test failures, other plant reliability issues or fuel supply problems arising during the course of an SRAS contract term can also leave the system exposed. In two of the past three financial years, the actual availability of the contracted services would not have met the system restart standard in two regions.[17] AEMO can generally terminate an SRAS contract for sustained failure to meet reliability levels, but this means another SRAS must be procured for the relevant region at short notice. There may be no others available in the relevant region; previously unsuccessful tenderers may have decided not to maintain their SRAS capability; extensive testing of alternatives may be required; or an available provider may demand a very high price for a short term service in an uncompetitive market. In any event, there can be significant delays before either the original SRAS capability can be re-established or a replacement can be tested and contracted.

The current SRAS procurement objective prevents AEMO from negotiating SRAS contract arrangements that might address these issues. The objective means, for example, that a combination of services that just meets the standard's aggregate reliability requirement must be procured over a slightly more expensive combination that would deliver a much higher level of confidence in the services.

For this reason AEMO considers it appropriate to replace the SRAS procurement objective with a requirement for AEMO to have regard to the national electricity objective in acquiring SRAS.

3.3 Generator performance standards

Lack of voltage and frequency control and available fault current are becoming increasingly problematic as synchronous generators withdraw from the market, but are vital for stability during the early stages of system restoration. There is no requirement for generating systems either to have black start capability, or to provide the electrical support that is required for successful system restoration.

More broadly than voltage or frequency control, the ability of inverter-connected systems to deliver all of the technical capabilities set out in NER S5.2.5 tends to be limited by design to the system operating conditions set out in those standards – namely system-intact and defined fault conditions. Most equipment manufacturers will design settings as closely as possible to meet the technical specifications, but generally not to exceed them.

Coming back to the voltage control example, AEMO understands that most current inverter connected generation technologies are capable of reactive power response at low or no active power output. This is

[17] AEMO, *Non Market Ancillary Services Cost and Quantity Report 2017-18*, September 2018, p.5; *Non Market Ancillary Services Cost and Quantity Report 2016-17*, September 2017, p.5

already a requirement for generating systems in South Australia.[18] Typically though, they can only provide a stable response with sufficient synchronous generation online. Improved design and tuning of the inverter control system could extend the range within which a stable response could be provided, in order to be useful in a system restoration scenario. However, as this is not an existing requirement, project developers and equipment manufacturers do not consider it.

3.4 SRAS testing by NSPs

The obligations of Network Service Providers (NSPs) as they relate to system restart are limited to:

- Providing any information AEMO reasonably requires to assess the capability of an SRAS to meet the system restart standard (clause 3.11.9(i)(1)).
- Negotiating in good faith with a prospective SRAS Provider to identify and, if possible, resolve issues that would prevent the delivery of effective SRAS proposed by that prospective SRAS Provider (clause 3.11.9(i)(2)).
- Participating in, or facilitating, testing of SRAS proposed to be provided by a prospective SRAS Provider where reasonable and practicable, on the basis that the NSP is entitled to recover its reasonable costs for those activities as negotiable services from the prospective SRAS Provider (clause 3.11.9(i)(3), with provision for the physical testing process to be included in AEMO's SRAS Guideline under clause 3.11.7(d)(3)).
- To provide AEMO with its local black system procedures (LBSPs) and take actions as required by those procedures and AEMO's directions in the event of a major supply disruption (clauses 4.8.12(d), 4.8.14).
- Jointly with AEMO, to 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*.
- Generally, 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 (clause 4.3.4(a)).

The NER only refer to NSP participation in testing requirements for prospective SRAS as part of AEMO's procurement process. There are no NER requirements for extended network testing for system restart beyond the scope of the service itself. As the definition of SRAS requires the stable delivery of electricity to a point on the network, physical testing of the SRAS itself cannot be mandated beyond that point.

The NER are silent on SRAS testing once SRAS has been acquired, presumably on the basis that the SRAS contracts will include a testing regime. As specified in the SRAS Guideline, the existing contract regime requires the involvement of the relevant NSPs, and AEMO expects that contracted SRAS providers will have negotiated appropriate arrangements with their NSPs to cover the costs and other procedural aspects of regular SRAS tests. Again, however, there is no basis on which AEMO can contractually mandate the extension of system restart testing further into the network because this extends significantly beyond the scope of the SRAS as a service and is likely to involve the participation of other registered participants.

NSPs have expressed reservations about conducting voluntary testing of network restart paths beyond or significantly beyond, SRAS delivery points. These include a lack of certainty regarding the potential for outages to increase exposure under regulatory incentive schemes, liability, and cost recovery given the need for coordination with other participants who may have different priorities or be unwilling to participate in testing on a voluntary basis.

