

# Power System Security Guidelines

**Prepared by:** AEMO Operational Support

**Document ref:** SO\_OP\_3715

**Version:** 105

**Effective date:** 3 June 2024

**Status:** DRAFT

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## Current version release details

Version	Effective date	Summary of changes
105	3 June 2024	Changes to reflect the National Electricity Amendment (Integrating energy storage systems into the NEM) Rule 2021 No.13 and Rule 2023 No. 2, including to incorporate references to Integrated Resource Providers and bidirectional units.

**Note: There is a full version history at the end of this document.**

# 1. Introduction

## 1.1. Purpose and application

These Power System Security Guidelines (Guidelines) are made in accordance with clause 4.10.1 of the National Electricity Rules (NER), and form part of the *power system operating procedures*. These Guidelines also incorporate the *reclassification criteria* required under NER 4.2.3B.

These Guidelines apply to AEMO and all *Registered Participants* and have effect only for the purposes set out in the NER. The NER and the National Electricity Law prevail over these Guidelines to the extent of any inconsistency.

These Guidelines describe:

- (a) how AEMO seeks to operate the *power system* within the limits of the *technical envelope*;
- (b) how AEMO seeks to meet its *power system security* responsibilities generally; and
- (c) the information and actions required from *Registered Participants* to assist in maintaining or restoring *power system security*.

## 1.2. Definitions and interpretation

### 1.2.1. Glossary

Terms defined in the National Electricity Law and the NER have the same meanings in these Guidelines unless otherwise specified in this clause.

Defined terms in the NER are intended to be identified in these Procedures by italicising them, but failure to italicise a defined term does not affect its meaning.

The words, phrases and abbreviations in the table below have the meanings set out opposite them when used in these Guidelines.

Term	Definition
AEMO	Australian Energy Market Operator Limited
AGC	<i>Automatic Generation Control System</i>
Asset Owner	<i>Registered Participant</i> that owns or operates a <i>power system plant</i> or facility.
Bureau or BOM	Bureau of Meteorology
<u>CB</u>	<u>Circuit Breaker</u>
DNSP	<i>Distribution Network Service Provider</i>
DPV	Distributed photovoltaics
ECS	Emergency Control Scheme
EMMS	Electricity Market Management System
FCAS	Frequency control ancillary services, being <i>market ancillary services</i>
FOS	<i>Frequency Operating Standard</i>
GIC	Geomagnetic Induced Current
GMD	Geomagnetic Disturbance

Term	Definition
Guidelines	These Power System Security Guidelines
JSSC	<i>Jurisdictional System Security Coordinator</i>
MNSP	<i>Market Network Service Provider</i>
NEM	<i>National Electricity Market</i>
NER	National Electricity Rules. NER followed by a number refers to the numbered rule or clause of the NER
NSP	<i>Network Service Provider</i>
PTP	Permission to proceed
PTR	Permission to restore
<u>Scheduled production unit</u>	<u><i>A production unit that is a scheduled resource</i></u>
Specific risk	See section 8.4.3
ST Timeframe	<i>Short term PASA timeframe</i>
TNSP	<i>Transmission Network Service Provider</i>
VDS	Var Dispatch Scheduler

### 1.2.2. Interpretation

These Guidelines are subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

## 1.3. Related documents

Reference	Title	Location
SO_OP_2000	Glossary	<a href="http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation/Power-system-operating-procedures">http://www.aemo.com.au/Electricity/National-Electricity-Market-NEM/Security-and-reliability/Power-system-operation/Power-system-operating-procedures</a>
SO_OP_3703	Short Term Reserve Management	
SO_OP_3705	Dispatch	
SO_OP_3707	Procedure for Issue of Directions and Clause 4.8.9 Instructions	
	Manual Load Shedding Standard	<a href="https://aemo.com.au/en/consultations/current-and-closed-consultations/manual-load-shedding-standard">https://aemo.com.au/en/consultations/current-and-closed-consultations/manual-load-shedding-standard</a>

## 2. AEMO Policy on the Management of Secure and Satisfactory Limits

*Network constraints*, developed from TNSP limit advice will be used by AEMO in the NEM *dispatch* process to ensure that *plant* remains within rating and *power transfers* remain within stability limits so that the *power system* is in a *secure operating state*.

AEMO will adhere to the signed off TNSP stability limit advice at all times but based on advice from the TNSP can operate to a more conservative stability limit. Operating to a less conservative limit requires AEMO to perform a due diligence on the advice received from the TNSP and is subject to a sign off by AEMO and the TNSP prior to the revised limit being utilised.



In all cases where AEMO makes a determination that it is necessary to adjust the *power system* such that the *power system* remains in or is returned to a *secure operating state*, AEMO will aim to minimise the impact on *market* outcomes.

AEMO may seek from the TNSP revised *plant* thermal ratings, or an agreed plan / network solution prior to invoking a *network constraint*.

AEMO may apply *constraints* to reflect the *technical envelope* at any time. Without limitation, examples of *constraint* action and considerations are likely to include *constraints* on:

- *interconnector* flows to levels whereby there are sufficient *market ancillary services* (FCAS) to cater for the loss of an interconnection;
- *interconnector* flows to levels which ensure that for the loss of that *interconnector* or part of that *interconnector* all other plant or equipment under AEMO's control or co-ordination is operated within the appropriate operational or emergency limits;
- *interconnector* or *intra-regional* flows to levels which ensure voltage conditions throughout the *power system* remain within the limits of operation as determined by AEMO and NSPs;
- *interconnector* or *intra-regional* flows to levels which ensure *voltage* conditions throughout the *power system* remain within limits for a *satisfactory operating state* under any *credible contingency event* scenario;
- *scheduled plant, WDR units resources* and/or *ancillary service generating units* to maintain transmission line flows within secure limits;
- *scheduled resources plant, WDR units* and/or *ancillary service generating units* to maintain *interconnector* or *intra-regional* flows within secure limits. This may take the general form: Risk <= Satisfactory limit – Secure limit; or
- a *regulated interconnector* controlled by a high voltage direct current system (HVDC) when the HVDC system is unable to control the *interconnector* flow to the level determined by the dispatch algorithm. In this case AEMO may set a fixed level of flow for the relevant *interconnector* at a physically realisable level.

Should AEMO not be able to manage secure and satisfactory limits through the use of *network constraints*, the following options will be used.

The options described are in a suggested priority order. They are available at all times but the circumstances at the time will dictate which particular option(s) will be utilised in managing the limit.

## 2.1. Revision to Plant Thermal Ratings

The TNSP provides to AEMO a revised *plant* thermal rating if available and AEMO inputs the revised plant rating into the operational systems.

## 2.2. Revision to Power System Limits

TNSP provides AEMO with revised *power system* limits together with any associated conditions. AEMO will perform a 'due diligence' of the revised limit to ensure that the advice is reasonable and that the *power system* remains in a *satisfactory operating state* following the *credible*

*contingency event* indicated in the limit advice. The due diligence process is a check only and is not to recalculate the *power system* limit.

If the TNSP and AEMO agree on the revised limit and the associated conditions as being valid, both parties sign off on the revised limit. AEMO applies the revised limit.

## 2.3. Implement Agreed Plan

Implement a plan agreed between AEMO and relevant *Registered Participants* (e.g. Contingency plan, *Network Support Agreement*).

## 2.4. Reconfigure Network

Consider *network* re-arrangements, including where possible; switching of *network elements*, providing additional reactive support, reconfiguration or return to service of plant. Switching reconfiguration options may include sacrificial switching.

