SRAS GUIDELINE

SYSTEM RESTART ANCILLARY SERVICES

Incorporating BOUNDARIES OF ELECTRICAL SUB NETWORKS

PREPARED BY:	AEMO Operations – Systems Capability
VERSION:	[2.0]
EFFECTIVE DATE:	[2 November 2020]
STATUS:	[DRAFT FOR FIRST STAGE CONSULTATION – 13 May 2020]

Approved for distribution and use by:

APPROVED BY:	[TBA]
TITLE:	[TBA]

DATE: / / 2020

VERSION RELEASE HISTORY

Version	Effective Date	Summary of Changes
1.0	15 December 2017	Initial version of the 'SRAS Guideline' under clause 3.11.7, reflecting the *National Electricity Amendment (System Restart Ancillary Services) Rule 2015 No. 5* (introduced in version 72 of the National Electricity Rules). Note: Supersedes the consolidated set of SRAS Guidelines made under National Electricity Rules version 64, clause 3.11.4A and 3.11.4B on 5 September 2014.
1.1	9 May 2018	Revised as a consequence of the consultation on the *Power System Model Guidelines*.
2.0	TBA	Updated and expanded to include enhanced technical requirements for black start services reflecting operational experience, and to reflect changes introduced by the *National Electricity Amendment (System restart services, standards and testing) Rule 2020 No. 6* incorporating: • Description of new restoration support services. • Guidance on the frequency and requirements for system restart tests. • Guidance on how AEMO expects to achieve the SRAS objective. Other minor updates and consequential changes required by the amending rule.

CONTENTS

TABLES

1. INTRODUCTION

1.1. Purpose and scope

(a) This document (Guideline) has effect only for the purposes set out in the National Electricity Rules (NER). The NER and the National Electricity Law prevail over this Guideline to the extent of any inconsistency.

(b) The Guideline incorporates:

(i) the *SRAS Guideline* made under NER clause 3.11.7(c) to address the matters specified in NER clause 3.11.7(d); and

(ii) AEMO's determination of the boundaries of *electrical sub-networks* under NER clause 3.11.8.

(c) This version of the Guideline is intended to reflect the *system restart standard* (SRS) published by the *Reliability Panel* on [15 December 2016, with an effective date of 1 July 2018 – *AEMO note: to be updated if SRS amended*]. It explains how AEMO proposes to procure SRAS in order to meet the SRS for each *electrical sub-network*.

1.2. Application

The amendment of this Guideline does not vary any SRAS Agreement entered into before the effective date of that amendment, and the SRAS Agreement continues in effect in accordance with its terms until it ends. In particular, the technical characteristics of the relevant SRAS and the parameters for SRAS Tests under the SRAS Agreement will be governed by the applicable provisions of the Guideline as it was in force on the date of that SRAS Agreement.

~~This Guideline applies to SRAS that AEMO has procured, or seeks to procure, under an SRAS Agreement if the service commencement date under that agreement is on or after 1 July 2018.~~

~~The previous version of the SRAS Guidelines published on 5 September 2014 continues to apply to the testing of SRAS procured under an SRAS Agreement entered into before the effective date of this Guideline, until that agreement ends.~~

~~1.2.~~1.3. Definitions and interpretation

1.3.1. Glossary

(a) Terms defined in the National Electricity Law and the NER have the same meanings in this these Guideline unless otherwise specified in this section.

(b) Terms defined in the NER are intended to be identified in this Guideline by italicising them, but failure to italicise a defined term does not affect its meaning.

(c) The words, phrases and abbreviations in the table below have the meanings set out opposite them when used in this Guideline.

Term	Definition
AEMO	Australian Energy Market Operator Limited
Black Start Service	An SRAS procured for the purpose of providing *black start capability*.

Cold load pickup	*Re-energisation* of *load* where greater than average *load* is initially expected due to both the in-rush of current and the recovery needs of machines that have been off supply for an extended period.
Contract Availability	For the purpose of determining the availability of an SRAS under an SRAS Agreement, includes availability of both SRAS Equipment and SRAS Transmission Components.
Delivery Point	For a Black Start Service, a~~A~~ nominated point on a *transmission system* to which power is to be delivered using SRAS Equipment and SRAS Transmission Components. For a Restoration Support Service, the *connection point(s)* of the relevant SRAS Equipment or another nominated point in the *power system*.
GPS	The registered *performance standards* for a *generating system*.
~~Generator Modelling Data~~	~~The data to be provided by an SRAS Provider to AEMO under clause 5.2 about each relevant *generating unit*, related *generating system* and other applicable SRAS Equipment.~~
ITT	An invitation to tender for the provision of SRAS issued by AEMO under section ~~clause~~ 7.3.
LBSP	*Local black system procedures* developed by a *Generator* or *Network Service Provider* under NER clause 4.8.12.
Minimum Restart Path	A restoration path required to energise sections of the *transmission network* and auxiliaries of non-black start *generating systems* sufficient to meet the SRS in an *electrical sub-network*.
Modelling Data	The data to be provided by an SRAS Provider to AEMO under section 5.2 about each item of SRAS Equipment.
NER	National Electricity Rules.
NSP	*Network Service Provider*
Restart Test Participant	In relation to a System Restart Test, a *Test Participant* as defined in clause 4.3.6 of the NER.
Restoration Support Service	An SRAS procured for the purpose of sustaining the stable *energisation* of *generation* and *transmission* following initial *energisation*.
SRAS	*System restart ancillary service*, including a proposed service where the context requires.
SRAS Agreement	An *ancillary services agreement* for the provision of SRAS.
SRAS Equipment	One or more identified *generating units* and other facilities used, or proposed to be used, to provide an SRAS to the Delivery Point, including SRAS Third Party Assets but excluding SRAS Transmission Components.
SRAS Equipment Availability	A parameter for the assessment of the availability of SRAS Equipment, determined in accordance with section~~clause~~ 3.6.2.
SRAS Equipment Reliability	A parameter for the assessment of the reliability of SRAS Equipment, determined in accordance with section ~~clause~~ 3.6.3.
SRAS Provider	A *Generator* with whom AEMO contracts to provide SRAS, or who submits or has been invited to submit an expression of interest or offer to provide SRAS to AEMO. **Note**: This modifies the NER definition.
SRAS Test	A physical test of the capability of SRAS Equipment to provide SRAS, conducted in accordance with section 4.1 to 4.4~~ clause 4~~.

SRAS Third Party Assets	Facilities and equipment within the SRAS Equipment that are owned or operated by a third party independent of (and not under the direction or control of) the SRAS Provider. **Note**: Examples include parts of a *transmission system* connecting SRAS units that are not co-located within a single *power station* site, or *distribution system* assets between a *power station* and the SRAS Delivery Point. Facilities or equipment operated by a contractor, agent or other person on behalf of the SRAS Provider are not SRAS Third Party Assets.
SRAS Transmission Components	Facilities and equipment forming part of the *transmission system* between (and including) the *transmission network connection point* to which the SRAS Equipment is *connected*, and the *transmission substation* or *switchyard* located at or immediately downstream of the Delivery Point.
SRS	The *system restart standard* determined by the *Reliability Panel* under the NER.
Stabilising Load Blocks	Blocks of *load* connected during the system restart process to assist stable operation of *generation*.
System Restart Test	As defined in the NER. This is a physical test within an *electrical sub-network* to verify the potential to implement the applicable *system restart plan*, and is conducted in accordance with NER clause 4.3.6.
Tender	A tender submitted in response to an ITT.
Test Procedure	A procedure for the conduct of an SRAS Test, that meets the requirements set out in section ~~clause~~ 4.2~~4.1~~.
TNSP	*Transmission Network Service Provider*
Transmission Component Reliability	A parameter for the assessment of the individual reliability of an SRAS, determined in accordance with section~~clause~~ 3.6.4
Trip to house load (or TTHL)	An electrical islanding scheme using *generating units* that can disconnect from the *transmission network* following a *major supply disruption* and continue to supply their own auxiliaries or an isolated segment of system *load*.

~~1.2.2.~~1.3.2. Interpretation

This Guideline is subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

1.4. Related documents

Title	Location
Power System Model Guidelines	https://www.aemo.com.au/-/media/Files/Electricity/NEM/Security_and_Reliability/System-Security-Market-Frameworks-Review/2018/Power_Systems_Model_Guidelines_PUBLISHED.pdf
Power System Design Data Sheets and Power System Setting Data Sheets	https://aemo.com.au/-/media/files/electricity/nem/security_and_reliability/system-security-market-frameworks-review/2018/power_system_design_and_setting_data_sheets_published.xlsx?la=en&hash=C369DA2C7325B80D65804006E7E67AE7

2. LEGAL AND REGULATORY FRAMEWORK

2.1. SRAS Procurement Objective

The SRAS Procurement Objective is to acquire SRAS to meet the SRS at the lowest long-term cost (~~, as defined in~~ NER clause 3.11.7(a1)).

2.2. SRAS Guideline

Sections~~Clauses~~ 3 to 8 of this Guideline comprise the *SRAS Guideline*. The *SRAS Guideline* is designed to meet the *SRAS Procurement Objective* and includes (in accordance with NER clause 3.11.7(d)):

(a) a description of the technical and availability requirements of SRAS (section~~clause~~ 3);

(b) a process for meeting the aggregate reliability of SRAS for each *electrical sub-network* under NER clause 8.8.3(aa)(3) (section~~clause~~ 5.5);

(c) a process for the modelling, assessment and physical testing of SRAS 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* (section~~clause~~ 4.5~~5~~, with physical testing of SRAS covered in section 4~~clause 4.3~~);

(d) guidance to *Registered Participants* on the factors influencing a decision of AEMO to conduct a System Restart Test, including the types of conditions or changes in the *power system* which could necessitate a test (section 4.5.1);

(e) guidance to *Registered Participants* required to participate in a System Restart Test on the measurements and data to be reported to AEMO about the operation of their *facilities* during the test (section 4.5.3 and Appendix B);

~~(d)~~(f) a process for determining the number and location of SRAS required to be procured for each *electrical sub-network* consistent with the SRS (section~~clause~~ 5.5.3);

(g) requirements designed to identify any inconsistencies between the arrangements used in the testing of *system restart ancillary services* and those planned to be used in the deployment of *system restart ancillary services* following a *major supply disruption* and how any inconsistencies will be assessed (section 4.2)

~~(e)~~(h) 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 SRAS to meet the *SRAS Procurement Objective* (section~~clause~~ 7~~6~~);

(i) guidance to Registered Participants on how AEMO will achieve the *SRAS Procurement Objective* (section 6)

~~(f)~~(j) a process for AEMO to follow for contacting a potential SRAS Provider to negotiate the provision of SRAS without a competitive tender process (section~~clause~~ 7.4); and

~~(g)~~(k) a process for a potential SRAS Provider to contact AEMO to offer the provision of SRAS without a competitive tender process, which offer AEMO is in no way obliged to accept (section ~~clause~~ 8).