[18] Essential Services Commission of South Australia, 2017 Model licence conditions for new generators, clause 16. Available at: https://www.escosa.sa.gov.au/ArticleDocuments/1050/20170817-Inquiry-LicensingArrangementsforGeneratorsSA-ModelLicenceConditions.pdf.aspx?Embed=Y

Accordingly, AEMO considers that the NER should include clear regulatory obligations to support the testing of system restart paths, given its importance in establishing the capability to meet AEMO's power system security responsibilities.

4. HOW THE PROPOSAL WILL ADDRESS THE ISSUES

4.1 Proposed rule

A draft of AEMO's proposed amendments to the NER is provided in Appendix A. The changes are summarised below.

4.1.1 Expand the range of potential system restart services

The definition of black start capability is modified to remove the limitation that it can only be provided by generation, to allow for the possibility that alternative technologies or plant combinations might provide that capability in future.

The definition of a system restart ancillary service is expanded to include ancillary services that can support system restart in the conditions expected in the early stages of a system restoration process, allowing AEMO to acquire such services in addition to black start capability, again from a range of potential facilities. The nature of these supporting services can be expected to change over time and between SRAS sub-networks depending on the characteristics of the power system within that sub-network. It is therefore proposed that the services would be specified in the SRAS Guideline, to be determined and amended in accordance with the rules consultation procedures. Section 4.2 below outlines the characteristics of potential restoration support services that could initially be included. Additional changes to the SRAS definition are also proposed to remove unnecessary duplication of concepts that are already incorporated by referencing black start capability, and instead tie in with the intended outcomes of the use of SRAS as specified in clause 4.3.1(p) – AEMO's power system security responsibilities.

In addition to extending competition for the provision of SRAS to non-generation technologies, expanding the range of services that AEMO can acquire for system restart could incentivise existing generators to modify their settings or technology to be able to offer as many of those services as possible, with the potential of also encouraging some synchronous generators to remain available for these purposes or seek to combine multiple facilities to provide a single service offer.

AEMO notes that, under the current commercial contracting framework provided for system restart services, there is no intention to acquire SRAS from regulated network service providers. The AEMC may wish to consider whether this needs to be addressed in the rule.

4.1.2 SRAS procurement objective

The SRAS procurement objective definition and references to it in clauses 3.11.7 and 3.11.9 are deleted, to remove the hurdle that this presents to:

- Developing new system restart services necessary to support restoration in the future power system.
- Acquiring a combination of services that delivers the best value in terms of reliability over the contract term, accounting for reasonably foreseeable contingencies.

Instead, AEMO's procurement of SRAS would be guided by the national electricity objective. By replacing a lowest cost objective with a focus on efficient operation in the long term interests of consumers with respect to price, reliability and security of supply, the NER will allow for the acquisition of a range of

services that represent a more efficient outcome that would support the ongoing transition of the NEM power system.

4.1.3 Generator performance standards

The technical access standards in Schedule 5.2.5 are expanded by the addition of a new clause S5.2.5.15, addressing the capability to provide active and reactive power in system restart conditions.

The proposed minimum access standard requires generating systems to have the capability to provide at least one of the restoration support services specified in the SRAS Guideline, while the automatic access standard contemplates that the capability will extend to all of those services. The services required for any particular connection location will be dependent on the characteristics of that part of the network. AEMO does not propose that black system capability itself would be mandatory.

The proposed rule is expected to ensure that all new grid-scale generation has the capability to be configured in a way that will enable the generating unit to provide support and control services in more extreme system conditions than are currently provided for in performance standards. The revised SRAS definition will allow any generator to offer one or more of those services to AEMO as SRAS, but unless contracted it will not need to activate the capability in normal operation. This allows new generators the opportunity to earn returns on their investment in the capability.

The proposed rule includes consequential changes to:

- Include this standard as an AEMO advisory matter.
- Include a reference to the new performance standard in clause 5.3.9 where a generating system is modified.

4.1.4 SRAS testing by NSPs

For tests of SRAS themselves, clause 3.11.9 is amended to clarify NSP involvement in the ongoing testing of SRAS once those services are contracted, as well as prospective SRAS. As for prospective services, NSPs are entitled to negotiate and recover their reasonable costs of participation in SRAS testing from the provider. AEMO expects that providers would factor these NSP costs into the testing charges proposed in the procurement process.

An explicit requirement for NSPs to comply with the SRAS Guideline is also included.

4.1.5 Extended testing by NSPs

Extended system restart path testing, where required, is likely to be conducted in conjunction with tests of one or more SRAS, but must be conducted outside the contract framework given the potential to involve additional network elements and other registered participants.