## 2.5. Reliability and Emergency Reserve Trader (RERT)

If there is sufficient notice, AEMO may dispatch or activate suitable *reserve contracts* in accordance with the NER<sup>1</sup> to address a *power system security* event, if the reserves have already been contracted for reliability reasons.

## 2.6. System Security Direction or Clause 4.8.9 Instruction

Identify any options for *power system security directions* or instructions under section 116 of the National Electricity Law and NER 4.8.9.

## 2.7. Reduction of FCAS Risk

If sufficient Raise FCAS are unavailable, use system security *constraints* to reduce the size of the largest *generation* at risk.

If sufficient Lower FCAS are unavailable, issue a direction under section 116 of *National Electricity Law* (which will be a *direction* where it applies to *scheduled load*, and otherwise will be a *clause 4.8.9 instruction*) for a reduction in the size of the largest *load* at risk.

## 2.8. Manual Load Shedding

AEMO will instruct *load shedding* as per section 5.

# 3. Network Configuration Policy

All *transmission elements* available for service shall be on-load unless specific operational requirements or instructions covering a particular *power system* condition dictate otherwise.

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<sup>1</sup> AEMO must comply with NER 3.20 and, where relevant, NER 3.8.14 and 11.128. See procedures SO\_OP\_3717, and SO\_OP\_3703.

### 3.1. Operation of Low Capacity Interconnections

Low capacity interconnections between *regions* arise when a *power system* event has resulted in *outages* of the *transmission lines* between interconnected *regions*.

This may leave an *interconnector* available with significantly reduced transfer capacity. A number of security issues may arise if a low capacity interconnection is used to reconnect two *regions*. AEMO has developed the following guidelines for management of low capacity interconnections. In order of preference below.

#### 3.1.1. Option 1: Power Systems Remain Separated until High Capacity Interconnection becomes available

Option 1 is preferred as it generally provides the lowest level of risk to *power system security*.

Low capacity interconnections present many issues associated with maintaining *power system security* due to possible power swings through the low capacity *transmission system* after a major *generation contingency event* on either side of the *interconnector*.

A *contingency event* associated with the low capacity connection is more than likely to result in a separation event. Management of power swings may actually require unnecessary *load shedding* in the area particularly where *constraint* action is ineffective.

#### 3.1.2. Option 2: Move the Separation Point to Maximise Transmission Capacity to Supply Local Demand

After a separation, some areas may have insufficient *transmission* capacity to *supply* local demand. This can be rectified by reconnecting through a low capacity interconnection and then separating the systems at a different location. The objective is to move the separation point to provide more *transmission* capacity to a local area where needed.

This may leave some *loads* on a single contingency (radial) but the risk is rated against the possible damage to *transmission* equipment due to uncontrolled power swings through a reconnected low capacity system.

During switching to rearrange the separation point, the demand on either side of the interconnection should be stable during the reconnection to prevent uncontrolled power swings.

Under some situations *supply* may need to be disconnected before a separation point can be relocated.

#### 3.1.3. Option 3: Re-establish a Low Capacity Interconnection then utilise Constraints and Contingency Plans to Manage Power System Security

This option is the highest risk to *power system security* as the low capacity connection will be highly unlikely to have sufficient capacity to carry additional loading due to the potential power swings from a *contingency event* on either side of the *interconnector*.

This option would only be applied in the following circumstances:

- (a) Pre-contingent *load shedding* has occurred or is forecast in the areas on either side of the *interconnector* and available *network* capacity is not sufficient to restore *load*.

- (b) Agreed contingency plans are available containing the following:
- (i) Manual or automatic actions to manage overloads due to contingent trip of *generation* on either side of the low capacity interconnection.
  - (ii) Manual or automatic actions to manage a contingency of one of the elements forming the low capacity interconnection.

If the above conditions cannot be achieved under the circumstances reconnection of a low capacity interconnection should not be attempted as AEMO would be unable to meet the requirements for *power system security*.

## 3.2. Transmission Line Outages opening a Bus Tie connection

When the outage of a *transmission line* results in the opening of a bus tie connection and the nature of the outage is such that the *transmission line* can be isolated and the circuit breakers forming the bus tie connection can be reclosed, then the TNSP should consider returning that bus tie connection to service in order to increase the resilience of the *power system*.

# 4. Black System

## 4.1. Declare a Black System

Following a major *power system* emergency, loss of more than 60% of predicted *regional load*, affecting one or more *power stations* satisfies the conditions for declaring *black system* condition in that *region*.

## 4.2. Exit a Black System

Restoration of the *power system* has reached to a level where all involuntary *load shedding* has ceased and clearance to restore the last *load block* has been given by AEMO.

The emergency situation is expected to continue to improve within the part of the *power system* declared as a *black system*.

# 5. Manual Load Shedding and Restoration

AEMO may direct the shedding or restoration of load to maintain *power system security*, under the provisions of NEL section 116 and NER 4.8.9.

This will be conducted in accordance with the *load shedding procedures* for respective NEM *regions*. These procedures are confidential and are provided to TNSPs and *Jurisdictional System Security Coordinators* (JSSCs).

# 6. System Security Protocol for **Generating Production Unit Commissioning or Testing**

The following applies to commissioning, or any other testing associated with *generating production units*.

## 6.1. Commissioning Program

In accordance with NER 5.8.4, the *Registered Participant* will provide AEMO with the *Generator / Integrated Resource Provider generator* commissioning program at least 3 months prior to the commencement of the *generator production unit* commissioning tests.

In accordance with NER 5.8.2, the *Registered Participant* must co-operate with AEMO and the relevant NSP(s) to develop procedures to ensure that the commissioning of *generating systems and/ integrated resource systems* is carried out in a manner that:

- (a) does not adversely affect other *Registered Participants*;
- (b) does not affect *power system security* or quality of supply of the power system; and
- (c) minimises the threat of damage to any other *Registered Participant's* equipment.

## 6.2. Submission of OffersDispatch Bids

During commissioning or testing, *generating-scheduled production units* are required to follow *dispatch* targets as determined by AEMO. To ensure that *dispatch* and *pre-dispatch* outcomes reflect the technical envelope, and to allow AEMO to perform its *power system security* and *reliability* obligations, *Generators / Integrated Resource ProvidersMarket Participants* should ensure all *dispatch bidoffers* associated with commissioning or testing are submitted to *pre-dispatch* at least 24 hours in advance.

Any changes to the commissioning plan or test should be provided as revised *dispatch bidoffers* with the final plan reflected in the *dispatch bidoffers* at least 2 hours prior to the commencement of the actual commissioning or testing. AEMO will not provide permission to proceed for the commissioning or tests if the final *offer-dispatch bid* is not submitted 2 hours in advance of the actual commissioning or testing. If the final commissioning or testing detailed in the final plan is delayed or altered, updated *dispatch bidoffers* must be submitted with sufficient time given in *pre-dispatch* to allow *power system security* assessments to take place. AEMO will not provide permission to proceed for the rescheduled commissioning or testing if the updated *dispatch bidoffer* is not submitted in sufficient time.

## 6.3. Load Rejection Tests

For commissioning tests and in particular load rejection tests the following applies:

- (a) If the test will result in an unsatisfactory operating state then permission to proceed for the test will not be granted by AEMO.
- (b) If the test results in the secure limit being exceeded but the secure limit is restored within 10 minutes (equivalent to 2 *trading intervals*), AEMO will grant permission to proceed for the test.
- (c) Sufficient ramp rates and telemetered rate of change (ROC) for the *generating-scheduled production unit* to reach 0 MW within one *trading interval* is required. If the required ROC is not reflected in the *dispatch bidoffers* for that *generating-scheduled production unit*, then permission to proceed for the load rejection test will not be granted by AEMO.