2.3. Boundaries of electrical sub-networks

Section~~Clause~~ 9 of this Guideline comprises AEMO's determination of the boundaries of *electrical sub-networks* under NER clause 3.11.8, which provides that:

(a) for the purpose of acquiring SRAS and determining and implementing the *system restart plan*, the *power system* is to be divided into *electrical sub-networks*; and

(b) AEMO must determine the boundaries of *electrical sub-networks* in accordance with the guidelines determined by the *Reliability Panel* under NER clause 8.8.3(aa)(5).

2.4. System Restart Standard

~~(a) This Guideline is intended to be consistent with the SRS determined by the *Reliability Panel* on 15 December 2016, effective from 1 July 2018.~~

The SRS[1] includes a determination of:

~~(b)~~(a) the maximum amount of time within which SRAS are required to restore *generation* and *transmission* capacity~~supply~~ in an *electrical sub-network* to a specified level, under the assumption that *supply* (other than that provided under an SRAS Agreement acquired by AEMO for that *electrical sub-network*) is not available from any neighbouring *electrical sub-network* (see columns 2 and 3 of Table 1 below);

~~(c)~~(b) the required aggregate reliability of SRAS for each *electrical sub-network*, being the probability that generation and transmission will be restored to the specified level in the specified timeframe (see column 4 of Table 1 below);

~~(d)~~(c) guidelines for assessing the diversity and determining the strategic location of SRAS; and

~~(e)~~(d) guidelines for determining *electrical sub-networks*.

Table 1 SRS requirements for each *electrical sub-network*

Electrical sub-network	Restoration Supply Level (MW)	Restoration Time (hours)	Required Aggregate Reliability
Queensland North	825	3.5	90%
Queensland South	825	3.0	90%
New South Wales *North of Sydney	1500 (*500)	2.0 (*4.0)	90% (*75%)
Victoria	1100	3.0	90%
South Australia	330	2.5	90%
Tasmania	300	2.5	95%

* For New South Wales AEMO shall procure SRAS north of Sydney, sufficient to also independently restart, without drawing power from the *power system*, at least 500 MW of *generation capacity* north of Sydney within four hours of a *major supply disruption* with an aggregate reliability of at least 75%.

2.5. Role of Network Service Providers

(a) NER clause 3.11.9(i) sets out obligations and rights of NSPs in relation to the procurement of SRAS, including the provision of information to AEMO and assistance to prospective SRAS Providers.

(b) This Guideline includes some requirements for NSPs to provide information, advice and assistance to AEMO and SRAS Providers for some aspects of the procurement and testing process for SRAS. Those requirements:

(i) do not limit the obligations or rights of NSPs under NER clause 3.11.9(i);

[1] As determined by the Reliability Panel on *[date]* with effect from *[date]*

(ii) are additional to NSP obligations to develop, review and amend an LBSP; and

(iii) do not cover the development of *system restart plans* under NER clause 4.8.12, but may relate to information that is used in preparing those plans.

3. SRAS DESCRIPTION

3.1. Overview

(a) An SRAS involves the operation of SRAS Equipment capable of providing:

(i) Black Start Services capable of starting without drawing power from the *power system* following *a major supply disruption*, and delivering power to a Delivery Point within a nominated timeframe, sufficient to allow supply to be made available to other *generating units*; or

(ii) Restoration Support Services with the capabilities described in this Guideline.

~~(a) starting without drawing power from the *power system* following *a major supply disruption*, and delivering power to a Delivery Point within a nominated timeframe, sufficient to allow supply to be made available to other *generating units*.~~

(b) AEMO will only procure an SRAS that meets the applicable minimum capability and technical requirements (detailed in sections 3.3 and 3.4~~clause 3.2 and 3.3~~) for the relevant type of service. These requirements apply to all sub-categories of SRAS unless specified~~, e.g. TTHL SRAS~~. In addition to these ~~mandatory~~ requirements~~:, AEMO assesses additional parameters to determine the reliability of each individual SRAS (detailed in clause 3.5):~~

(i) each SRAS Agreement will establish contracted performance levels to be achieved by the SRAS Provider; and

(ii) AEMO uses the assessed individual reliability of each SRAS in determining which SRAS, or combination of SRAS, to procure in order to meet the aggregate reliability requirement for an *electrical sub-network* (as described in section~~clause~~ 3.6), and to assess whether the SRS is being met on an annual basis.

3.2. Capability Requirements - General

An SRAS must be provided using SRAS Equipment that:

(a) meets the applicable technical requirements detailed in section~~clause~~ 3.3~~,~~ (for a Black Start Service) or section 3.4 (for Restoration Support Services), as evidenced by (as applicable) SRAS Tests, modelling and assessment under section 4.5~~5~~, and System Restart Tests as evidenced by testing under ~~clause~~ section 4; and

(b) where the SRAS is being provided under an SRAS Agreement~~*ancillary services contract*~~, meets the individual contracted performance requirements for the individual reliability parameters detailed in section~~clause~~ 3.6.

3.3. Technical Requirements – Black Start Services

SRAS providing a Black Start Service must demonstrate the capability to ~~Equipment must~~ meet the following technical requirements~~, to be demonstrated in accordance with the testing requirements in clause 4~~:

[AEMO note: these requirements to be further reviewed and amended as necessary to allow for SRAS equipment where the main source is not a generating unit.]

(a) in the case of TTHL, automatic disconnection of the *generating unit(s)* within the SRAS Equipment from the *power system* using approved tripping schemes[2];

(b) start without drawing energy from the *power system* or, in the case of TTHL, remain in operation after disconnection from the *power system*;

(c) operate at zero export load for a specified minimum period;

(d) close onto a *de-energised busbar*[3];

(e) supply a specified level of *generation* output to a Delivery Point for a specified minimum period;

(f) control *network voltage* within limits to meet minimum requirements specified by AEMO, when supplying its auxiliary loads with the voltage setpoint to be controllable in the range agreed at the Delivery Point or at a specified location (steady state voltage control);

~~(g) control *power system frequency* within limits to meet minimum requirements specified by AEMO; and~~

(g) provide dynamic voltage control within a range of 90% to 110% of nominal voltage:

(i) when supplying its auxiliary loads;

(ii) during energisation of *network elements*;

(iii) during restoration of load blocks and non-black start generating system auxiliaries;

(iv) within damping and settling time requirements as agreed with AEMO; and

(v) with droop settings and accuracy requirements as agreed with AEMO;

(h) control *power system frequency* within limits to meet minimum requirements specified by AEMO for the following conditions:

(i) when the SRAS Equipment is the only source of controlling *network frequency* and as other sources of *frequency* control become available on a Minimum Restart Path;

(ii) when supplying its auxiliary loads or under minimum loading requirements;

(iii) during energisation of network elements; and

(iv) during restoration of load blocks;

(i) provide dynamic *frequency* control:

(i) when supplying its auxiliary loads or under minimum loading requirements;

(ii) during energisation of *network* elements;

(iii) during restoration of load blocks;

(iv) within a *frequency* range as agreed by AEMO within the *extreme frequency excursion tolerance limits*; and

(v) with droop and deadband settings (when applicable) as agreed with AEMO;

[2] The tripping schemes must be able to be activated by sustained excessive high or low *frequency* excursions, and where required by AEMO; *frequency* rate-of-change and/or loss of *synchronisation* or sustained excessive low *voltage* excursions. Settings are proposed by the SRAS Provider for AEMO's approval and, in principle, should be set so the unit stays online as long as possible and trips to house load just before it would otherwise trip. ~~, with all settings specified or approved by AEMO.~~

[3] The reason for this demonstrated ability is to ensure that there are no interlocks that would prevent closing onto a *de-energised busbar*.

(j) energise sections of *transmission network* sufficient to energise auxiliaries of at least one other *generating system*;

(k) assist in provision of sufficient fault current for correct operation of *protection systems* for the Minimum Restart Path; and

~~(h)~~(l) operate in a stable manner with no adverse effects on *power system security* during *network* switching and *load* restoration.

3.4. Technical Requirements - Restoration Support Services

3.4.1. Requirements for all Restoration Support Services

A Restoration Support Service described in section 3.4.2 must be capable of being provided in accordance with the specified technical requirements for each of the following conditions:

(a) supplying its auxiliary loads or its minimum loading requirements, when generating;

(b) during *energisation* of *network* elements (including transformers, lines); and

(c) during restoration of load blocks,

with appropriate controls and *protection systems* in place to avoid the service adversely affecting *power system security*, provided that:

(d) *power system voltage* is within 90% - 110% of *nominal voltage* at the *connection point* of the SRAS Equipment; and

(e) *power system frequency* is within a range agreed with AEMO within the *extreme frequency excursion tolerance limits*.

3.4.2. Specific Restoration Support Services

In addition to the capabilities described in section 3.4.1, a Restoration Support Service must be capable of providing two or more of the attributes described in the following paragraphs, in the *power system* conditions expected at the location of the SRAS Equipment after a *major supply disruption*, sustained for a minimum duration specified by AEMO:

(a) (Self-start capability) Energise up to its *connection point* with a predetermined level of external supply (via the restored power system) or internal supply (such as batteries/UPS) to auxiliaries to enable independent start-up of the *generating system*.

(b) (Voltage/Reactive power control capability) Provide steady state and dynamic *voltage* or *reactive power* at the *connection point* or a specified agreed location in the *power system* (including within the *generating system*) to within an agreed accuracy level and allows the *voltage* or *reactive power* setpoint to be controllable in the range agreed.

The steady state and dynamic *voltage* or *reactive power* control must have the ability to operate:

(i) within damping and settling time requirements as agreed with AEMO; and

(ii) within 90% to 110% or *nominal voltage* or if providing *reactive power* control, in a manner than helps support *network voltages* and *energisation* during restoration.

Specific levels of *voltage* or *reactive power* control, including droop, are to be agreed with AEMO.

(c) (Frequency control capability) Provide steady state and dynamic *frequency* control to assist maintenance of frequency during restoration to within a specified frequency range (not

exceeding the *extreme frequency excursion tolerance limits*) and with droop/deadband settings as agreed with AEMO.

Frequency control can be provided to increase and/or decrease active power transfer in response:

(i) to an increase or decrease *in power system frequency*; and/or

(ii) to an *active power* setpoint change sent by AEMO.

(d) (Stabilising load) Provide stabilising load to support a Black Start Service or other large *generating systems* on the Minimum Restart Path.