This extended testing must be carefully planned, with the benefit of detailed advance modelling and analysis, to avoid adverse impacts on end users. Tests must be undertaken by NSPs and coordinated with any affected connected participants in addition to the SRAS provider. Subject to the need to maintain power system security and reliability, testing would be expected to require outages or partial outages of multiple transmission elements, and may involve the participation of one or more non-SRAS generators and distribution network service providers.

A new clause 5.7.7A is proposed, specifying the circumstances in which AEMO can require a test, and the resulting obligations of the NSP and other registered participants. Given the level of planning and coordination that will be required, AEMO proposes that the scope of the system restart communication protocols established under clause 4.8.12(j) will also be expanded to cover these tests.

The general provisions for coordination, participation and costs for system restart tests have been modelled on the existing clause 5.7.6, which allows NSPs to require tests of generating units for power system modelling or performance assessment purposes. AEMO considers that the purpose of extended restart testing is comparable to tests that may be required under clause 5.7.6 for modelling purposes. These tests would, in effect, confirm the veracity of modelled simulations of plant behaviour under conditions that cannot be validated in the normal range of operation.

Including the proposed provision for this testing in the NER will remedy existing uncertainty by clarifying that the tests:

- Are part of the functions of AEMO and NSPs under the NER, and therefore subject to the liability and cost recovery regimes in the national energy legislation.
- Are only conducted when AEMO determines reasonably necessary to verify the viability of a system restart plan to meet the system restart standard or AEMO's power system security responsibilities. It is noted that AEMO's responsibilities and the system restart plan extend beyond the capability to restart only a set quantity of supply expressed in the standard, and system restart needs ultimately to result in the restoration of mass load.
- Will be required by AEMO, and as such under the current structure of transmission network incentive schemes their market impact would be excluded.
- May require the cooperation and participation of any registered participant, without compensation, subject to obligations to minimise the operational impacts on all parties.

4.1.6 Transitional matters

AEMO considers that the proposed rule could come into effect immediately, subject to suitable transitional provisions in relation to the SRAS Guideline.

As described in section 4.2, if the proposed rule is made, AEMO will need to amend its SRAS Guideline to incorporate the requirements for additional system restart support services. Accordingly, a transitional period will be required after the rule is made for consultation to be undertaken on those changes, and consultation before the effective date of the rules should be included part of the formal rules consultation procedures.

4.2 AEMO procedure changes

If the proposed rule is made, AEMO envisages that it will need to consult on changes to its SRAS Guideline, in accordance with the rules consultation procedures under NER 8.9, to specify the type, characteristics, parameters and testing requirements for the acquisition of system restart support services. These amendments will need to be completed in time for AEMO to procure those services in parallel with the renewal of existing SRAS.

In parallel, AEMO is also reviewing other aspects of the SRAS Guideline and other guidelines that may assist the ability to prepare for a black system scenario. These include the specification of the black start capability service, the boundaries of electrical sub-networks (removing any unnecessary restrictions on the efficient acquisition and use of SRAS)[19] and the guide for preparing local black system procedures (with a focus on better understanding the capability of asynchronous generation fleet and its interactions with the broader power system in restart conditions).

In terms of timing:

[19] If sub-network boundaries are amended, this will trigger a review of the system restart standard

- The standard term of most current SRAS contracts expires on 30 June 2021, and typically the procurement and testing process takes six to nine months, requiring commencement in quarter 4, 2020.
- The SRAS Guideline changes must be completed before the procurement process starts. Given the nature of the proposed changes, AEMO considers it should allow between six and eight months to prepare for and conduct the consultation process, starting in quarter 1, 2020. If appropriate, AEMO will seek to progress its consultation in parallel with the AEMC's consultation on this proposed rule, subject to the final determination.

AEMO is aware that it is important for the AEMC and stakeholders to understand the nature of the likely new SRAS support services and associated capabilities when considering this proposed rule. For reference and subject to consultation on the SRAS Guideline, AEMO's preliminary thinking about the likely capabilities of both black start and restoration support services is set out below.

4.2.1 Proposed SRAS capabilities – indicative requirements

A black start service is likely to require all the following characteristics:

- Energise its delivery point without external supplies.
- Operate stably with its auxiliary supplies only or with network loads in a power island.
- Maintain its nominated MW supply level for a nominated period, generally at least 4 hours.
- Ability to perform at least two, and preferably three or more sequential start-ups.
- Provide steady-state and dynamic voltage control including under the conditions supplying its auxiliary loads.
- Provide steady state and dynamic frequency control when supplying its nominated MW supply level.
- Energise sections of transmission network so as energise auxiliaries of sufficient non-black start generating systems (to collectively provide a minimum restart path to load restoration).
- Provide sufficient fault current for correct operation of protection systems for the minimum restart path.
- Response not adversely impacted by other generation or network elements.