## 6.4. Rate of Change ~~and Offer~~ Requirements

In addition to the procedure detailed in section 6.2, the following is required to accommodate scheduled production generating unit related tests where *load* is expected to be significantly reduced (e.g. load rejection tests, guard gate tests, governor valve testing, SRAS TTHL tests etc.). These steps need to be completed by midway through the *trading interval* immediately prior to *the trading interval* in which the test will take place.

- (a) If the test is not reflected in the dispatch bid offers for that scheduled production generating unit, then permission to proceed for the load rejection test will not be granted by AEMO. This includes sufficient offered and telemetered rate of change (ROC) for the scheduled production generating unit to reach 0 MW within one *trading interval*. For example if the load rejection test is 700 MW, the ROC down would have to be at least 140 MW/min to ensure receipt of a 0 MW target prior to the test. The AEMO EMMS will use the lesser of offered rate of change or telemetered rate of change<sup>2</sup> unless the telemetered ROC is 0 MW/min. In this case the telemetered ROC will be ignored and the offered ROC used instead.
- (b) If sufficient telemetered ROC down cannot be entered by the Generator / Integrated Resource Provider, then they should set the ROC to 0 MW/min. For example if the ROC down required is 156 MW/min, but the maximum that can be entered by the Generator / Integrated Resource Provider is 23 MW/min, then the ROC down should be set to 0 MW/min by the Generator / Integrated Resource Provider. This is to ensure that EMS ignores the telemetered ROC and uses the offered ROC.
- (c) If AEMO are still receiving non zero telemetered values for ROC down after the Generator / Integrated Resource Provider has set the telemetered ROC down to 0 MW/min, then, as a last resort, AEMO may manually replace the values to zero in EMS.
- (d) To restore the *frequency* to within the normal band as quickly as possible during a load rejection test, AEMO may enable additional raise regulation FCAS. The amount of additional raise regulation FCAS required will vary with system conditions, however, it should be sufficient such that the total raise regulation FCAS is in the range of 50-70% of the MW lost during the load rejection test.

## 7. Contingency Management

Contingency management refers to AEMO's operational management of the *power system* so that the *power system* remains in a *satisfactory operating state* following the loss of a *power system* element. In most cases *network constraints* will be used to manage this process.

A contingency on the *power system* may result in changed *power system* configuration and/or operating conditions, some of which are listed below:

- Reduced *transmission* capacity between *generating systems / integrated resource systems* and *load* centres
- Reduced *interconnector transmission* capacity

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<sup>2</sup> An offered rate of change greater than the registered rate of change will be rejected by the AEMO EMMS. To enable testing Generators / Integrated Resource Providers should ensure a suitable rate of change has been registered.

- Separation of parts of the *network* into islands
- *Production units* *Generation* and *Loads* relying on single connections resulting in larger than normal *credible contingencies*
- Operation of special *protection schemes* that may include runback of *generation* or shedding of pre-defined *load blocks*
- In cases where *network constraints*, plant re-rating or the use of *network support and control ancillary services* would not on their own, ensure that the *power system* remained in a *satisfactory operating state* following the occurrence of a *credible contingency event* or *protected event* it may be necessary to develop a contingency plan

In considering necessary contingency plans, AEMO will aim to minimise the impact on the market outcomes, and also minimise the need for involuntary *load shedding*. In general, AEMO would seek to manage *power system security* (as previously mentioned in section 2 of this document) in order of preference:

- Reconfigure the *transmission network*
- *Direction* or *clause 4.8.9 instruction*
- Involuntary *load shedding* post contingency
- Involuntary *load shedding* pre-contingency (applicable only in cases of unplanned *transmission outages*).

Contingency plans will need to be agreed among parties involved in the execution of the plan. This will typically be AEMO, TNSPs, DNSPs and *Generators / Integrated Resource Providers*. For example, if a contingency plan involves possible *load shedding* including sacrificial switching, then the relevant TNSPs and DNSPs will have to agree to the potential for *load shedding* as part of this plan. Other affected parties may also require notification.

An attribute of a *secure operating state* is the ability to return to a *satisfactory operating state* following a *credible contingency event* (NER 4.2.4).

Generally, a *credible contingency event* can be regarded as the unplanned tripping of any single item of *plant*. The majority of *contingency events* are considered as either credible or non-credible at all times. Some however, may be credible or non-credible depending on other circumstances at the time.

Only *credible contingency events* are considered when assessing whether the system is in a *secure operating state*.

## 7.1. Definition of a Credible Contingency Event

- Under NER 4.2.3(a), a **contingency event** means ‘an event on the *power system* which AEMO expects would be likely to involve the failure or removal from operational service of *plant*, or a sudden and unplanned change to the level of output, consumption or power flow of *plant*’.
- Some *power system plant*, including *distribution network elements* and non-dispatchable *generating-production units* and *loads*, are not individually represented in AEMO’s system models. For *power system security* purposes, AEMO will only assess the potential impact of a *credible contingency event* involving that type of *plant* if its relevant failure, removal from service or change could reasonably be considered to affect the security of the

*transmission network* (whether or not in conjunction with modelled power system elements).

#### Example (1)

If the trip of a *transmission element* and a *network element* in the *distribution system* has no greater impact on security of the *transmission network* than the trip of the *transmission element* on its own, then AEMO will not consider the *distribution element* as part of the *contingency event* for the purpose of classifying the event as either a *credible contingency event* or *non-credible contingency event*.

#### Example (2)

If the *disconnection of load* at the same time as the trip of a *transmission element* has no greater impact on security of the *transmission network* than the trip of the *transmission element* on its own, then AEMO will not consider the *disconnection of this load* as part of the *contingency event* for the purpose of classifying the event as either a *credible contingency event* or *non-credible contingency event*.

- (c) The voluntary removal from service of *transmission network* equipment by a TNSP due to routine or unusual conditions is regarded as a planned or short notice *outage*; it is not regarded as a *contingency event*.

## 7.2. Definition of a Non-Credible Contingency Event

*Non-credible contingency events* are *contingency events* other than *credible contingency events*. Events which are normally considered to be *non-credible contingency events* include:

- (a) the trip of any busbar in the *transmission network*;
- (b) the trip of more than one *transmission element*;
- (c) the trip of more than one *network element* in circumstances as described in example 1 in section 7.1 above;
- (d) the trip of *transmission plant* in a manner that is not normal (e.g. protection operated but did not isolate the plant as per design);
- (e) the trip of multiple *generating-production units* (except if the loss of the multiple *generating units production units* is already credible due to their network connection e.g. connected via a single line or transformer);
- (f) the trip of more than one *load* block where the combined *load* lost exceeds that which would normally be considered a *credible contingency event* in that *region*;
- (g) a combination of *transmission plant*, *scheduled-generating-units production units* or *load*, including *wholesale demand response units* where that combination is not normally considered likely.

## 7.3. Non-Credible Contingency Event Reporting

When AEMO becomes aware that a *non-credible contingency event* has occurred, a Market Notice must be issued within two hours containing the following information:

- (a) time event occurred;
- (b) region; and
- (c) elements that tripped or substantially changed power flow (e.g. *generating-production units*, *network elements*, *load*, including *wholesale demand response units*).