(e) (Fault current capability) Assist in provision sufficient fault current for correct operation of *protection systems* for the Minimum Restart Path.

~~3.4.~~3.5. Arrangements with NSPs and others

Each SRAS Provider must have in place documented arrangements with:

(a) the TNSP on whose *transmission system* the Delivery Point is located; ~~and~~

(b) the owner or operator of any SRAS Third Party Assets; and

~~(b)~~(c) for a Restoration Support Service, the NSP to whose *transmission* or *distribution system* the SRAS Equipment is connected,

sufficient to ensure that the SRAS can be provided and tested in accordance with the requirements of this Guideline and the terms of the SRAS Provider's offer or SRAS Agreement.

~~3.5.~~3.6. SRAS Individual Reliability

~~3.5.1.~~3.6.1. Overview

(a) AEMO uses the following assessment parameters (factors) to determine the individual reliability of an SRAS:

(i) SRAS Equipment Availability (see section ~~clause~~ 3.6.2);

(ii) SRAS Equipment Reliability (incorporating start-up performance where applicable) (see section~~clause~~ 3.6.3); and

(iii) Transmission Component Reliability (see section~~clause~~ 3.6.4).

(b) Information reasonably required by AEMO to assist in its determination of individual reliability is to be provided by:

(i) the SRAS Provider in respect of SRAS Equipment (including SRAS Third Party Assets); and

Note: AEMO would generally require this information in an SRAS offer, under an SRAS Agreement, or under section~~clause~~ 8(g) of this Guideline.

(ii) the relevant TNSP in respect of SRAS Transmission Components, as described in section~~clause~~ 3.6.4.

~~3.5.2.~~3.6.2. SRAS Equipment Availability

(a) SRAS Equipment Availability is the percentage availability of the SRAS Equipment over a period of 12 months, which may be historical or forecast depending on the context for the assessment.

(b) For these purposes, availability represents the percentage of time over the relevant period for which the SRAS Equipment was (or is expected to be) operationally capable of delivering SRAS at the proposed or contracted levels at the Delivery Point, that is, excluding:

(i) periods of maintenance or service outages of, or affecting, any component of the SRAS Equipment;

(ii) periods during which the SRAS Equipment was otherwise not capable of delivering SRAS at those levels, or taken not to be capable due to failure or non-performance of an SRAS Test when due.

(c) Although outages of SRAS Transmission Components will affect the capability to deliver SRAS at the Delivery Point, these are disregarded in the assessment of SRAS Equipment Availability, to avoid double counting with the Transmission Component Reliability factor when determining individual reliability. Those outages are, however, taken into account in Contract Availability.

(d) During a procurement process and as an ongoing requirement under an SRAS Agreement, an SRAS Provider will be required to inform AEMO of its maintenance schedule, and provide historical maintenance records for the SRAS Equipment covering the period to be assessed for availability.

(e) In assessing SRAS Equipment Availability, AEMO may also rely on any other relevant information available to it as the *NEM* market and system operator.

~~3.5.3.~~3.6.3. SRAS Equipment Reliability

(a) SRAS Equipment Reliability represents the probability that all components of the SRAS Equipment required to deliver SRAS will operate without failure. AEMO will determine this as a percentage that combines its evaluation of the following sub-factors:

(i) historical (tested) ~~start-up~~ performance where applicable - see paragraph (b);

(ii) single points of failure - see paragraph (c);

(iii) component age and condition – see paragraph (d);

(iv) fuel storage where applicable – see paragraph (e);

(v) communications link redundancy – see paragraph (f); and

(vi) previous SRAS experience - see paragraph (g).

(b) For Black Start Services and Restoration Support Services with self-start capability, h~~H~~istorical start-up performance is assessed as a pass or fail based on the start-up (or TTHL) performance in the most recent SRAS Test or System Restart Test. When evaluating start up performance for procurement purposes:

(i) the test must have been conducted within the 6 months prior to the time of assessment, unless AEMO allows a longer period in its absolute discretion; and

(ii) AEMO will not generally procure an SRAS that has failed two attempts to start during the test.

(c) Single points of failure is a measure of the reliability of major components of the SRAS Equipment, taking into account their configuration and substitutability, e.g. alternate *generating units*. Generally, the reliability of individual components that are equally important in the delivery of SRAS will be weighted equally in this assessment.

(d) Component age and condition is a measure of the possibility that a component of SRAS equipment may fail having regard to its age, maintenance or upgrade history. This includes *protection systems* and *control systems*. Generally, the reliability of individual components that are equally important in the delivery of SRAS will be weighted equally in this assessment.

(e) For Black Start Services and Restoration Support Services with self-start capability, fuel or energy~~Fuel~~ storage is an assessment of redundancy within supply arrangements, for example the availability of alternate sources of fuel to start and operate the SRAS Equipment, where required~~as applicable~~ for the SRAS to be provided.

(f) Communications link redundancy is a measure of the reliability of the communications infrastructure used by the SRAS Provider or any operator of SRAS Third Party Assets, to start up and operate the SRAS Equipment after receiving an instruction to do so.

(g) Previous SRAS performance is a measure of proven experience in providing SRAS capability under any previous SRAS Agreement.

~~3.5.4.~~3.6.4. Transmission Component Reliability

(a) Transmission Component Reliability is a percentage determined by AEMO based on the relevant TNSP's assessment of the reliability of the SRAS Transmission Components.

(b) For these purposes, a TNSP must give AEMO, on request, the TNSP's engineering assessment of the reliability of nominated SRAS Transmission Components taking into account their:

(i) historical and forecast availability;

(ii) technical characteristics;

(iii) age and condition;

(iv) redundancy.

(c) The TNSP's reliability assessment should include any recommended sensitivity margins the TNSP considers reasonable, having regard to the nature of the components and expected operating conditions.

(d) The TNSP must promptly respond to AEMO's reasonable requests for further information or clarification of information provided under paragraph (b) or (c).

(e) If requested by AEMO and if reasonably practicable to do so without material adverse impact on *power system security* or the operation of *connected plant* other than SRAS Equipment, a TNSP must use reasonable endeavours to plan and conduct a test of SRAS Transmission Components to confirm the reliability assessment, in conjunction with an SRAS Test.

~~3.5.5.~~3.6.5. Calculation of individual reliability

The individual reliability of an SRAS is determined by multiplying the assessed percentages of SRAS Equipment Availability, SRAS Equipment Reliability and Transmission Component Reliability.

4. ~~SRAS~~ TESTING

Sections 4.1~~4.1~~ to 4.4 set out requirements in relation to the conduct of SRAS Tests and associated requirements and reporting. Section 4.5 sets out guidance in relation to System Restart Tests under NER clause 4.3.6, including AEMO's considerations when determining whether to conduct a

System Restart Test, and guidance on the measurements and data to be reported to AEMO about the operation of *facilities* involved in a System Restart Test.

4.1. SRAS Test requirements

(a) An SRAS Test must reflect as closely as possible how the SRAS will be used - initiated, started, connected and operated - in a real *major supply disruption*), recognising that real event conditions cannot be exactly replicated in a test.[4] Accordingly:

(i) the SRAS Provider and any operator of SRAS Third Party Assets;

(ii) the NSP to whose *network* the SRAS Equipment is connected; and

(iii) if different, the TNSP on whose *network* the Delivery Point is located,

must assist AEMO, in a collaborative process, to prepare for and conduct an SRAS Test, while ensuring mutual awareness of the different requirements for a real event.

(b) A test for the purpose of demonstrating:

(i) Black Start Service capability; or

(ii) the self-start capability of a Restoration Support Service, if applicable,

~~A test for the purpose of demonstrating SRAS capability during a procurement process or under an SRAS Agreement (SRAS Test)~~ must demonstrate the parameters listed in Appendix A, subject to any variations specified in an applicable SRAS Agreement.

~~(a)~~(c) Variations may be agreed, for example, to accommodate testing requirements specific to a particular component of SRAS Equipment or SRAS Third Party Assets, or steps required under section~~clause~~ 4.2(b).

~~(b)~~(d) An SRAS Test must be conducted in accordance with the Test Procedure most recently submitted by the SRAS Provider and accepted by AEMO under section~~clause~~ 4.2 prior to the date of the SRAS Test, unless AEMO otherwise agrees.

4.2. SRAS Test Procedures

(a) An SRAS Provider's Test Procedure must:

(i) itemise the steps required to implement the SRAS Test;

(ii) specify how the requirements and evidence set out in Appendix A will be demonstrated and recorded;

(iii) replicate to the extent possible ~~subject to paragraph (b), exactly~~ replicate the process that would occur if AEMO required the relevant SRAS to be provided following a *major supply disruption*;

(iv) provide annotated operating diagrams showing the SRAS Equipment and how the SRAS Equipment is isolated and islanded from local supplies and network connections; and

(v) address any other matters the SRAS Provider considers relevant.

[4] Generally for an SRAS test the grid is live and customer load cannot be interrupted. This limits the extent to which a test can reflect a real event. However, to the extent possible the test should be designed to best replicate how the SRAS is expected to be used in a real event.

(b) As ~~If~~ a Test Procedure will ~~does~~ not exactly replicate the process that would occur if AEMO required the relevant SRAS to be provided following a *major supply disruption*, the Test Procedure or accompanying information must:

~~(i) identify the differences;~~

~~(ii) explain why the Test Procedure cannot reasonably replicate that process;~~

~~(iii)~~(i) 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)~~(ii) include evidence demonstrating that those steps can be successfully performed with no adverse impact on the delivery of SRAS.

(c) The SRAS Provider must submit its Test Procedure (including any updated Test Procedure) electronically to AEMO together with the written endorsement of:

(i) the owner or operator of any SRAS Third Party Assets within the SRAS Equipment, in respect of the testing of the relevant SRAS Third Party Assets; and

(ii) the TNSP on whose *transmission system* the Delivery Point is located, in respect of the TNSP's facilitation of, or participation in, an SRAS Test,

including in respect of the matters specified in ~~and, where~~ paragraph (b) ~~applies~~, as applicable ~~the endorsement must extend to any additional or different steps to be taken by the relevant party following a *major supply* disruption~~.

(d) A Test Procedure is not valid unless AEMO has accepted it. AEMO's review is limited to confirming that the Test Procedure addresses the requirements of paragraphs (a), (b) and (c).

(e) AEMO may reject a Test Procedure if it is not satisfied that the Test Procedure addresses the requirements of paragraphs (a), (b) or (c).

(f) AEMO is taken to have accepted a Test Procedure unless it has notified the SRAS Provider of its rejection:

(i) if submitted with an SRAS offer, at the time of accepting that offer; or

(ii) if submitted at any other time, by the end of the 5th *business day* after submission.