A restoration support service would need to be provided by a facility that could energise its delivery point with a pre-determined level of external supply, and provide one or more nominated services sustained for a minimum period. Initial support services are likely to include the ability to:

- Energise sections of transmission or distribution network so as energise auxiliaries of other non-black start generating systems under specified system conditions.
- Provide steady-state and dynamic voltage control including under the conditions supplying its auxiliary loads.
- Provide steady-state and dynamic frequency control when supplying its nominated MW supply level.
- Provide sufficient fault current for correct operation of protection systems in its restoration path.

4.3 Stakeholder engagement

In preparing this rule change proposal, AEMO sought initial feedback from NEM transmission network service providers distributors in relation to the proposals for extended network testing.

Most NSPs indicated cautious support for the inclusion of a mandatory system restart testing regime in the NER, for the purpose of providing greater regulatory certainty. They generally saw benefits in conducting

occasional network-level testing, which could also be useful to better identify the extent of other emerging issues in parts of the network. However, they expressed reservations about the potential scope of the testing rules, including in relation to:

- The need for extensive coordination and minimisation of impact on generators means there will be limited opportunities for testing and extensive coordination of outage planning will be required.
- Different issues will need to be managed between regions and in different network areas, for example where synchronous generators on the restart path are the key source of system strength for nearby wind and solar farms.
- Testing must not involve any involuntary customer load interruption.
- The need to ensure test outages are excluded from the market impact component of regulatory incentive schemes.

AEMO has sought to take account of NSP concerns around flexibility in the proposed drafting of the rule, allowing for testing to be planned cooperatively between AEMO and NSPs in each region.

5. HOW THE PROPOSED RULE CONTRIBUTES TO THE NATIONAL ELECTRICITY OBJECTIVE

AEMO considers the proposed rule will be in the long term interests of electricity consumers with respect to security of supply and the security of the power system. The proposal will encourage efficient investment in existing and new capabilities to assist system restart and restoration as the power system transitions towards a system that is dominated by asynchronous resources.

The capability to restart and restore supply in the event of a system collapse is something we hope never to need. Nevertheless, if that capability is allowed to erode and the system cannot be restored to a point where mass load restoration can proceed, the social, economic and technical consequences of a prolonged blackout could be catastrophic.

During the SA black system in 2016, the only useable SRAS source was unable to deliver, for reasons that have been well documented and since addressed[20]. On the day, the SA power system was restarted from Victoria, and a transmission path energised to major generation at Torrens Island. In the scenario where contracted SRAS is not used, the services required to support stable restoration are still essential. Until now it has been assumed they would be freely available from traditional synchronous generation. However, as changes in the generation mix and location of generation tend to remove or reduce the usefulness of existing capability, the security of the power system will be jeopardised unless appropriate steps are taken to secure additional sources.

The NEM is a changing power system, with increasing penetration of different generation and network technologies, displacement of traditional synchronous generation and changes in power flows as a result of active demand response and distributed energy resources. In the face of this transformation, power system modelling has rapidly become significantly more complex and detailed in order to predict plant performance in different conditions with reasonable confidence levels. However, modelling cannot substitute for real world experience. A black system will never be a credible scenario, plant responses cannot be tested in a commissioning environment, and it is almost certain that there will be both known and unknown unknowns in the increasing range of interactions that can occur in black system and restart conditions. AEMO considers that greater depth of testing, on a periodic basis, is therefore also essential to:

[20] AEMO, Black System South Australia Final Report, March 2017, Chapter 5 and p 103

- Confirm and refine the efficient and effective level of procurement of SRAS (including support services) needed to meet the system restart standard
- Improve preparation and education of AEMO, transmission and distribution operators, generators and potentially major industrial loads on the processes, risks and interactions involved in system restart.
- Significantly increase the level of assurance that SRAS restoration will succeed using the services procured for the benefit of all NEM users.