## 8. Reclassifying Contingency Events

### 8.1. Abnormal Conditions

A *non-credible contingency event* may be reclassified as a *credible contingency event* when AEMO determines the existence of *abnormal conditions* make the occurrence of the relevant *non-credible contingency event* reasonably possible.

### 8.2. AEMO Responsibilities

#### 8.2.1. Reclassification determinations

AEMO is responsible for determining and declaring a *non-credible contingency event* to be a *credible contingency event* and taking any additional measures it considers reasonably practicable to maintain *power system security* following the reclassification. AEMO will make these determinations with regard to NER 4.2.3A and the *reclassification criteria* (see section 8.4).

#### 8.2.2. Market notification

AEMO will notify all *Market Participants* of any reclassifications as soon as is practicable by the issue of a Market Notice.

A reclassification Market Notice will identify the reclassified *contingency event*, including the *region* and nature of the *abnormal conditions*, and any constraint sets invoked.

Market Notices will not communicate *connection point supply* reliability details and may not include a detailed description of risk where this may reveal confidential or sensitive information.

#### 8.2.3. Regular reporting

Every six months, AEMO will issue a report on decisions made to re-classify *non-credible contingency events* to be *credible contingency events*. The report will cover the requirements of NER 4.2.3A(i).

### 8.3. Registered Participant Responsibilities

While AEMO has overall responsibility for maintaining *power system security*, it relies on *Registered Participants* to promptly provide and update information about threats and risks of which they become aware.

*Registered Participants* are best placed to observe and understand how local conditions or other circumstances present at any time may affect the operation of their *plant*. Examples of circumstances that *Registered Participants* should communicate to AEMO include and are not limited to:

- (a) external environmental conditions, including extreme weather events that have the potential to impact *plant* operation;
- (b) reduction in *plant* facility redundancy or circumstances that put *plant* on a single point of failure (e.g. where secondary *protection systems* or *control systems* have failed), or an issue which puts *plant* at a higher risk of disconnection; or

- (c) actual or threatened cyber-attack with the potential to affect systems that control *plant* operation.

**Note:** These are examples only and not an exhaustive list of circumstances that could impact plant operation.

For further details on *Registered Participants*' obligations please refer to the NER including clause 4.8.1 and 4.8.2 (all *Registered Participants*), 4.3.3(e) (*System Operators*), 4.3.4(a) (NSPs), and to the AER NEM Readiness Guide and checklist.<sup>3</sup>

Where *abnormal conditions* are identified, the relevant NSP(s) should be consulted before deciding on the best course of action in response to risks presented by the *abnormal conditions*.

The NSP will be the primary contact with the state emergency services including the Country Fire Authority, Rural Fire Services etc. on the subject of bushfires. The NSP will provide AEMO with all the relevant information on bushfires. AEMO will not directly communicate with the state emergency services.

Figure 1 below provides a summary of AEMO's process for a typical assessment of *abnormal conditions* leading to reclassification. Some steps and actions may vary depending on the nature of the risk presented by the *abnormal conditions*, in particular:

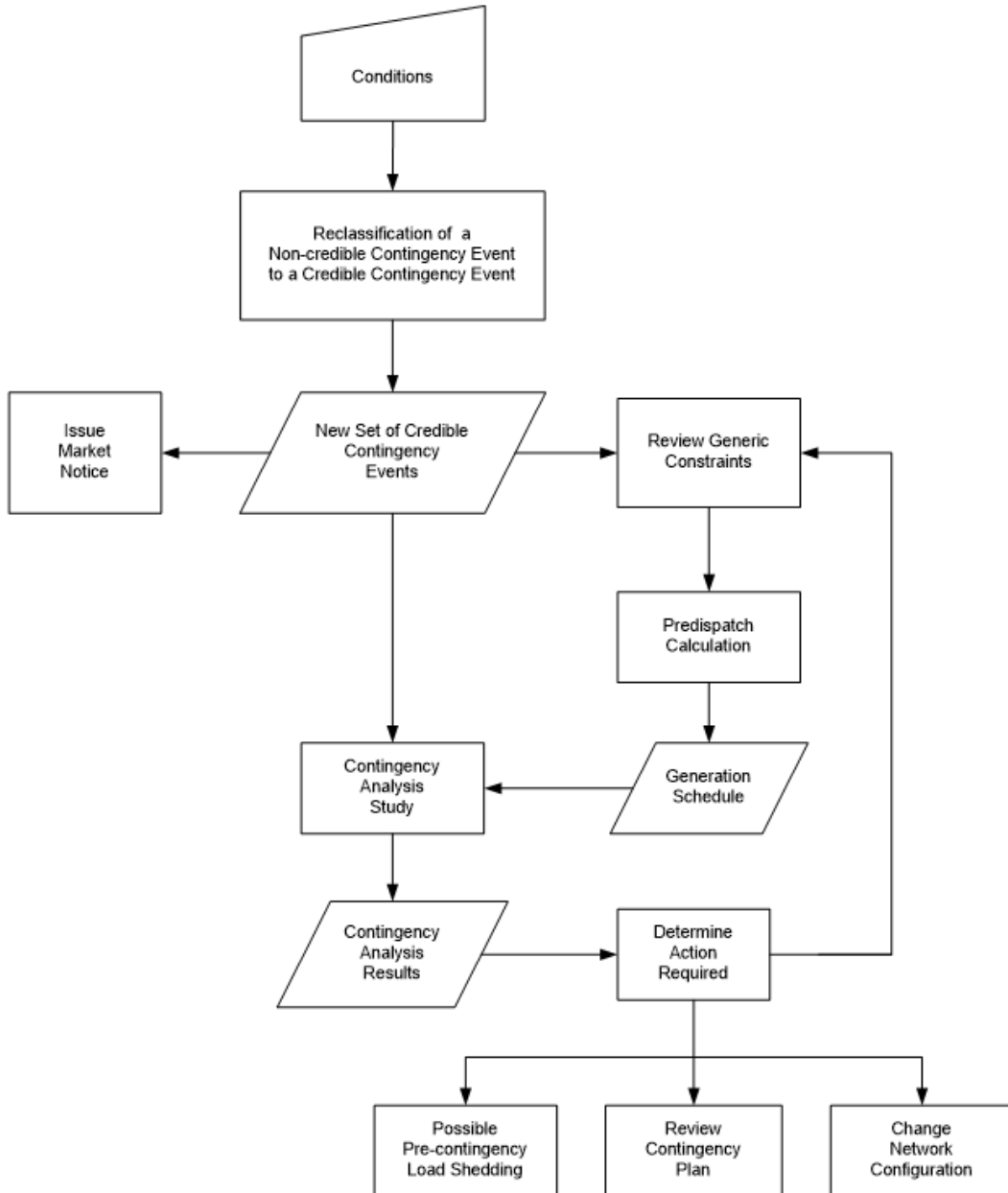
- whether it is practicable to identify a set of *power system* elements at risk of impact from the *abnormal conditions* such that the reclassified *contingency event* can reasonably be managed by applying specific *constraints* on those at-risk elements (**specific risk**); or
- whether the reclassified *contingency event* involves risks to *plant* that cannot be individually identified, or the potential impact of the event cannot reasonably be managed by applying specific constraints on at-risk *power system* elements (**widespread risk**).

The *reclassification criteria* set out the detailed reclassification assessment criteria and range of potential responses for various types of *abnormal conditions*.

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<sup>3</sup> <https://www.aer.gov.au/wholesale-markets/compliance-reporting/nem-readiness-guide-and-checklist>

Figure 1 Summary of typical process for reclassification of a non-credible contingency event to a credible contingency event.