4.3. SRAS Test ~~Testing~~ frequency and timing

4.3.1. Testing for procurement

(a) AEMO will not enter into an SRAS Agreement unless satisfied that the capability to provide the SRAS has been successfully demonstrated by an SRAS Test within the 6 months prior to the intended commencement date of the agreement, evidenced by a test report in accordance with section~~clause~~ 4.4, unless exceptional circumstances apply.

(b) The existence of exceptional circumstances will be determined by AEMO in its absolute discretion. By way of example and without limiting AEMO's discretion, such circumstances could arise where:

(i) AEMO considers that the acquisition of the SRAS would best meet the *SRAS Procurement Objective* for the relevant *electrical sub-network*;

(ii) an SRAS Test cannot reasonably be conducted before the SRAS Agreement is entered into; and

(iii) AEMO believes on reasonable grounds that the SRAS Equipment will be capable of providing the SRAS in accordance with the terms of the SRAS Agreement.

4.3.2. Testing of contracted SRAS

(a) An SRAS Agreement will specify the number and frequency of SRAS Tests to be conducted.

(b) An SRAS Test will generally be required by AEMO:

(i) within 20 *business days* after a period of maintenance involving intrusive work on SRAS Equipment or SRAS Transmission Components, in particular electrical, control, and energy or fuel storage systems; ~~causing any major component of the SRAS Equipment or SRAS Transmission Components to be out of service for 7 days or more;~~ and

(ii) on ~~at~~ one additional occasion ~~date and time~~ per year, either:

(A) in conjunction with a System Restart Test, or

~~(A)~~(B) ~~to be~~ at a date and time nominated by AEMO on no less than 5 *business days*' notice to the SRAS Provider, subject to paragraph (c).

(c) In scheduling an SRAS Test under paragraph (b)(ii)(B), AEMO seeks to balance the need for a reasonable level of assurance that the SRAS is 'always ready' against the need to minimise the *power system* and *market* impacts of testing for *Registered Participants*. With that objective, AEMO will:

(i) liaise with the relevant TNSP ~~before the start of~~before and during each financial year to determine suitable periods~~to determine four or more one-week periods~~ in that year during which an SRAS Test would not be expected to disrupt the *supply* of electricity or threaten *power system security*;

(ii) consider any reasonable requests of the SRAS Provider and the TNSP in relation to scheduling;

(iii) use best endeavours to schedule the test to minimise the departure from the *commitment* and *dispatch* of the relevant *generating units* that could reasonably be expected at that time; and

(iv) provide a formal notice of the proposed test date and time to the TNSP not less than 15 *business days* in advance, and for those purposes AEMO and the TNSP are entitled to assume that the most recently accepted Test Procedure will apply.

(d) After nomination of the test date and time by AEMO, the TNSP must make any arrangements necessary to facilitate the SRAS Test with any *Registered Participants* (other than the SRAS Provider) who need to participate in the test, on a confidential basis.

(e) The TNSP, and any other *Registered Participant* required to be involved in an SRAS Test, must not disclose details of the timing of an SRAS Test under paragraph (b)(i)(i)(ii) to the SRAS Provider before AEMO has done so.

(f) Where SRAS Equipment includes multiple alternative *generating units*, any one of which may be used to provide the SRAS, AEMO will specify the *generating unit* to be included in each SRAS Test so that, as far as practicable:

(i) tests after maintenance will include any units that were out of service during that maintenance; and

(ii) otherwise, successive SRAS Tests should rotate through all alternative *generating units*.

4.3.3. General provisions

(a) AEMO may witness any SRAS Test.

(b) SRAS Tests can be performed in conjunction with any planned outages on the *transmission network* (that may require the SRAS Equipment to be offline) if it is safe to do so without adversely impacting *power system security*.

(c) SRAS Agreements will permit AEMO to request an SRAS Test at any other time if AEMO considers the SRAS may not be capable of being provided in accordance with contract requirements.

4.4. SRAS Test Report

(a) An SRAS Provider must submit a test report to AEMO after each SRAS Test.

(b) A relevant NSP must, on request, provide data, observations and assistance to the SRAS Provider for the purpose of preparing the test report.

~~(b)~~(c) All test reports must:

(i) document the steps of the SRAS Test consistent with the approved ~~SRAS~~ Test P~~p~~rocedure;

(ii) document the results, including all relevant evidence specified in Appendix A; ~~and~~

(iii) if applicable, indicate how and why the approved ~~SRAS~~ Test ~~p~~Procedure was not followed in any respect; and

~~(iii)~~(iv) identify any unexpected outcomes identified by the SRAS Provider or a relevant NSP, that may require changes to either the SRAS Test Procedure or the procedures for an actual *major supply disruption*.

~~(c)~~(d) In addition, for an SRAS Test conducted under an SRAS Agreement, the test report must:

(i) be provided within 15 *business days*;

(ii) state whether the contracted levels of performance and minimum technical requirements were achieved; and

(iii) state reasons for any failure to establish any required item, the remedial actions taken (or to be taken) to resolve those matters, the results of any remedial actions, and the expected timeframe in which incomplete remedial actions will be completed.

4.5. System Restart Tests

4.5.1. When required

(a) AEMO will generally consider the need for a System Restart Test to confirm the validity of part of a *regional system restart plan* when one or more of the following circumstances exist:

(i) a Minimum Restart Path has not previously been tested, or not tested for an extended period (at least three years);

(ii) significant changes to *generation* or *network* conditions in the Minimum Restart Path within an *electrical sub-network* have occurred since the date of any previous test, including:

(A) upgrade of *control systems* (e.g. automatic *voltage* regulation and governors);

(B) upgrade of *protection systems* that could activate during system restart;

(C) connection or commissioning of new or expanded *generation*, load, or *network elements*;

(D) mothballing, decommissioning or de-rating of *plant*;

(iii) procurement of new or different SRAS not previously tested on the Minimum Restart Path;

(iv) a previous System Restart Test was unsuccessful, or a re-test is necessary to confirm the effectiveness of measures implemented to address previously identified issues;

(v) significant changes to NSP or *Generator* switching sequences covered under SRAS Agreements, *local black system procedures* or *energy support arrangements* that impact on the *system restart plan*;

(vi) significant changes to the *system restart plan* since any previous test; or

(vii) on reasonable request by a TNSP.

(b) The existence of any of the conditions listed in paragraph (a) does not require the conduct of a System Restart Test. AEMO will consider all relevant circumstances to determine whether testing is reasonable and prudent. In particular, a System Restart Test will only be initiated following modelling and assessment of any relevant changes indicating their expected impact on the *system restart plan* and *power system security*.

(c) A System Restart Test will be planned and conducted in accordance with NER clause 4.3.6. All Restart Test Participants whose *plant* is impacted by a proposed System Restart Test are expected to understand and comply with their obligations under that clause.

4.5.2. System Restart Test Procedures

(a) Restart Test Participants (other than SRAS Providers with current approved SRAS Test Procedures in place) must prepare test procedures in respect of their participating *facilities* and submit them to AEMO in accordance with NER clause 4.3.6(e) and 4.3.6(k), with a copy to the relevant *Transmission Network Service Provider*.

(b) Test procedures for a System Restart Test should (as applicable):

(i) identify the items of *plant* included in the System Restart Test;

(ii) provide annotated operating diagrams showing how equipment is isolated and islanded from local supplies and *network connections*;

(iii) itemise the steps required for the Restart Test Participant to prepare for energisation or start-up and operate the relevant *plant* in System Restart Test conditions;

(iv) specify how the evidence set out in Appendix B will be recorded; and

(v) address any other matters the Restart Test Participant considers relevant.

4.5.3. Reporting of measurements and data

For the purposes of NER clause 4.3.6(s)(1),[5] Restart Test Participants must provide to AEMO data, measurements, results and analysis in respect of their respective *facilities* that:

(a) document the steps of System Restart Test consistent with the submitted *test program* and procedures applicable to the *facilities*;

[5] Within one month of a System Restart Test

(b) document the test results, including all relevant evidence, measurements and data specified in Appendix B; and

(c) if applicable, indicate how and why the applicable *test program* or procedures were not followed in any respect.

5. SRAS MODELLING AND ASSESSMENT

5.1. Overview

(a) ~~This clause 5 describes the modelling and assessment process AEMO undertakes todetermine which SRAS AEMO should acquire in each *electrical sub-network* in order to meet the SRAS Procurement Objective.~~ This section 4.5~~5~~ describes the modelling and assessment process AEMO undertakes to:

(i) confirm or validate technical capabilities of SRAS that cannot be readily established through SRAS Tests;

(ii) determine which SRAS AEMO should acquire in each in order to meet the SRAS Procurement Objective (including the need for Restoration Support Services); and

(iii) determine feasibility of System Restart Testing.

The *power system* modelling and simulation studies performed for these purposes are an integral and interdependent part of the studies performed to develop and validate each *regional system restart plan*.

~~(a)~~(b) In accordance with the SRS, AEMO must procure sufficient SRAS for each *electrical sub-network* with a specified probability of restoring a specified minimum level of *supply* (i.e. *generation* and *transmission* capacity) within a specified target timeframe. The probability is referred to as the aggregate reliability requirement. The SRS levels, timeframes and aggregate reliability requirements for each *electrical sub-network* are reproduced in Table 1 in section~~clause~~ 2.4.

~~(b)~~(c) The remainder of this section~~clause~~ provides guidance on:

(i) the information AEMO needs for its modelling and assessment;

(ii) how AEMO will model the expected contribution of an SRAS to energising the auxiliaries of other *power stations* and rebuilding the *power system* in an *electrical sub-network*; and

(iii) how AEMO assesses, from the offers available, which SRAS or combinations of SRAS are expected to meet the SRS requirements.~~;~~

~~(iv) how AEMO selects, from the available options to meet the SRS, the SRAS it will acquire for each *electrical sub-network*.~~

~~5.1.~~5.2. Information required

(a) For the purposes of AEMO's SRAS modelling and assessment, SRAS Providers must give AEMO:

(i) the applicable SRAS Test evidence detailed in Appendix A;

(ii) for Restoration Support Services, the results of applicable commissioning tests if not previously provided to AEMO, and the evidence detailed in Appendix B for any previous System Restart Test;

(iii) Modelling Data in the form required by the *Power System Model Guidelines*, *Power System Design Data Sheets* and *Power System Setting Data Sheets*, including, if necessary, alternative data following the process set out in those guidelines; and

~~(ii) the Generator Modelling Data in the form listed in the spreadsheet published from time to time on AEMO's website; and~~

~~(iii)~~(iv) confirmation that the performance of proposed SRAS Equipment is consistent with the current LBSP, or an explanation of any differences.