6. EXPECTED BENEFITS AND COSTS OF THE PROPOSED RULE

The proposed rule would be expected to result in increased costs in the short to medium term for:

- AEMO, in relation to the cost of acquiring SRAS, including restart support services.
  The cost of such services is likely to vary significantly depending on the type of technology providing them, and the available supply in different parts of the power system. AEMO has not sought to estimate the costs given the range of possible scenarios and the proposal to procure these services on a competitive basis where possible. In the medium to long term, however, the potential expansion of the pool of providers of these services to inverter-based technologies may result in lower costs as equipment manufacturers develop and install systems with the requisite capabilities. This is because inverter-based generation technologies have no or limited fuel cost, lower operating costs, and lower maintenance costs as on average they are a few decades younger than conventional black start providers. Further, in the event of an anticipated gap in SRAS sources within a timeframe of say five-years, inverter-based generation can be constructed in much shorter timeframes than thermal and hydro plant.
- Network service providers, in relation to extended network testing.
  As tests would be required by AEMO, the efficient costs associated with this testing are expected to be recovered through charges for prescribed transmission services.
- Generators, particularly non-SRAS generators, in relation to extended network testing.
  Some generators who are not SRAS providers may need to be involved in extended network testing, to demonstrate the ability of the procured services to ultimately establish connections to those generators along the restart path. The proposed rule includes a requirement to minimise the impact on all participants involved in these tests, both from an operational and commercial perspective. It should also be noted that the benefits to be gained from extended system restart testing benefits all connected users of the NEM, whether consumers or generators.

The benefits of the rule are difficult to quantify, given the extreme and rare circumstances in which SRAS is expected to be actually used. As indicated in section 5, SRAS are effectively an insurance policy to minimise the impact of a worst-case scenario that might otherwise involve substantially greater economic and social cost. The proposed rule facilitates:

- Service enhancements to alleviate the risk that, in the relatively near future in some regions, there will not be sufficient (or sufficiently effective) SRAS to meet the system restart standard or ultimately to enable restoration of all load following a black system event, resulting in potentially very significant economic and social cost for electricity consumers.
- Restart path testing sufficient to verify the feasibility and timing of selected restart paths and identify unforeseen issues that cannot be modelled and could delay or prevent a successful restoration.

Incentivising enhanced control capabilities of inverter-connected generating systems that provide restoration support in emergency conditions will have the by-product of contributing to improved system

performance in non-credible contingency conditions that involve disconnection of multiple synchronous generators. This is because those controls will be sensitive to the number and proximity of online synchronous generators. A loss of significant nearby synchronous generators would be seen by the controls in a very similar way to blackout conditions, and the inverter-connected generator could respond to provide support that could significantly reduce the risk of system collapse occurring.

The potential for the proposed rule to encourage new black start capable technologies may support the development of inverter-connected technologies of a grid-forming type. These types of technologies would automatically meet many of the automatic access standards for connection and, by their nature, would not cause adverse system strength impacts requiring costly system strength remediation schemes (e.g. installation of synchronous condensers). Grid-forming technologies would therefore have significant benefits both for the resilience of the power system, and the speed and cost of the generator connection process.

APPENDIX A. DRAFT RULE

This draft is based on version 122 of the National Electricity Rules. Proposed additions are shown underlined and deletions in ~~strikeout~~ format.

A.1 Chapter 3

3.11.7 Guidelines and objectives for acquisition of system restart ancillary services by AEMO

(a) [not used].

(a1) *AEMO* must use reasonable endeavours to acquire *system restart ancillary services* to meet *the system restart standard*, having regard to the *national electricity objective.* ~~at the lowest cost (**the *SRAS* Procurement Objective**).~~

(b) *AEMO* must consult with the relevant *Network Service Provider* to identify and resolve issues in relation to the capability of any *system restart ancillary service* proposed to be provided by an *SRAS Provider* in an *electrical sub-network* to meet the *system restart standard*.

(c) *AEMO* must develop and *publish* the *SRAS Guideline*. The *SRAS Guideline* must be designed to ensure that the *system restart standard* is met, having regard to the *national electricity objective.* ~~at the lowest cost.~~

(d) The *SRAS Guideline* must include:

(1) a description of the technical and availability requirements of *system restart ancillary services*;

(2) a process for meeting the aggregate required reliability of *system restart ancillary services* for each *electrical sub-network* under clause 8.8.3(aa)(3);

(3) a process for the modelling, assessment and physical testing of *system restart ancillary services* proposed to be provided by an *SRAS Provider*, including any assumptions to be made by *AEMO* regarding the state of *transmission elements* during a *major supply disruption*;

(4) a process for determining the number and location of *system restart ancillary services* required to be procured for each *electrical sub-network* consistent with the *system restart standard*;

(5) guidance to *Registered Participants* on the factors that *AEMO* must take into account when making a decision to follow a particular type of procurement process to acquire *system restart ancillary services* to meet the *SRAS Procurement Objective*;

(6) a process for *AEMO* to follow for contacting a potential *SRAS Provider* to negotiate the provision of *system restart ancillary services* without a competitive tender process; and

(7) a process for a potential *SRAS provider* to contact *AEMO* to offer the provision of *system restart ancillary services* without a competitive tender process, which offer *AEMO* is in no way obliged to accept.