## 8.4. Reclassification Criteria

### 8.4.1. Requirements

NER 4.2.3B(a) requires AEMO to develop *reclassification criteria* setting out:

- (a) the criteria AEMO must use when considering whether *abnormal conditions* make the occurrence of a *non-credible contingency event* reasonably possible (i.e. the decision to reclassify as a *credible contingency event*); and
- (b) information about the measures AEMO may implement to maintain *power system security* following a reclassification decision, including:

- (i) risks to the *power system* of different *abnormal conditions* that the measures may seek to address;
- (ii) the *network elements* or other plant in relation to which measures may be implemented in response to different *abnormal conditions*;
- (iii) other measures or a range of measures that AEMO is likely to consider in different *abnormal conditions*.

#### 8.4.2. Content of reclassification criteria

The *reclassification criteria* to identified abnormal conditions are set out in the following appendices to these Guidelines:

- Appendix A – Bushfires
- Appendix B - Lightning threats to double-circuit *transmission lines*
- Appendix C – Specific risks relating to *plant* operation
- Appendix D – Severe wind (including tropical cyclones)
- Appendix E – Geomagnetic disturbances
- Appendix F – Floods
- Appendix G – Widespread pollutants
- Appendix H – Landslides
- Appendix I – Sudden or unexpected changes to solar generation
- Appendix J – Earthquakes and tsunamis
- Appendix K – Large scale social unrest
- Appendix L – Cyber attacks

#### 8.4.3. Response measures

The measures AEMO may implement following reclassification will be common to many *abnormal conditions* (giving regard to principles for managing secure and satisfactory limits outlined in section 2). To avoid repetition, these common measures are listed here. Each *reclassification criteria* appendix either references this section where the common measures apply or lists any measures that are specific to the relevant *abnormal conditions*.

For specific risks, AEMO will typically invoke the applicable reclassification constraints required to maintain *power system security* for the reasonably possible trip or change in output, consumption or power flow of the identified *power system plant*.

For widespread risks, AEMO will take measures it considers reasonable and appropriate to manage the risk in all the circumstances, which may include one or more of:

- constraining the *dispatch* of *scheduled plant resources*;
- limiting *interconnector* flows;
- issuing *directions* or *clause 4.8.9 instructions* for the purpose of managing system strength, voltage, frequency or inertia requirements;
- procuring additional *market ancillary services*;

- reconfiguring the *network* (including sacrificial switching);
- recalling planned *network outages*;
- recalling planned *generation outages*;
- maximising *reactive power reserves*;
- activating contingency plans;
- implementing temporary limits in SCADA systems;
- DPV curtailment;
- pre-contingent and/or post-contingent *load shedding*.

#### 8.4.4. Departures from reclassification criteria

AEMO may, if considered necessary to maintain *power system security*, reclassify a *non-credible contingency event* and implement measures in response to *abnormal conditions* that are not contemplated in the *reclassification criteria*. This may happen if the relevant conditions were not covered by the criteria, or the specified responses would not have been appropriate in the particular circumstances that arose.

AEMO will report under NER 4.2.3A(j) and (k) on any reclassification responses that were not consistent with the *reclassification criteria*.

## 9. Communication System Outages

In the event of an extended failure in the telemetry of operational data<sup>4</sup>, the following applies:

- *Market Participants* are to maintain the last valid *dispatch instruction* on the assumption that the communications loss is relatively localised.
- *Market Participants* may be requested by AEMO to switch from AGC to local control.
- *Market Participants* may be requested by AEMO to disregard VDS instructions.
- *Market Participants* are to advise AEMO immediately if a *generating-unit/production unit* trips, cannot follow *dispatch instructions*, or if their reactive capability is approaching unit limits.
- TNSPs should monitor frequency and interconnector flows, as well as voltage at key locations.<sup>5</sup>
- AEMO may direct a *power station* to provide frequency control, if necessary.

## 10. Basslink Technical envelope

When calculating Tasmanian FCAS requirements for the loss of Basslink a time delay is applied. This is referred to as the Loss of Link time (LOL).

Faults associated with the overhead line sections of Basslink, such as those caused by bushfires or lightning, may result in an extended LOL time of 650ms. Since 1:1 load arming for the Frequency Control System Protection Scheme<sup>6</sup> is being used, no additional FCAS is required for this contingency.

<sup>4</sup> Defined in the Power System Data Communication Standard made under NER 4.11.2(c)

<sup>5</sup> This requirement may also be covered by the instrument of delegation with AEMO.

<sup>6</sup> The Frequency Control System Protection Scheme provides high speed tripping of load or *generation* in Tasmania following an unplanned outage of Basslink, to help manage system frequency.

## 11. Planned Outage Coordination

The criteria used by AEMO for granting permission to proceed with planned *network outages* is that at any time during the *outage*, the *power system* must be maintained in a *secure* and *reliable operating state*.

If the post-contingency power flow through a *network element* is above the continuous rating but within the short term rating, such *outages* will be permitted to proceed subject to TNSPs providing a suitable contingency plan detailing the method for bringing the power flow through the *network element* to the continuous rating within the required time frame.

### 11.1. Switching Time and Remaining Secure

A factor in the assessment of planned work is the concept of switching time, which is the time taken for a series of switching operations to occur.

During a planned switching sequence it is permitted for the *power system* to be in a *satisfactory operating state*, although not secure, for a period not exceeding five minutes. This also applies to changes in protection, control or secondary circuits during planned work.

The *power system* must be restored to a *secure operating state* within five minutes, if necessary by the implementation of an agreed *plan*. The *plan* must identify potential problems and the manner in which they will be managed and the steps to be taken to restore a *secure operating state*.

The *plan* must be able to restore a *secure operating state* if a *contingency event* occurs, including a circuit breaker that fails to close. During planning of the work the sequence of operations should be reviewed to minimise the time that the *power system* is insecure. The conditions that need to be satisfied in order to utilise switching sequence time are as follows:

- The switching sequence is clearly detailed and understood and limited to no greater than five minutes and subject to the prevailing *power system* conditions.
- The relevant parties identify and acknowledge that the *power system* is insecure and develop a plan to manage any potential delays which may affect restoration of the *power system* to a *secure operating state*.

This approach is not intended for fault level control. The policy for fault level control is that the next switching step must relieve circuit breaker rupture levels.

### 11.2. Constraints Ramping and Permission to Proceed

Unless advised to the contrary AEMO will assume that all *network outages* will commence at the time specified in the AEMO Outage Scheduler (NOS). It should be noted that if an *outage* requires AEMO Permission to Proceed (PTP), then the TNSP is still required to contact AEMO prior to taking any equipment out of service.

It is the responsibility of the TNSP to advise AEMO of any change to the start time for a planned *outage*.

AEMO will invoke *outage constraints* and Network Outage Constraint ramping *constraints* to ensure ramping is complete at the requested *outage* start time.

The *outage constraint* must be in a *Pre-dispatch* run, to provide the necessary inputs to the ramping constraint. Once a suitable *pre-dispatch PreDispatch*-result is available the ramping *constraints* can be invoked. The default ramp time is 35 minutes but can be varied dependant on system conditions.

For further details refer to the Constraint Formulation Guidelines and Constraint Implementation Guidelines documents which are published on AEMO website at [AEMO Congestion Related Policies and Processes](#).