~~(b) If the SRAS Provider is unable to give AEMO all Generator Modelling Data relevant to its offered SRAS, it must give AEMO:~~

~~( ) a list of the missing data and the reasons why it could not be provided; and~~

~~( ) any alternative data or assumptions the SRAS Provider considers could be substituted for the missing data, and their source.~~

~~(e) AEMO will endeavour to substitute the missing data, either as proposed by the SRAS Provider or using data or assumptions that AEMO considers to be more reliable. However, AEMO will take into account the reliability of the substituted data in assessing the results of the *power system* studies conducted under clause 5.4.~~

(b) For the purposes of conducting *power system* studies and assessing aggregate reliability as contemplated in this section~~clause~~ 4.5~~5~~, AEMO may request from an NSP, and the NSP must give AEMO on request, any information or modelling data (consistent with the *Power System Model Guidelines*) AEMO reasonably requires to determine the ability of any proposed SRAS to: ~~energise *network* paths downstream of a Delivery Point for a proposed SRAS.~~

(i) energise *network* paths downstream of a Delivery Point for a proposed Black Start Service; or

~~(i)~~(ii) for a proposed Restoration Support Service, otherwise assist the restoration of a Minimum Restart Path, including pick-up of Stabilising Load Blocks.

~~(f)~~(c) AEMO will also consult with *Jurisdictional System Security Coordinators* in relation to any specific requirements relating to the restoration of Stabilising Load Blocks or other jurisdictional system security issues to be taken into account in AEMO's modelling and assessment.

~~5.2.~~5.3. Initial Qualification

Based on the information provided by SRAS Providers, NSPs, and any other relevant information held by AEMO under the NER, AEMO will identify all the proposed services that demonstrate compliance with the SRAS capability requirements in section~~clause~~ 3.2 to AEMO's reasonable satisfaction. Only those services will be further assessed in accordance with the remaining provisions of this section~~clause~~ 4.5~~5~~.

~~5.3.~~5.4. Power System Studies

~~5.3.1.~~5.4.1. Objectives

(a) AEMO will conduct *power system* studies in relation to combinations of ~~the~~ proposed SRAS to:

(i) verify the capacity of the proposed SRAS to start and supply auxiliaries of other *power stations*, assist the stable *energisation* of *generation* and *transmission* and pick-up of Stabilising Load Blocks, facilitating a rebuild of the *power system*;

(ii) determine which other *power stations* can be *energised* subsequent to the SRAS rebuilding sections of the *power system*;

(iii) determine the preferred paths to allow *energisation* of the required sections of the *power system*;

(iv) confirm ability to restore Stabilising Load Blocks;

(v) confirm each electrical sub-network is capable of being maintained in a *satisfactory operating state* to the extent practicable during the restoration process, and in a *secure operating state* from a stage in the restoration when it is practicable to do so;

(vi) determine potential changes to operating modes and *control system* settings of the SRAS Equipment; and

(vii) determine necessary changes to the settings of protective relays for the SRAS Equipment and *transmission network* in the *energisation* path.

(b) AEMO will not generally conduct *power system* studies in respect of a proposed SRAS if:

(i) AEMO has previously conducted studies for that proposed SRAS with identical restoration paths and with the same combination of other SRAS substantially as contemplated by section~~clause~~ 5.4.2; and

(ii) AEMO considers there have been no material changes to the SRAS Equipment or the relevant parts of the *power system* since those last studies.

~~5.3.2.~~5.4.2. Studies required

The following studies are envisaged:

(a) Steady-state studies to:

(i) confirm appropriateness of initial operating point including required *transformer* tap settings;

(ii) establish correct initial conditions for dynamic analysis; and

(iii) confirm *voltage* variations are maintained within the operational limits for all steps of the *system restart plan* applicable to the relevant *electrical sub-network*.

(b) Transient *load-generation* balance studies of:

(i) adequacy of speed governors and/or frequency control systems, and appropriateness of control modes and settings;

(ii) adequacy of *voltage* and *reactive power control system*;

(iii) *power station* auxiliary motor starting; and

(iv) cold load pickup (*loads* other than those associated with *power station* auxiliaries).

(c) Transient over*voltage* studies of:

(i) component *energisation*, e.g. *transmission line, transformer*, static and dynamic reactive power support devices;

(ii) harmonic resonance; and

(iii) surge arrester duty.

(d) *Network* fault studies to:

(i) verify integrity of the restoration path for *credible contingency events*;

(ii) verify appropriateness of protective relays settings during *contingency events*; and

(iii) verify appropriateness of the settings applied to excitation system control and associated limiters.

(e) Where measured test data exists from a SRAS Test or a System Restart Test, verify adequacy of the modelling by comparing measured and simulated responses that replicate the physical test.

~~5.3.3.~~5.4.3. Performance assessment requirements

(a) The *power system* studies will be based on modelling of the SRAS Equipment, its *control systems* and *protection systems*, and relevant *network elements* including *transmission lines, loads, protection systems*, dynamic and static *reactive support* plant and *transformers*, under *black system* conditions.

(b) In conducting the *power system* studies, AEMO assumes that all *network elements* will be capable of operating within their technical limits, subject to any operating restrictions applicable in a *black system* condition and identified by AEMO's *power system* modelling.

Note: The failure of a relevant major *transmission element* is taken into account in AEMO's assessment of individual and aggregate reliability of SRAS procured for an *electrical sub-network*.

(c) AEMO's assessment will be subject to general principles for maintaining *power system security* that require the *power system* to be operated in a *satisfactory operating state* to the extent practicable during the restoration process, and in a *secure operating state* from a stage in the restoration when it is practicable to do so. However, the criteria for the permissible *frequency* range will be in accordance with the *frequency operating standards* for island systems.

(d) The supply *voltage* should remain between ± 10% of normal *voltage* during the restoration process. However, the *voltage* must at all times remain within any applicable limits set by the TNSP.

(e) A *credible contingency event* will be assumed in system restoration studies. For all *contingency events* it is expected that all equipment is secure against damage.

(f) *Registered Participants* are expected to adhere to their registered *performance standards* for all relevant *plant*~~*Generating units* are expected to adhere to their registered *performance standards*~~. For the purposes of SRAS assessment only, AEMO may assume~~accept~~ limited non-compliance with the *performance standards* to allow for *black system* conditions and to ensure maximum utilisation of the technical capability of the *generating unit* during *power system* restoration.

~~5.4.~~5.5. Aggregate Reliability

~~5.4.1.~~5.5.1. Overview

(a) The aggregate reliability of SRAS for each electrical sub-network specified in the SRS represents the probability that generation and transmission will be restored to the MW specified level in the specified timeframe for that electrical sub-network (see Table 1).

(b) AEMO determines the aggregate reliability of SRAS services available for each electrical sub-network considering:

(i) the individual reliability of each selected SRAS (see section~~clause~~ 3.6);

(ii) electrical, geographical and fuel source diversity between the selected SRAS (see section~~clause~~ 5.5.2); and

(iii) strategic location of SRAS (see section~~clause~~ 5.5.3).

(c) AEMO's assessment of each of the above factors is described in the following sub-sections~~clauses~~.

~~5.4.2.~~5.5.2. Diversity

In accordance with the guidelines in the SRS for assessing diversity of services, AEMO considers the following factors when determining aggregate reliability for the *electrical sub-network*, accounting for *transmission system* reliability:

(a) Electrical: any single points of failure in the *transmission system* affecting all the procured SRAS in the *electrical sub-network* such as:

(i) a single transmission line from the Delivery Point to the immediate point in the transmission system; or

(ii) a single transmission corridor that connects all the procured SRAS with the remainder of the electrical sub-network.

(b) Geographical: geographical proximity of two or more SRAS sources, such that a natural disaster or other foreseeable location-specific event affecting one of them is likely to also affect the other.

(c) Fuel Source: the risk of failure or shortage of energy or fuel supply from the same cause impacting two or more SRAS services within an electrical sub-network.

~~5.4.3.~~5.5.3. Additional principles for electrical diversity

In assessing single points of failure in a *transmission network*, AEMO will apply the following principles and assumptions:

(a) a single point of failure within the *transmission network* is generally considered to exist where a *credible contingency event* can impact the ability of more than one SRAS to energise the auxiliaries of other *power stations*;

(b) the failure of any single major *transmission element* is considered a *credible contingency event*, irrespective of the cause;

(c) the failure of a *transmission* corridor that is considered generally susceptible to interruption due to a single event, e.g. *transmission lines* vulnerable to lightning, will be treated as a *credible contingency event*; and

(d) except in relation to vulnerable lines, *contingency events* that are normally non-credible (including multiple *credible contingency events*), will not be taken into account in determining potential single points of failure.

~~5.4.4.~~5.5.4. Diversity objective

(a) In its selection of SRAS for an *electrical sub-network*, AEMO seeks diversity in each of the factors in the SRS, where this can reasonably be achieved while meeting the other requirements of the SRS.

(b) Where diversity in all three factors cannot reasonably be achieved, AEMO will seek diversity in at least two factors if possible.

(c) The SRS aggregate reliability requirement for an *electrical sub-network* may not be met if diversity can only be achieved in one factor.

~~5.4.5.~~5.5.5. Strategic Location of SRAS

An SRAS will be assessed as having a strategic location if it can relatively quickly establish, or support establishment of, a path to the *transmission network* and other *generating units*, or facilitate pick-up of Stabilising Load Blocks. Relevant considerations include, without limitation:

(a) there is a relatively short physical distance between the SRAS Equipment and other generation centres within an electrical sub-network that will assist in meeting the overall SRS requirements; and

(b) there are few potential constraints or technical limitations in the *transmission network* between the SRAS Equipment and areas of the *transmission network* that need to be re-energised most quickly to maximise the restoration of *generation* and *transmission* in an *electrical sub-network*.

6. SELECTION OF SRAS TO MEET SRAS PROCUREMENT OBJECTIVE

(a) Based on the modelling and assessment process described in section 5, AEMO will identify each service or combination of services that meets the SRS requirements for each *electrical sub-network*.

(b) From the identified list and using the offers submitted by SRAS Providers, AEMO will select and seek to procure the service or combination of services that meets those SRS requirements at the lowest cost.