(e) *AEMO* may amend the *SRAS Guideline* from time to time.

(f) When making or amending the *SRAS Guideline*, *AEMO* must, subject to paragraph (g), consult with:

(1) *Registered Participants*; and

(2) Such other persons who, in *AEMO's* reasonable opinion, have, or have identified themselves to *AEMO* as having, an interest in the *SRAS Guideline*,

in accordance with the *Rules consultation procedures*.

(g) *AEMO* may make minor and administrative amendments to the *SRAS Guideline* without complying with the *Rules consultation procedures*.

[...]

3.11.9 Acquisition of system restart ancillary services by AEMO

(a) If *AEMO* proposes to acquire a *system restart ancillary service*, *AEMO* must enter into an *ancillary services agreement* with a prospective *SRAS Provider* following the completion of any procurement process to acquire *system restart ancillary services* in accordance with clause 3.11.7(a1). ~~which *AEMO* is satisfied will enable it to meet the *SRAS Procurement Objective*.~~

(b) Subject to paragraph (c), *AEMO* must only acquire *system restart ancillary services* from a person who is a *Registered Participant*.

(c) *AEMO* may enter into an agreement to acquire *system restart ancillary services* with a person who is not a *Registered Participant* if that agreement includes a condition for the benefit of *AEMO* that no *system restart ancillary services* will be provided under the agreement until that person becomes a *Registered Participant*.

(d) An *SRAS Provider* must comply with an *ancillary services agreement* under which they provide one or more *system restart ancillary services*

(e) A dispute concerning any aspect, (other than the aspect of price), of a *system restart ancillary services* agreement or a call for offers conducted by *AEMO* for the acquisition of *system restart ancillary services*, must be dealt with in accordance with rule 8.2.

(f) *AEMO* may from time to time require an *SRAS Provider* which provides a *system restart ancillary service* under an *ancillary services agreement* to demonstrate the relevant *plant's* capability to provide the *system restart ancillary service* to the satisfaction of *AEMO* according to standard test procedures. An *SRAS Provider* must promptly comply with a request by *AEMO* under this clause.

(g) A prospective *SRAS Provider* must provide to *AEMO* sufficient data, models and parameters of relevant *plant* in accordance with the requirements specified in the *Power System Model Guidelines*, the *Power System Design Data Sheet* and the *Power System Setting Data Sheet*, to facilitate a thorough assessment of the *network* impacts and *power station* impacts of the use of the relevant *system restart ancillary service*.

(h) If *AEMO* seeks to enter into an *ancillary services agreement* with a prospective *SRAS Provider*, *AEMO* and that *SRAS Provider* must negotiate in good faith as to the terms and conditions of the *ancillary services agreement*.

(i) 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*;

(2) cooperate ~~negotiate~~ in good faith with an *SRAS Provider* or 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~~ and facilitate, testing of a *system restart ancillary service* by an *SRAS Provider* under paragraph (f) and, to the extent reasonable and practicable, 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

(4) comply with the *SRAS Guideline*,

and ~~when participating in or facilitating such~~ in respect of its activities under paragraphs (2) or (3), the *Network Service Provider* will be entitled to recover from the *SRAS Provider or* 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*.

A.2 Chapter 4

4.8.12 System restart plan and local black system procedures

(a) *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*.

(a1) The *system restart plan* must cover the entire *national grid* but may consist of one or more separable components.

(a2) For the purposes of section 54A(2) of the *National Electricity Law*, *AEMO* may disclose the whole or any component of the *system restart plan* to:

(1) a *Jurisdictional System Security Coordinator*;

(2) a *Network Service Provider*;

(3) a *Generator* contracted to provide *SRAS*;

(4) any other *Registered Participant* whose assistance *AEMO* considers is necessary for the implementation of the *system restart plan*,

for the purposes of preparing for, and participating in, system restoration activities during a *major supply disruption*.

(a3) A *Jurisdictional System Security Coordinator* to whom the whole or any component of the *system restart plan* is provided to under paragraph (a2)(1) is deemed to be a *Registered Participant* for the purposes of Part C of Chapter 8.

(b) The *system restart plan* is *confidential information*.

(c) The *system restart plan* must be consistent with the *system restart standard*.

(d) Each *Generator* and *Network Service Provider* must develop *local black system procedures* in accordance with the guidelines referred to in clause 4.8.12(e). A *Generator's* or *Network Service Provider's local black system procedures* must be consistent with any *ancillary services agreement* to provide *system restart ancillary services* to which that *Generator* or *Network Service Provider* is a party. On request from *AEMO*, or as a result of a significant change of circumstances, a *Generator* or *Network Service Provider* must review, and amend if appropriate, its *local black system procedures*.