Note

**Network Outage Constraint ramping also extends for six *trading intervals* beyond the start time of the outage constraint. This will ensure that the technical envelope for the outage remains current for a period long enough for the TNSP to complete the necessary switching.**

The following rules apply.

### 11.2.1. Ramping Constraint has NOT Commenced

- If the TNSP advises of a revised (**later**) start time prior to the ramping *constraint* invoking then AEMO will adjust the *outage* start time and create a new ramping constraint.
- If the TNSP is unable to advise AEMO of a start time, all the *constraints* invoked for the *outage* will be revoked. The TNSP should contact AEMO when the *outage* is ready to commence. AEMO will then invoke the relevant *outage constraints*. Before PTP can be given a *pre-dispatch PreDispatch*-run must again take place to provide the necessary inputs to the ramping *constraints*. PTP will be given when line flows have been ramped to the *outage* conditions.
- If the TNSP requests an earlier start time for the *outage* and the ramping *constraint* has not been invoked, then only if there is sufficient time to allow the revised start time to be reflected in *the pre-dispatch PreDispatch*-and with sufficient ramp time available, AEMO will agree to this earlier start time. PTP will be given when line flows have been ramped to the *outage* conditions.

### 11.2.2. Ramping Constraint has Commenced

- If the TNSP requests an **earlier** start time then this could be denied.
- If 30 minutes has expired from the planned start time and permission to proceed (PTP) has not been sought then the ramp will cease and a new ramp must be commenced prior to the *outage* proceeding at a later time. AEMO will adjust the *outage constraint* time accordingly. Before PTP can be given a *pre-dispatch PreDispatch*-run must again take place to provide the necessary inputs to the ramping *constraints*. PTP will be given when line flows have been ramped to the *outage* conditions.
- If PTP has been given for the scheduled start time and switching has not commenced within 15 minutes AEMO may advise the TNSP that unless switching is completed within the next 15 minutes then the ramp will expire and a new ramp must be commenced prior to the *outage* proceeding at a later time (refer to note in section 11.2).

- If the TNSP advises of a revised (**later**) start time of 30 minutes or less, the *outage constraint* start time may be altered and the ramping *constraint* end time will automatically be extended by that altered amount of time.
- If the TNSP advises of a revised (**later**) start time of greater than 30 minutes, the *outage constraint* start time may be altered however the ramping *constraint* will end immediately and a new ramping *constraint* must be created. AEMO will adjust the *outage constraint* time accordingly. Before PTP can be given a pre-dispatch ~~PreDispatch~~ run must again take place to provide the necessary inputs to the ramping *constraints*. PTP will be given when line flows have been ramped to the *outage* conditions.
- If the TNSP is unable to advise AEMO of a start time, all the *constraints* invoked for the *outage* will be revoked and the ramping *constraint* will end immediately. The process in section 11.2.1 will then be followed.

## 12. Interconnector Rate of Change Limitations prior to Transmission Outages

Step changes in *interconnector* transfer limits may result in a situation where the total generator production unit rate of change capability on either side of an *interconnector* is exceeded for a short time. To avoid a violation of the *constraint* equation or “overconstrained dispatch”, AEMO imposes maximum limits on the rate of change of *inter-regional* power flow. This can happen when transfer limits are reduced significantly at the start of *transmission network outages*.

Table 1 below specifies the maximum rates of change of *inter-regional* power flow to be applied at the start of planned or short notice *transmission network* outages. This process is used to reduce *inter-regional* power flow only and is not required for *interconnector* capacity increases.

**Table 1 Interconnector rate of change**

Direction of flow prior to reduction	Max reduction in flow per trading interval	Direction of flow prior to reduction
Queensland to NSW (QNI)	200	MW/5 min
NSW to Queensland (QNI)	200	MW/5 min
Queensland to NSW (Terranorra)	80	MW/5 min
NSW to Queensland (Terranora)	80	MW/5 min
Victoria to South Australia (Heywood AC)	30	MW/5 min
South Australia to Victoria (Heywood AC)	50	MW/5 min
Victoria to South Australia (Murraylink)	25	MW/5 min
South Australia to Victoria (Murraylink)	40	MW/5 min
Tasmania to Victoria (Basslink)	200	MW/5 min
Victoria to Tasmania (Basslink)	200	MW/5 min



Direction of flow prior to reduction	Max reduction in flow per trading interval	Direction of flow prior to reduction
VIC to NSW	200	MW/5 min
NSW to VIC	200	MW/5 min

## 13. Protection System Outages

If a *Registered Participant* becomes aware that any relevant protection system or control system is defective or unavailable for service, that *Registered Participant* must advise AEMO. If AEMO considers it to be a threat to *power system security*, AEMO may direct that the equipment protected or operated by the relevant protection system or control system be taken out of operation or operated as AEMO directs.

### 13.1. Total Outage of Protection Schemes

If all the primary protection schemes on a *transmission element* are removed from service the *transmission line* is normally removed from service. An exception to this may arise if the outage of the *transmission line* would interrupt *supply* and adequate backup protection is available to maintain system security. Situations of this kind should be resolved between the NSP and AEMO.

### 13.2. Planned Outage of One Protection of a Duplicated Scheme

Normally the *power system* equipment can remain in service.

The duration of the outage for a *transmission line* should be kept to a minimum and, not greater than eight hours unless agreed by AEMO and the relevant NSPs. Refer NER Schedule S5.1.2.1 (d).

If the *transmission line* protection remains unserviceable after eight hours and provided there is agreement between AEMO and the relevant NSPs for the outage to continue, then follow the approach as for unplanned *outages*.

### 13.3. Unplanned Outage of One Protection of a Duplicated Scheme

The NER (refer S5.1.2.1(d)) may be interpreted to apply to planned *outages* for maintenance purposes and the following clarifies the approach for unplanned *outages* of one protection of a duplicated scheme.

Normally the *transmission element* can remain in service provided that the NSP provides reasonable assurance that the remaining protection will clear a fault in primary protection timeframe; and

The protection repair is being progressed with expected resolution within 24 hours, with the understanding that work starts as soon as is safe to do so and should be completed within this specified time.

If these conditions are not met then the affected *transmission element* must be taken out of service.

## 13.4. Degraded Clearing Times

Degraded or longer clearing times can result during *outages* of protection signalling or inter-tripping equipment. Degraded clearing times can also result if high speed primary protection such as distance or pilot wire protection is taken out of service and the alternative protection is a slower directional over current scheme. Temporary protection schemes can also result in longer clearing times. The effect of this on system security needs to be assessed in consultation with the TNSP.

Where there is a risk to system security and any of the following apply:

- High speed clearance of some faults is no longer possible.
- There are periods when the risk of fault on the *power system* is high.
- The degraded clearing times are to apply for extended periods.

Then:

- The *power system* must be operated to more restrictive limits which correspond to the longer clearing times, or;
- The protection settings must be reduced to provide faster clearing times. If this leads to loss of discrimination, operating limits must be reduced to correspond with the possibility of inappropriate operation, or;
- The affected *transmission element* must be taken out of service.

## 13.5. Outage of Additional Non-Duplicated Protection Schemes

Protection schemes required for the detection of special low probability events such as Directional Earth Fault Comparison schemes, designed to detect high impedance faults which may occur during bushfires, may be taken out of service, and the primary plant left in service. This action may only be taken provided the risk of this type of fault is not high and the outage is of short duration, that is, less than 8 hours unless agreed by AEMO and the relevant NSPs.

*Outages* of other types of protection schemes which may not be duplicated, such as transformer buchholz or differential protection, should be treated in a similar way.