(c) AEMO interprets long-term cost as:

(i) capturing short-term costs, thereby allowing AEMO to balance potentially higher up-front costs with long-term efficiencies; and

(ii) entering into long-term contracts, or procuring specific combinations of SRAS, if AEMO reasonably expects this will result in the lowest long-term costs for consumers.[6]

(d) By way of example and without limitation, the following may be relevant considerations for AEMO in determining the portfolio of SRAS Agreements likely to result in the lowest long-term cost in respect of an *electrical sub-network*:

(i) the impact of forecast *power system* development on the effectiveness of current and potential Minimum Restart Paths, including whether and when Restoration Support Services may be needed to supplement Black Start Services;

(ii) actual and forecast availability and reliability of *facilities* with *black start capability;*

(iii) the relative value for money of alternative SRAS;

(iv) the ability to share risk through callable options, renegotiation triggers, etc. ; and

(v) the potential to facilitate or accelerate the investment, development, maintenance and availability of capabilities required to achieve the SRS in expected future *power system* conditions, and the cost and benefit of doing so.

~~(c)~~(e) If, using reasonable endeavours, AEMO is unable to acquire sufficient services to meet the SRS for an *electrical sub-network*~~requirements, or to procure the lowest cost option~~, AEMO will acquire the service or combination of services that meets the *SRAS Procurement Objective* as closely as possible.

7. PROCUREMENT PROCESSES

7.1. Procurement options

(a) AEMO may procure SRAS for an *electrical sub-network* where AEMO considers the applicable SRS is not being met, or is unlikely to be met from a given date, for example due to:

(i) expiry or termination of an SRAS Agreement; or

(ii) material and sustained changes in the performance or reliability of SRAS Equipment, or in the *transmission system*; or

(iii) expected unavailability of an existing SRAS for an extended period.

(b) AEMO may procure SRAS using one or a combination of two processes:

(i) open competitive tender; or

(ii) direct request for offer.

(c) If AEMO is procuring SRAS for multiple *electrical sub-networks* in the same timeframe, different procurement processes can apply in different *electrical sub-networks*.

(d) Section~~Clause~~ 7.2 describes the matters AEMO will consider in determining which procurement process to use, and sections~~clauses~~ 7.3 and 7.4 describe the minimum requirements of each type of process.

7.2. Considerations for determining process

(a) For the purposes of this section~~clause~~ 7, 'competing SRAS Providers' are SRAS Providers that are not related bodies corporate within the meaning of the *Corporations Act 2001* (Cth) or, in relation to an SRAS Provider that is not a body corporate within the meaning of that Act, does not have an equivalent association with another SRAS Provider.

(b) AEMO will procure SRAS for an *electrical sub-network* using an appropriate competitive tender process, if AEMO considers (subject to paragraph (c)):

(i) the available SRAS from competing SRAS Providers is likely to exceed the level required to meet the SRS for that *electrical sub-network*; or

(ii) having regard to the need for the procurement process, any specific requirements necessary to meet the SRS could be provided by more than one competing SRAS Provider.

(c) AEMO will directly request one or more SRAS Providers to make an offer to provide SRAS for an *electrical sub-network*, if AEMO considers:

(i) neither of the conditions in paragraph (b) applies;

(ii) there is insufficient time to conduct a competitive tender for a replacement SRAS to cover an actual or anticipated temporary shortfall; or

(iii) the SRS cannot be met unless AEMO acquires SRAS from specified SRAS Equipment owned by that SRAS Provider(s).

7.3. Open competitive tender minimum requirements

(a) A competitive tender must be open to any prospective SRAS Provider able to meet the technical and reliability requirements in section~~clause~~ 2.4 of this Guideline for one or more relevant *electrical sub-networks*.

(b) AEMO must publish an invitation to tender (ITT) for SRAS on its website.

(c) In any ITT, AEMO must specify the tender process steps and timelines, and the information to be submitted in or with a tender offer, including:

(i) forms for the submission of technical information or prices;

(ii) the period within which an SRAS Test must have been conducted prior to the date of the offer, or may be conducted after the offer if applicable;

(iii) the proposed duration of the SRAS Agreement (see section~~clause~~ 7.5);

(iv) any information that may be required from a *Network Service Provider* or other third party;

(v) the minimum validity period of the offer;

(vi) any applicable exclusions or modifications to the ~~Generator~~ Modelling Data that may apply to particular types of SRAS; and

(vii) any criteria or principles that AEMO proposes to apply to the evaluation of offers, in addition to those specified in this Guideline.

(d) As soon as reasonably practicable after publication of an ITT, AEMO must notify those potential SRAS Providers that, to the best of AEMO's knowledge, would be capable of providing SRAS for a relevant *electrical sub-network* in accordance with the requirements of this Guideline.

7.4. Direct request for offer process

(a) If AEMO decides to procure SRAS for an *electrical sub-network* by directly requesting offers, AEMO must issue a request to all potential SRAS Providers that, to the best of AEMO's knowledge, would:

(i) be capable of providing SRAS for that *electrical sub-network* in accordance with the requirements of this Guideline; and

(ii) assist in meeting the SRS given the need to be met by the procurement process.

(b) The request must specify the offer process and timelines, and the information to be submitted in or with an offer, including the matters in paragraphs (i) to (vii) of section ~~clause~~ 7.3(c).

7.5. Form of SRAS Agreement

(a) AEMO will maintain a form of SRAS Agreement on its website.[7]

(b) At the time of making an offer to AEMO for SRAS under any procurement process, an SRAS Provider must notify AEMO of any changes it proposes to the terms of the published agreement.

(c) AEMO is entitled to propose and negotiate any changes to the form of agreement that it considers appropriate in relation to an offer or tender for SRAS.

7.6. Disputes

A dispute concerning any aspect of a tender or negotiation for the provision of SRAS (other than price) must be dealt with in accordance with NER rule 8.2.

8. UNSOLICITED SRAS OFFERS

(a) In this section~~clause~~ 8, the term *Registered Participant~~Generator~~* is taken to include a person who intends to become ~~registered as~~ a *Registered Participant~~Generator~~*.

(b) A *Registered Participant~~Generator~~* may at any time submit to AEMO an expression of interest or offer to provide SRAS for one or more *electrical sub-networks*.

(c) AEMO may develop and publish, on the SRAS page of its website, a form for the submission of expressions of interest or offers under this clause.

(d) If no form is published, a *Registered Participant~~Generator~~* must identify the proposed SRAS Equipment and include in its expression of interest or offer sufficient information to allow AEMO to model the performance of the proposed SRAS through *power system* studies and assess its capability to meet the applicable requirements in this Guideline~~Appendix A~~.

(e) An expression of interest or offer is valid for the period specified by the *Registered Participant~~Generator~~* in its submission. If no period is specified, AEMO must assume it remains valid for two years.

(f) Information submitted under this ~~clause~~ section is *confidential information*.

(g) AEMO:

(i) may at any time request further information from a *Registered Participant~~Generator~~* to assess the capability of an SRAS proposed under this clause;

(ii) may, but is not obliged to, accept any offer to provide SRAS, subject to the requirements of section~~clause~~ 7; and

(iii) must, before commencing a procurement process under section~~clause~~ 7, notify any *Registered Participants~~Generators~~* who have submitted expressions of interest or offers for proposed SRAS that AEMO considers technically capable of meeting the requirement for which SRAS is to be procured.

[7] Current location: https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/ancillary-services/system-restart-ancillary-services-guideline~~http://aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Ancillary-services/System-restart-ancillary-services-guidelines~~

9. BOUNDARIES OF ELECTRICAL SUB-NETWORKS

The boundaries of *electrical sub-networks* in accordance with the requirements of SRS effective until 1 July 2018 are described in Table 2 and shown geographically on the maps in Appendix ~~B~~C.

Table 2 Boundaries of electrical sub-networks

Electrical Sub-Network	Cut-Set across transmission corridors connecting Electrical Sub-Networks	Approximate Generation and Load
Queensland North Calvale – Halys 275 kV lines (8810 & 8811) South Pine – Palmwoods 275 kV line (808) South Pine – Woolooga 275 kV line (807) South Pine – Palmwoods 110 kV lines (745 & 746) Refer to Appendix C~~B~~.1	One 275 kV double circuit in one transmission corridor, and two single 275kV circuits in another transmission corridor connecting Qld North and Qld South. One weak, low capacity 110 kV parallel system. Loss of western 275 kV corridor with high southerly transfers can result in the loss of the 275 kV eastern corridor. The major generation centre in QLD North electrical sub-network is in Central Qld.	Generation: 6,000 MW Load: 3,150 MW
Queensland South (*as above for the cut set with QLD North*) QNI Bulli Creek –Dumaresq 330 kV lines (8L & 8M) Directlink Terranora – Mudgeeraba 132 kV DC lines (DC1, DC2 & DC3) Refer to Appendix C~~B~~.1	One 330 kV double circuit transmission corridor A DC Directlink[8] between Qld South and NSW (i.e.: Terranora – Mudgeeraba). These transmission corridors link Qld South and NSW. The major generation centre in Qld South electrical sub-network is in South West Qld.	Generation:6,715 MW Load: 6,500 MW
New South Wales (*as above for the cut set with QLD South*) Murray–Dederang 330 kV lines (67, 68) Wodonga–Jindera 330 kV line (060) Buronga–Redcliffs 220 kV line (0X1) Refer to Appendix ~~B~~C.2	One 330 kV double circuit transmission corridor, One 330 kV single circuit transmission corridor One weak 220 kV single circuit transmission corridor connection between Redcliffs and Buronga. The major generation centres in NSW electrical sub-network are in Hunter Valley and Snowy Mountains area.	Generation: 16,000 MW Load: 14,050 MW
Victoria (*as above for the cut set with NSW*) Heywood – South-East 275 kV lines (1 & 2) Murraylink Basslink Refer to Appendix ~~B~~C.3	One 275 kV double circuit transmission corridor A DC Murraylink[8] between Vic and SA. A DC Basslink[8] between Vic and Tas The major generation centre in Vic electrical sub-network is in Latrobe Valley.	Generation: 12,000 MW Load: 9,775 MW

[8] These links (direct current) requires stable Alternative Current sources at both ends of the convertor stations for power transfer.