Note

This clause is classified as a civil penalty provision under the National Electricity (South Australia) Regulations. (See clause 6(1) and Schedule 1 of the National Electricity (South Australia) Regulations.)

(e) 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*.

(f) *Local black system procedures* must:

(1) 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*; and

(2) appropriately incorporate any relevant *energy support arrangements* to which a *Generator* or *Network Service Provider* may be party.

(g) Each *Generator* and *Network Service Provider* must submit its *local black system procedures*, including any amendments to those procedures, to *AEMO* for approval. In considering whether to grant approval, *AEMO* must take into account the consistency of the *local black system procedures* with:

(1) the guidelines referred to in clause 4.8.12(e); and

(2) relevant components of the *system restart plan*.

(h) *AEMO* may request amendments to *local black system procedures*, including, without limitation, imposing conditions in respect of any *energy support arrangement* as *AEMO* reasonably considers necessary to ensure the integrity of the *system restart plan*. When requesting amendments to the *local black system procedures*, *AEMO* must provide reasons for those requested amendments.

(i) Requests by *AEMO* for amendments under clause 4.8.12(h) must be by notice in writing to a *Generator* or *Network Service Provider*. Reasonable requests by *AEMO* for amendments under clause 4.8.12(h) must be complied with by a *Generator* or *Network Service Provider*.

(j) *AEMO* and *Network Service Providers* must jointly develop:

(1) communication protocols to facilitate the exchange of all information relevant to the roles played by *AEMO*, *Network Service Providers*, *Generators* and *Customers* in the implementation of the *system restart plan*.; and

(2) procedures for the periodic testing of the capability of *network elements* and other *plant* included in the *system restart plan* to restore *supply* to a level consistent with the *system restart standard*, in accordance with clause 5.7.7A.

A.3 Chapter 5

5.3.9 Procedure to be followed by a Generator proposing to alter a generating system

[...]

(d) Without limiting paragraph (a), a proposed alteration to the equipment specified in column 1 of the table set out below is deemed to affect the performance of the *generating system* relative to technical requirements specified in column 2, thereby necessitating a submission under subparagraph (b)(3), unless *AEMO* and the *Network Service Provider* otherwise agree.

Column 1 (altered equipment)	**Column 2 (clause)**
machine windings	S5.2.5.1, S5.2.5.2, S5.2.8
power converter	S5.2.5.1, S5.2.5.2, S5.2.5.5, S5.2.5.12, S5.2.5.13, S5.2.5.15, S5.2.8
reactive compensation plant	S5.2.5.1, S5.2.5.2, S5.2.5.5, S5.2.5.12, S5.2.5.13, S5.2.5.15
excitation control system	S5.2.5.5, S5.2.5.7, S5.2.5.12, S5.2.5.13, S5.2.5.15,
voltage control system	S5.2.5.5, S5.2.5.7, S5.2.5.12, S5.2.5.13, S5.2.5.15
governor *control system*	S5.2.5.7, S5.2.5.11, S5.2.5.14, S5.2.5.15
power *control system*	S5.2.5.11, S5.2.5.14
protection system	S5.2.5.3, S5.2.5.4, S5.2.5.5, S5.2.5.7, S5.2.5.8, S5.2.5.9, S5.2.5.10, S5.2.5.15,
auxiliary supplies	S5.2.5.1, S5.2.5.2, S5.2.7

remote control and monitoring system	S5.2.5.14, S5.2.6.1, S5.2.6.2

5.7 Inspection and Testing

[...]

5.7.7A System restart tests

(a) If *AEMO* determines that a test is reasonably necessary to verify whether the implementation of a component of the *system restart plan* is likely to be consistent with the achievement of the *system restart standard* or the *AEMO power system security responsibilities* for an *electrical sub-network*, *AEMO* must notify the *Transmission Network Service Provider(s)* in respect of that *electrical sub-network*.

(b) If a *Transmission Network Service Provider* receives a notice under paragraph (a), it must notify any *Registered Participant* in respect of *plant connected* to its *network* that is required to participate in the test in accordance with the relevant procedures developed under clause 4.8.12(j)(2).

(c) In consultation with *AEMO* and after consulting with the *Registered Participants* notified under paragraph (b), the *Transmission Network Service Provider* must prepare a *test program* for the test and provide that *test program* to *AEMO* and each such *Registered Participant* within [xx] *business days* of receiving a notice under paragraph (a).