## 13.6. Outage of Signalling Systems

*Outages* of signalling systems such as fast zone two blocking can cause loss of discrimination and suitable remedial measures should be agreed with the TNSP. These measures may include the temporary application of a block or removal of the fast zone two tripping feature.

*Outages* of accelerated inter-tripping on one protection scheme of a duplicated scheme normally will not result in loss of zone one clearing times on the protected *transmission element* and thus should not impact on system security.

*Outages* of direct or accelerated inter-tripping associated with Circuit Breaker Fail protection in “breaker and a half” switchyards may require opening of coupler circuit breakers provided this does not cause additional security problems.

Provided the system security issues have been adequately addressed the affected primary plant can remain in service.

### 13.7. Transfer Limit Reductions due to Protection Outages

*Outages* of protection or associated signalling equipment can lead to a reduction in transient stability transfer limits.

Various types of protection schemes designed to enhance system stability such as single pole tripping and reclosing or power swing blocking could also result in a reduction of safe power transfer limits if they are not available. Changes to these limits will be agreed between AEMO and the appropriate TNSP.

### 13.8. System Protection Services

Under frequency protection is designed to return system *frequency* to normal following multiple *generation* contingencies. The NER require 60% of the total *load* of a *region* to be connected to under frequency protection. This protection is distributed across the *region* and taking the under frequency scheme out of service at one substation has little effect on the overall scheme and the security of the *power system*.

Under voltage schemes are designed to protect smaller areas within the *power system* from under voltages during contingencies. The outage of these schemes will impact on the security of the *power system* but only for a limited number of contingencies. The outage will need to be assessed against other planned *outages* of system equipment and any known risk factors such as weather conditions.

There are special control schemes (e.g. ECS) and devices that allow higher *inter-regional* and *intra-regional* transfer levels when they are in service. *Outages* of these schemes will be assessed to determine if new *constraints* need to be applied to the associated transfer limits.

### 13.9. Rules Requirements

NER 4.3.1 defines the responsibility AEMO has for *power system security*.

NER 4.6.2. AEMO is required to co-ordinate, in consultation with *Network Service Providers*, the protection of *power system* plant which could affect *power system security*.

NER 4.6.5 defines AEMO's responsibility to determine, in consultation with the *Network Service Providers*, the best course of action to adopt for partial, or complete, removal from service of the protection equipment protecting *transmission lines*. The NSP must comply with AEMO's determination unless in their reasonable opinion it would threaten the safety of any person or cause material damage.

NER 4.8.2 defines a *Registered Participant's* responsibility to advise AEMO of any relevant protection or control system that is defective or unavailable. If there is risk to *power system security* AEMO can direct the affected *plant* to be taken out of service or to be operated in an appropriate manner. The *Registered Participant* must comply with a direction given by AEMO.

## 13.10. Follow up on Protection Operations

AEMO will request details of protection operations resulting from *power system* faults. This advice should include the protection schemes which have operated, fault clearing times and a statement by the TNSP as to whether the protection operation is normal or abnormal.

## 14. Voltage Control

AEMO will maintain voltage levels across the *transmission network* within the relevant limits set and advised by the NSPs and to a target voltage range.

Adequate *reactive power reserves* are maintained for *power system security*.

There are several methods of voltage control available, but the two most commonly used are;

- Changing transformer taps
- Injecting or absorbing reactive power into connection points.

Other methods include:

- *Load shedding* (automatic or manual)
- *Network* reconfiguration

The *reactive power facilities* available to AEMO include;

- Synchronous ~~generator~~production unit voltage controls
- Synchronous condensers
- Static VAR compensators (SVC)
- Shunt and series capacitors
- Shunt reactors
- Transformer tap changing.

In addition to these facilities NSPs may enter into agreements for additional *reactive power ancillary services*.

### 14.1. Reactive Reserve

The amount of *reactive power reserve* required depends on the *power system* conditions and the severity of the critical contingency. A requirement for both fast dynamic reactive reserve plant and static reactive plant exists.

Fast dynamic reactive reserve plant includes SVCs, ~~generators~~production units, *synchronous condensers* and automatically switched shunt reactive plant. Static reactive plant consists of shunt capacitors and *reactors* used as base level voltage and reactive support.

### 14.2. Voltage Control Process

AEMO uses the Var Dispatch Scheduler (VDS) as the primary tool for dispatching *reactive power* devices in the NEM. It is an automated system that determines the dispatch of *reactive power* devices satisfying the specified objectives. Dispatch of *reactive power* devices are

published to TNSPs and *Generators / Integrated Resource Providers* in the form of electronic instructions.

VDS uses the following inputs to determine dispatch of *reactive power* devices selected for control by VDS:

- Availability of *reactive power* devices.
- *Voltage* limits and the desired *voltage* profiles across the NEM *transmission system*.
- Pre-contingency and post-contingency *voltage* violations identified in AEMO real time contingency analysis.
- VDS parameters assigning priorities for *reactive power* devices.

AEMO on-line staff monitor/verify the *reactive power dispatch* by VDS. AEMO and TNSPs will communicate with each other if adjustments to *reactive power dispatch* by VDS is required and AEMO will implement agreed changes to the *reactive power dispatch*.

### 14.3. System Strength and Inertia

AEMO will ensure system strength and inertia requirements within each *region* are met through ensuring adequate *synchronous generating units* and/or synchronous machines are in service.

If sufficient levels of system strength or inertia are not being maintained, AEMO will take one or more of the following actions:

- Use the contracted *inertia network services* or *system strength services* available in the *region* to meet the gap.
- Apply network constraints to dispatch available *synchronous generating units*.
- Consider options for directing *generating units*.

## 15. Fault Level Control

Both AEMO and the TNSPs have input to the determination of fault levels and maintaining them within plant capabilities.

The TNSP is responsible for providing to AEMO the Short Circuit current ratings of all assets within AEMO's area of control.

TNSPs have a NER obligation to provide AEMO with *network* modelling data which would enable AEMO to determine fault levels at all bus bars in the *transmission system*. TNSPs are also required to provide the contributions of any *distribution connected units embedded generation* that may influence the fault levels at those buses.

### 15.1. AEMO Responsibilities

AEMO's roles and responsibilities are primarily determined by the NER which incorporates *Power system security* (Chapter 4) and *Network Connection* (Chapter 5). Some of these responsibilities include, but are not limited to:

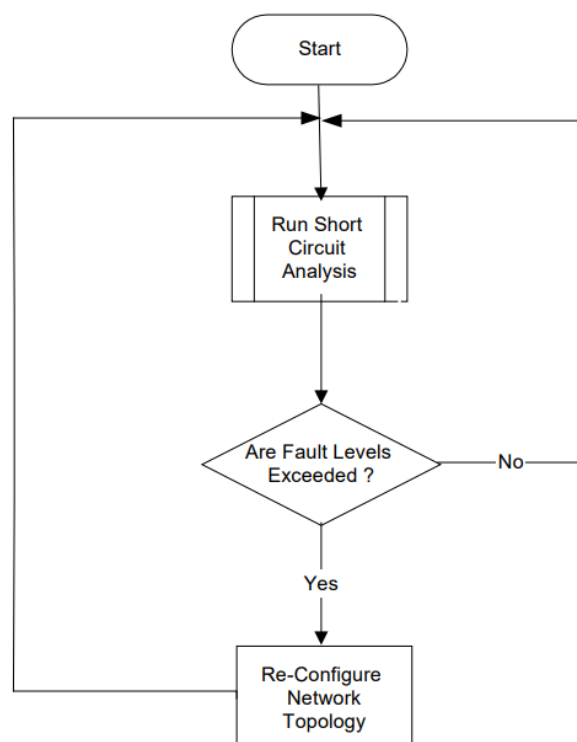
- in consultation with the *Network Service Providers*, determine the short circuit fault current level at all *busbars* of the *power system*.
- ensuring that there are processes in place, which allow the determination of short circuit fault currents levels in real time.
- identifying any bus which could potentially be exposed to a short circuit fault current exceeding the maximum fault current ratings or the minimum fault level ratings, as defined by the limit advice.
- provide processes/plans to remove identified or potential short circuit fault current levels in excess of plant ratings.