South Australia (*as above for the cut set with Vic*) Refer to Appendix ~~B~~C.4	One 275 kV double circuit transmission corridor A DC Murraylink[8] between Vic and SA. The major generation centre in SA electrical sub-network is in Adelaide.	Generation: 4,575 MW Load: 3,050 MW
Tasmania Basslink Refer to Appendix ~~B~~C.5	A DC Basslink[8] between Vic and Tas. Electrical distance is not an applicable factor for a DC link. There are multiple generation centres in Tas electrical sub-network.	Generation: 2,860 MW Load: 1,750 MW

APPENDIX A. SRAS TEST REQUIREMENTS

A.1 Black Start Services and self-start capability for Restoration Support Services

Item	Assessment	Capability	Test	Evidence Required
1	Isolate SRAS test unit	SRAS to operate as an electrical island for the duration of test (excluding item 7).	SRAS to be electrically isolated from all sources of supply not associated with the unit	Documentation showing all the isolation points at zero volts by measurement. This includes alternating current supplies to battery chargers etc.
2a	Start (non-TTHL)	Start without external supply.	Start using same procedure or process as would be used for a system restart.	Provide data showing output trends of SRAS unit. ~~(~~As a minimum, continuous recordings of ~~generator~~ MW, Mvar, voltage (RMS), current (RMS), frequency over the duration of the test. During transients that occur during the test also provide three phase instantaneous waveforms for voltage and current at unit terminals and other points of interest. ~~Voltage, Frequency over the duration of the test)~~
2b	Trip to House Load	Trip to house load from at least 80% of its registered capacity (as registered with AEMO).	Demonstrate trip operation of TTHL relay to disconnect SRAS from power system. SRAS to then remain operational at house load.	Provide data output trends of SRAS unit. ~~(~~As a minimum, continuous recordings of ~~generator~~ MW, Mvar, voltage (RMS), current (RMS), ~~Voltage, f~~Frequency over the course of the test.~~)~~
3	Zero Export	Operate in a stable manner at zero export load.	Run at zero export load for at least 30 minutes.	Frequency and voltage trends (or other equivalent trends) to demonstrate the SRAS operated in a stable manner at zero export load for at least 30 minutes.
4	Voltage Control (Black Start Service, Restoration Support Service only if applicable)	Control SRAS voltage.	Change SRAS output voltage by 5% above and below nominal output voltage and hold each change for 5 minutes (measured at generator terminals or other agreed point). Can be done concurrently with item 3.	Provide output voltage trend for the duration of the ~~SRAS~~ test.

5	Frequency Control (Black Start Service, Restoration Support Service only if applicable)	Control SRAS frequency.	Change SRAS output frequency by 0.5 Hz above and below 50 Hz and hold each change for 5 minutes (measured at generator terminals or other agreed point). Can be done concurrently with item 3.	Provide output frequency trend for the duration of the ~~SRAS~~ test.
6	Transformer energisation	Energise connection point transformer	Energise the transformer using the same procedure or process as would be used for a system restart.	Provide RMS voltage and current traces for the duration of the test, and high-speed voltage and current waveform data for transient events such as transformer energisation (from pre-disturbance to return to steady-state).
~~6~~7	Energise De-energised Busbar	Close onto a de-energised busbar.	SRAS to close onto a de-energised busbar (or other de-energised electrical equipment agreed by AEMO).	Provide RMS voltage and current traces for the duration of the test, and high-speed voltage and current waveform data for transient events such as busbar energisation (from pre-disturbance to return to steady-state).~~Provide voltage trend of for the busbar for the duration of the SRAS test.~~
~~8~~7	Output Capability (Black Start Service, Restoration Support Service only if applicable)	SRAS to supply specified capability.	Synchronise to the network and demonstrate capability to ramp to the specified capability within the specified timeframe.	Provide RMS output trends for the duration of the test, and high-speed voltage and current waveform data for transient events such as the moment of re-synchronisation (from pre-disturbance to return to steady-state).~~Provide SRAS output trend for the duration of the SRAS test.~~

9~~8~~	Timeframes	Provide SRAS in specified timeframe	Timeframes demonstrate ability to provide SRAS in accordance with timeframes in ~~the~~ SRAS A~~a~~greement or offer	Record relevant ~~the~~ time~~s~~ ~~at the following milestones~~ over the duration of the SRAS ~~t~~Test. Generally:~~:~~ • Start of the ~~SRAS~~ test ~~-~~(item 2 start) • Time at stable operation , energised and at synchronous speed/available (item 2 end), and ~~(item 2 end) -~~ ready to energise a de-energised busbar. • ~~Time of commencement of the zero export load ability (start item 3).~~ • ~~Times of completion of the zero export load ability (end item 3).~~ • ~~Time of connection to isolated busbar (item 6).~~ • Time commenced loading for capability test (item 8~~7~~ start). Only where applicable for a restoration support service. • Time at contracted capability (item 8~~7~~ end).
10~~9~~	Maintenance~~Regular -~~ diesel generator (if part of SRAS Equipment)	Start up and operate for minimum period	Periodic operation of diesel generator independent of full SRAS Test (monthly unless otherwise agreed), with evidence to be provided with Test Report.	Most recent maintenance records and maintenance plan for this item of plant~~Maintenance records or time-stamped data trends~~
11	Maintenance - energy storage systems used in SRAS (e.g. batteries/UPS, accumulators)	Energy storage system maintains charge when isolated from charging mechanism	Periodic testing of energy storage capability. Hold-up tests or similar recognised capability test	Most recent maintenance records and maintenance plan for this item of plant
12	Maintenance – TTHL trip function	Ensure unit TTHL at correct settings	Simulation tests to prove operation at settings	Most recent maintenance records and maintenance plan for this item of plant

APPENDIX B. SYSTEM RESTART TEST REPORTING OF MEASUREMENTS AND DATA REQUIREMENTS

This Appendix details the reporting and measurement data to be provided by Restart Test Participants during a System Restart Test.

Where high speed measurement equipment is installed, particularly at asynchronous *plant* that utilise fast acting inverter controls, the outputs from this equipment must be provided, to capture the *plant's* dynamic response more accurately.

This Appendix details the reporting and measurement data to be provided by Restart Test Participants during a System Restart Test, whereby a section of the *network* and, where included in the *test program*, other non-SRAS facilities will be *energised* using a Black Start Service and Restoration Support Services if applicable.

B.1 Indicative System Restart Tests - Overview

The table below provides an indication of the types of System Restart Tests that could be required. These are examples only. Different *power system* conditions and network topology may require additional or modified tests. The specific measurements quantities and data to be provided by Restart Test Participants will be determined as part of a detailed the *test program* for the relevant System Restart Test, depending on the nature and type of test being conducted.

Test #	Assessment Example	Test Example
A	Start-up of Black Start Service or self-start Restoration Support Service	Start the *facility* using the same operating procedure or process as would be used following a *major supply disruption*. This test and the evidence required is covered in more detail in Appendix A.
B	Restart of Restoration Support Service	Restart the SRAS Equipment using the same operating procedure or process as would be used following a *major supply disruption*, and which would be used as part of the Minimum System Restart Path under test. This may involve a self-start or restart from the *power system*.
C	Energisation of one or more *transmission/distribution* lines	Energise a *transmission/distribution* line as part of the Minimum System Restart Path under test.
D	Energisation of one or more power transformers	Energise a power *transformer* as part of the Minimum System Restart Path under test.
E	Energisation of generator auxiliaries	Energise non-SRAS *generating unit* auxiliaries, such as motor loads, as part of the Minimum System Restart Path under test.
F	Synchronisation of *generating units*	Synchronise participating *generating units* as required to test the Minimum System Restart Path.

B.2 General requirements for measurements

This section describes the general requirements for reporting of measurements and data by Restart Test Participants following a System Restart Test of a type described in section B.1.

As a general principle, RMS quantities should be provided for the duration of a test, while waveform data should be provided only for a transient event (from pre-disturbance to a return to steady-state).

- Format of measurement data (CSV or COMTRADE)
- RAW and RMS data to be provided for all electrical quantities for all three phases.
- Sampling rate:
  - A minimum resolution of 100 Hz for root mean square (RMS) data (3-phase)
  - 10 kHz resolution for control signals or waveform data.

    Note: For synchronous machines, data at a lower sampling rate to be discussed and agreed with AEMO prior to testing.
- The following data and information if requested by AEMO
  - All the pre-processed measurement (raw) data
  - Scaling factors for all signals
  - Signal sampling rate
  - Information on post-processing of raw measurement data, such as re-sampling, filtering, averaging and calculations of the signals
- Where measured voltages and currents need to be provided these should be made available in
  - three phase instantaneous waveforms (only where specifically noted / transients)
  - three-phase RMS and
  - positive sequence RMS forms
- Where applicable, generating units/facilities with high speed measurement equipment to be used for the test where practicable.

B.3 SRAS Providers

This section details the types of data to be provided for Black Start Services and Restoration Support Services, including continuous recordings covering the duration of the test. The specific measurements quantities and data to be provided by SRAS Providers will be confirmed as part of a detailed *test program* for the relevant System Restart Test, depending on the nature and type of test being conducted.

The measurements are to be provided for each type of SRAS Equipment participating in the test. For example, where the SRAS Provider's facility consists of a combination of generating units and other dynamic reactive plant (such as a synchronous condenser).

Required measurement data[A]	Comments
General (for all types of SRAS)	
Active power at the Delivery Point	When the Delivery Point is energised. Only where applicable for Restoration Support Services.
Reactive power at the Delivery Point	
Three phase voltage at the Delivery Point	Include waveform data for duration of equipment energisation/transients, starting 500 ms prior to the transient and at least 100 ms after voltages settle.
Current and voltage waveforms and status signals for any relays within the Delivery Point which operates during the tests	
Local Frequency	
SRAS synchronous generating units	
Active power at generating unit(s) terminals	Only where applicable for Restoration Support Services.
Reactive power at generating unit(s) terminals	
Voltage at generating unit(s) terminals	Include waveform data for duration of equipment energisation/transient, starting 500 ms prior to the transient and at least 100 ms after voltages settle.
Field voltage	
Field current	
Speed reference of the governor	
AVR output (e.g. control output(s))	
AVR limiter outputs (e.g. OEL/UEL)	
PSS outputs (where applicable)	
SRAS asynchronous generating units	
Active power at terminals of at least one inverter[B]	Where an inverter has high speed measurement equipment installed (independent of the device being measured), provide the output of that measurement unit. Only where applicable for Restoration Support Services.