(d) The *test program* must be designed to achieve the objective of the test having regard to the following principles:

(1) *power system security* must be maintained in accordance with Chapter 4;

(2) the extent and duration of variation from the *central dispatch* outcomes that would otherwise occur in the absence of the test should be minimised; and

(3) to the extent reasonably practicable, the timing and duration of the test should be coordinated with other operational requirements of the *Transmission Network Service Provider* and other affected *Registered Participants* so as to minimise the impact of the test on the operations of all parties.

(e) Subject to paragraph (f), the *Transmission Network Service Provider* must conduct the test in accordance with the *test program*, but not less than 30 *business days* after the *Transmission Network Service Provider* provides the *test program* to *AEMO* and the relevant *Registered Participants* under paragraph (c).

(g) If, at any time before or during a test under this clause 5.7.7A, *AEMO* considers that the test could reasonably be expected to adversely affect *power system security*, *AEMO* may direct that the *test program* be modified, including by deferring the test.

(h) Each *Registered Participant* whose *plant* is included in a test under this clause 5.7.7A must:

(1) cooperate with, and comply with instructions given by, *AEMO* and the relevant *Transmission Network Service Provider* in planning, preparing for and conducting the test; and

(2) act in good faith in respect of, and not unreasonably delay, the test.

(i) Each *Registered Participant* and *AEMO* must bear its own costs associated with tests conducted under this clause 5.7.7A and no compensation is to be payable for financial losses incurred as a result of these tests or associated activities.

[...]

S5.2.5.15 System restoration

Automatic access standard

(a) In this clause, **restoration support service** means a *system restart ancillary service* of a type referred to in paragraph (b) of the definition of that term.

(b) The *automatic access standard* is a *generating system* must have *plant* capabilities and *control systems* sufficient to be capable of offering all types of restoration support service specified in the *SRAS Guideline*.

Minimum access standard

(c) The *minimum access standard* is a *generating system* must have *plant* capabilities and *control systems* sufficient to be capable of offering at least one of the restoration support services specified in the *SRAS Guideline*, where each relevant restoration support service is identified in the *negotiated access standard*.

A.4 Chapter 10

AEMO advisory matter

A matter that relates to *AEMO*'s functions under the *National Electricity Law* and a matter in which *AEMO* has a role under clause 5.3.4B or in schedules 5.1a, 5.1, 5.2, 5.3 and 5.3a. Advice on the acceptability of *negotiated access standards* under the following clauses are deemed to be *AEMO advisory matters*: S5.1.9, S5.2.5.1, S5.2.5.3 to S5.2.5.5, S5.2.5.7 to ~~S5.2.5.14~~S5.2.5.15, S5.2.6.1, S5.2.6.2, S5.3a.4.1 and S5.3a.14.

black start capability

A capability that allows a *generating unit* or other *facility* or a combination of *facilities*, following ~~its~~ *disconnection* from the *power system*, to be able to deliver electricity to either:

(a) 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*.

~~***SRAS Procurement Objective***~~

~~Has the meaning given in clause 3.11.7(a1).~~

system restart ancillary service or ***SRAS***

A service provided by *facilities* with ~~*black start capability* which allows~~:

(a) *black start capability*; or ~~*energy* to be supplied; and~~

(b) the ~~one or more~~ capabilities described in the *SRAS Guideline* to supply one or more services to sustain the stable energisation of *generation* and *transmission* ~~a *connection* to be established~~,

sufficient to ~~restart large~~ facilitate the restoration and maintenance of *power system security* and the restart of *generating units* following a *major supply disruption*.

test program

In respect of an *inter-network test* or a system restart test under clause 5.7.7A, means the program and co-ordination arrangements for the test including, without limitation:

(1) test procedures;

(2) the proposed timing of the test;

(3) operational procedures to manage *power system security* during the test;

(4) required *power system* conditions for conducting the test;

(5) for an *inter-network test*, test facilitation services including, as necessary, *ancillary services* required to achieve those *power system* conditions;

(6) criteria for continuing or concluding a test and the decision-making process relevant to the test; and

(7) contingency arrangements.

A.5 Chapter 11

11.xxx.1 Definitions

In this rule 11.xxx:

Amending Rule means the National Electricity Amendment (xxx) Rule 20xx.

commencement date means [xxx 2020].

11.xxx.2 Amended Procedures

(a) As soon as practicable after the commencement date, and in accordance with the *Rules consultation procedures*, *AEMO* must amend the *SRAS Guideline* to take into account the Amending Rule.

(b) If, prior to the commencement date and for the purposes of amending the *SRAS Guideline* in anticipation of the Amending Rule, *AEMO* undertook consultation or a step equivalent to that required in the *Rules consultation procedures*, then that consultation or step is taken to satisfy the equivalent consultation or step under the *Rules consultation procedures*.