Required measurement data[A]	Comments
Reactive power at terminals of at least one inverter per inverter type (if applicable)[B]	Where an inverter has high speed measurement equipment installed (independent of the device being measured), provide the output of that measurement unit.
Voltage at terminals of at least one inverter per inverter type (if applicable)[B]	Where an inverter has high speed measurement equipment installed (independent of the device being measured), provide the output of that measurement unit.
Park controller(s) outputs (where applicable)	Such as active power, reactive power, voltage and frequency (as applicable).
Frequency control set point reference (where applicable)	
Status of all generating units used in the test	
Voltage or power factor or reactive power set point reference (where applicable)	
SRAS dynamic reactive plant (not including generating units)	
Reactive power at the SRAS reactive plant terminals	Where the SRAS includes reactive plant as part of the service (e.g. synchronous condenser).
Voltage at the reactive plant terminals	
Reactive plant switching status (e.g. filters, capacitors)	

[A] For Restoration Support Services, the measurements are only required when the restoration service has started and is participating in the test
[B] The three quantities, active power, reactive power and voltage, must be monitored at the terminals of the same device

B.1 Network Service Providers

This section details the types of data to be provided for *network elements*. Specific measurement and data requirements may be specified in the relevant *test program.*

Required measurement data	Comments
Voltage at each terminal station on the test path[A]	Include waveform data for duration of equipment energisation/transient, starting 500 ms prior to the transient and at least 100 ms after voltages settle.
Frequency	
Current and voltage waveforms and status signals for any relays which operates during the test	

Required measurement data	Comments
Voltage at LV and HV side of all transformers being energised	Only required for transformer energisation tests. Include waveform data during transformer energisation, starting 500 ms prior to energisation and for at least 100 ms after voltages settle.
Current at LV and HV side of all transformers being energised	Only required for transformer energisation tests. Include waveform data during transformer energisation, starting 500 ms prior to energisation and for at least 100 ms after voltages settle.
Status signals for *network elements* (e.g. change in operating mode(s), transformer tap position etc.)	
Reactive power and voltage at connection point of network dynamic reactive plant participating in the test (e.g. synchronous condenser)	Include voltage waveform data for duration of equipment energisation/transient, starting 500 ms prior to the transient and at least 100 ms after voltages settle.

[A] The measurement data is only required for terminal stations/buses that have been energised or are being energised.

B.2 Other Restart Test Participants

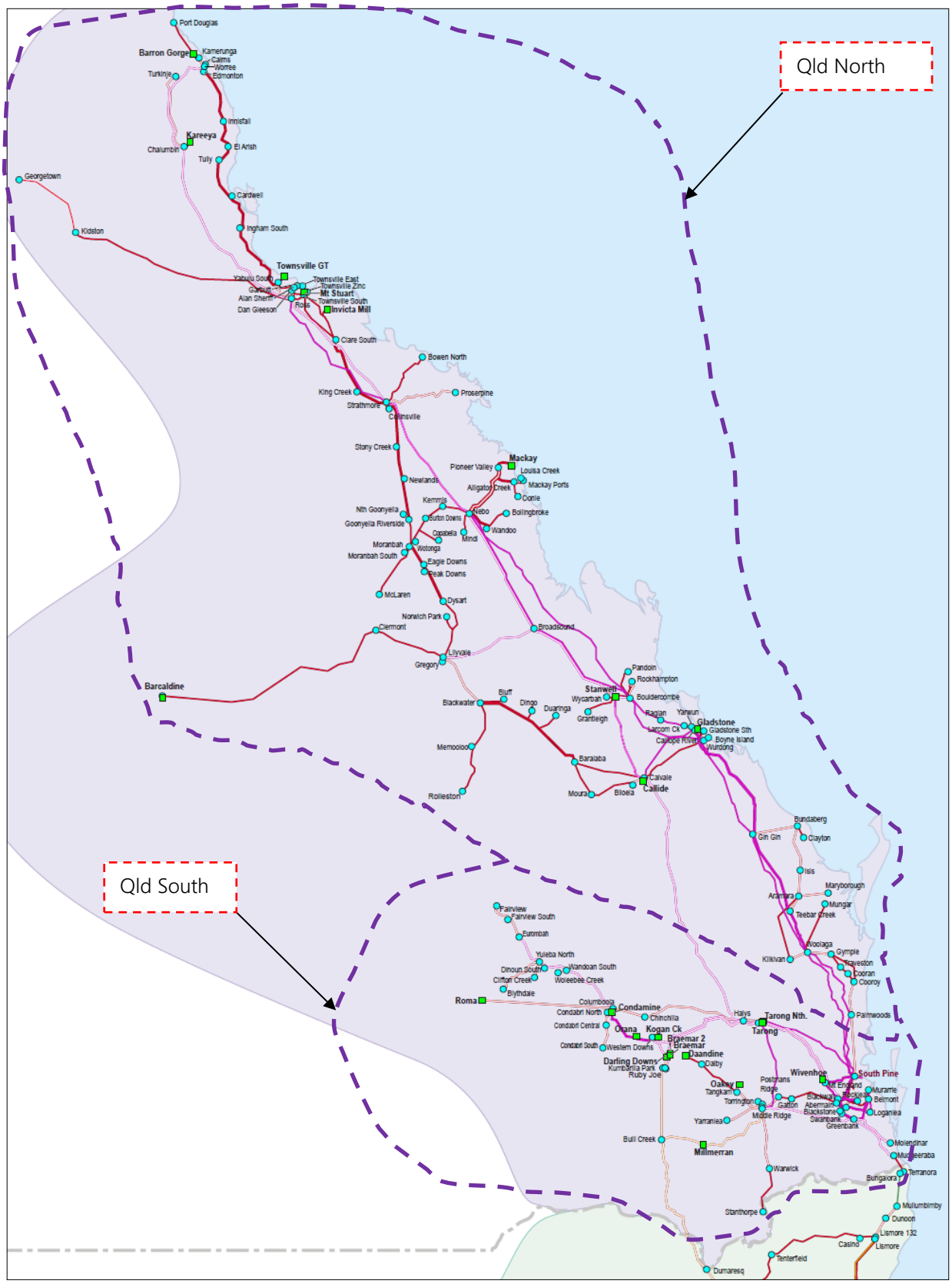
This section details the types of data to be provided for *facilities* other than SRAS sources and *network* elements. Specific measurement and data requirements may be specified in the relevant *test program*.

Required measurement data	Comments
Generating systems	
Active power at connection point	When the connection point is energised.
Reactive power at connection point	When the connection point is energised.
Voltage at connection point	When the connection point is energised. Include waveform data for duration of equipment energisation/transient or auxiliary start-up, starting 500 ms prior to the transient and at least 100 ms after voltages settle.
Local frequency	

Required measurement data	Comments
Current and voltage waveforms and status signals for any relays which operates during the test	
Dynamic reactive plant (e.g. synchronous condenser)	
Reactive power at connection point	When the connection point is energised.
Voltage at connection point	When the connection point is energised. Include waveform data for duration of equipment energisation/transient, starting 500 ms prior to the transient and at least 100 ms after voltages settle.
Current and voltage waveforms and status signals for any relays which operates during the test	
Auxiliary plant (e.g. motors, fans, pumps)	
Active power consumption at connection point (or another suitable location)	
Reactive power at connection point (or another suitable location)	
Voltage at connection point (or another suitable location)	

~~Appendix A.~~APPENDIX C. MAPS OF ELECTRICAL SUB-NETWORKS

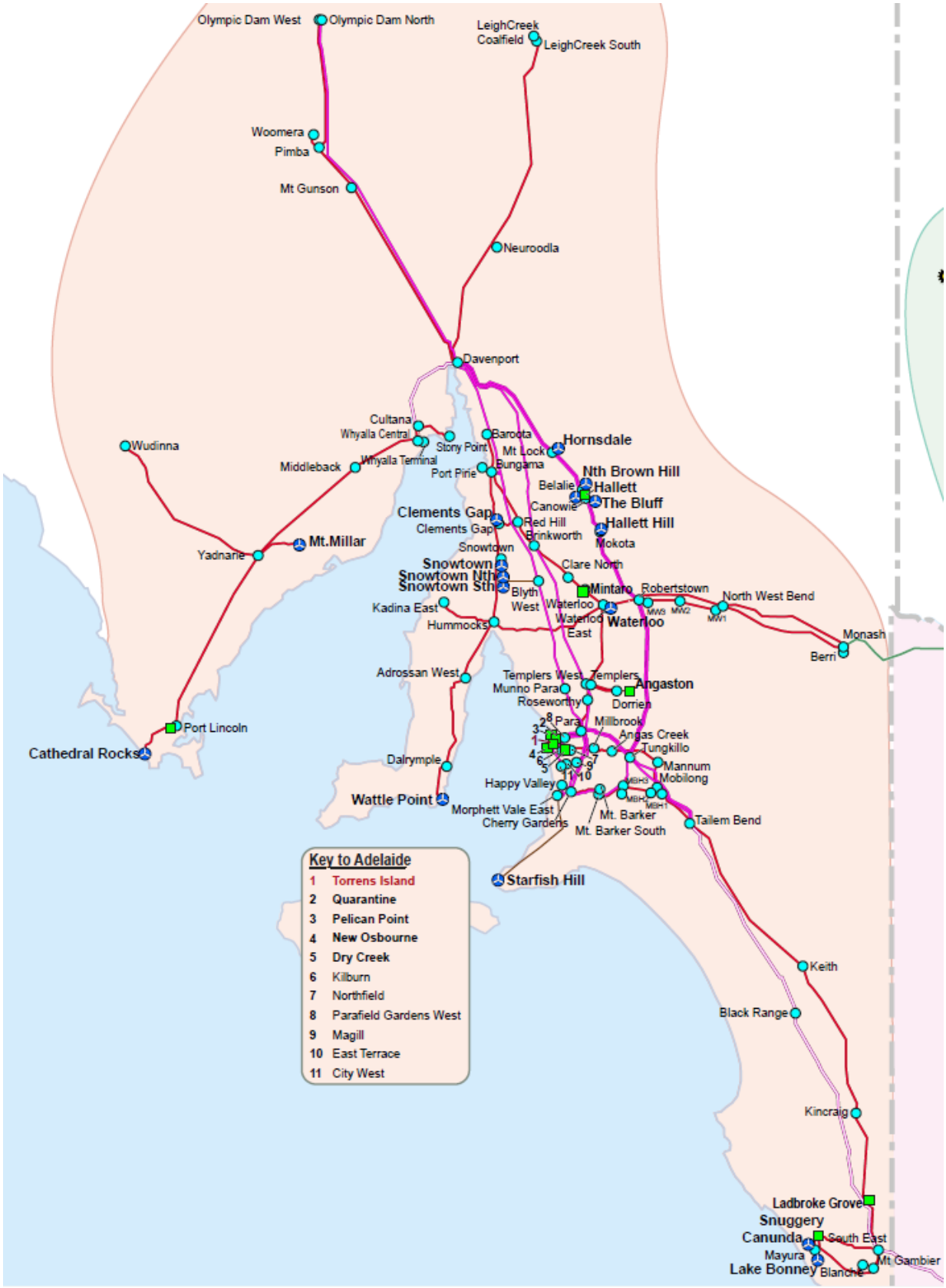
~~A.1~~C.1 Queensland North and South



~~A.2~~C.2 New South Wales (actual regional boundary shaded in light green)

~~A.3~~C.3 Victoria (actual regional boundary shaded in light pink)

~~A.4~~C.4 South Australia (actual regional boundary shaded in light orange)



~~A.5~~C.5 Tasmania (actual regional boundary shaded in light green)