AEMO's RTNET (state estimator) application snaps the SCADA values in 5 minute samples and solves the power flow case; the results of this analysis are used as a base case for the Real Time Short Circuit (RTSCT) application (Figure 2).

AEMO's RTSCT module calculates three phase and single phase to earth fault current flows. Short circuit faults are defined for all station buses in the *transmission network*, specific faults are defined for other locations, remote from buses where short circuit currents may have the potential to exceed CB ratings.

These defined faults can be included or excluded from the Short Circuit process run as required. Normally all defined faults are included.

**Figure 2** Fault level control process



The RTSCT module can also be used in study mode to assess the impact of expected system changes or to review options for resolving situations where fault current ratings, may be expected to be exceeded.

## 15.2. Operational Policy

AEMO's RTSCT analysis results indicate both the total short circuit current available from a defined fault and the individual current contributions from each of the input circuits to that fault, for both 3 phase and 1 phase short circuit faults.

AEMO will use the total fault current available at a specific bus to assess whether maximum or minimum fault ratings at that location are exceeded. The assumption being, total fault current available at a bus is required to be broken by any CB attached to that bus.

On occasions where there may be discrepancies between AEMO's RTSCT results and either a TNSP operating policy or TNSP online analysis results. AEMO will discuss options with the TNSP to determine a practical solution.

Where discrepancies are shown to be material and reasons for such discrepancies are not obvious AEMO will take the conservative path and revert to the existing TNSP policy, until the variance is resolved.

In the case of a planned outage, it may be necessary to exceed fault levels for short periods during a switching sequence in order to avoid *load* interruption, plant overloads or where alternative approaches may impose other risks to the *power system*. The policy under these conditions requires that the next switching step must reduce the fault levels to within the fault current breaking capacity of the CBs.

# 16. Control of Power System Frequency and Time Error

## 16.1. Frequency Operating Standards

AEMO is responsible for controlling the *power system frequency* and monitoring time error. In order to fulfil these obligations AEMO will, when required:

- Source additional FCAS by adjusting the requirement.
- Issue directions to participants to provide FCAS if the available FCAS **bidoffers** are not sufficient to meet the *power system* requirements.
- Issue *directions* to participants to control the *frequency* according to the *frequency operating standard (FOS)*<sup>7</sup>.
- Issue *clause 4.8.9 instructions for load shedding* to control *frequency* according to the FOS.

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<sup>7</sup> The FOS forms part of the *power system security standards* and is made by the Reliability Panel and published by the AEMC. The revised FOS is effective from 9 October 2023. Refer to: <https://www.aemc.gov.au/sites/default/files/2023-04/FOS%20-%20CLEAN.pdf>

- AEMO will monitor and report on time error accumulation<sup>8</sup>.

## 16.2. Frequency Control

AEMO dispatches FCAS in order to:

- Control the minute to minute variations of *power system frequency* as a result of the continuous changes in *load* of the *power system* to within the Normal Frequency Band under steady load. These are known as the *regulating raise service and regulating lower service*.
- Ensure *power system frequency* variations resulting from various contingencies are controlled to the requirements of the FOS. These are known as contingency FCAS services and include *very fast raise service/very fast lower service, fast raise service/fast lower service and delayed raise service/delayed lower service*

## 16.3. Regulation and Time Error Control

The revised FOS removes the quantified limit on accumulated time error while retaining the requirement for this metric to be monitored and reported.

Time error control is achieved using Automatic Generation Control Systems (AGC).

## 16.4. Control of Frequency following a Contingency Event

If following a *contingency event* there is insufficient FCAS available to cover the loss of a *generating production unit* AEMO will take action according to AEMO's Policy on the Management of Secure and Satisfactory Limits (see section 2).

AEMO will:

- Issue directions for the provision of FCAS.
- Issue directions for a reduction in the size of the *generation* at risk.

## 16.5. Control of Frequency during Periods of System Restoration

The FOS allows for a wider *frequency* range to apply during periods of system restoration<sup>9</sup>.

## 17. Use of Network Support and Control Ancillary Service

*Network support and control ancillary services* (NSCAS) is a service which provides AEMO with a capability to control the real or *reactive power* flow into or out of a *transmission network* in order to:

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<sup>8</sup> Under clause 4.8.16(b)(2) of the NER, AEMO will continue to prepare and publish quarterly reports on the achievement of the FOS including rate of time error accumulation in the NEM and Tasmania.

<sup>9</sup> System restoration is defined in the FOS.



- maintain power system security and reliability of supply of the transmission network in accordance with the power system security standards and the reliability standard; and
- maintain or increase the *power transfer capability* of that *transmission network* so as to maximise the present value of net economic benefit to all those who produce, consume or transport electricity in the *market*.

There are three common types of NSCAS:

- Network loading ancillary service (NLAS)
- Voltage control ancillary service (VCAS)
- Transient and oscillatory stability ancillary service (TOSAS)

It is to be noted that only a limited number of service providers are available and the geographical locations of these service providers dictates the effectiveness of the service provided.

Network loading ancillary service (NLAS) is the capability of reducing an active power flow from a *transmission network* in order to keep the current loading on *transmission elements* within their respective ratings following a *credible contingency event* in a *transmission network*.

Voltage control ancillary service (VCAS) is the capability to supply *reactive power* to, or absorb *reactive power* from, the *transmission network* in order to maintain the *transmission network* within its *voltage* and stability limits following a *credible contingency event* but excluding such capability provided within a *transmission* or *distribution system* or as a condition of *connection*.

Transient and oscillatory stability ancillary service (TOSAS) is the capability to control power flow into or out of the *transmission network* to maintain the *transmission network* within its transient or oscillatory limits and to maintain or increase power transfer capability by improving transient or oscillatory stability.

Refer to **SO\_OP\_3708 Non Market Ancillary Services** for more information.

## 18. Application of thermal ratings in Dispatch

The *Power System Security Working Group* has endorsed the following approach in using thermal ratings in *NEM* dispatch systems (Table 2).

**Table 2 Application of thermal ratings**

Type of Rating	Method of Post-Contingency Management
Other than short term ratings	No action is required
15 min rating **	Constraint equations in EMMS Automatic post-contingency actions Manual (operator actions)
10 min rating	Automatic post-contingency actions Pre-arranged Manual (operator) actions
5 minute or shorter term rating	Automatic post-contingency actions “Specific” Manual (operator) actions

“Specific” manual action includes manual *load shedding* or any other pre-arranged specific operator actions that can be completed within 5 minutes. Operators will most probably be on standby to initiate the post contingency action.

\*\* Subjected to meeting requirements specified by TNSPs.

## 19. Advice of Variance to interconnector transfer limits

A Market Notice will be issued for, but not limited to:

- any short notice (less than 1 hour notice) or unplanned outage which requires the invoking of *constraints* with *interconnector* terms on the LHS; or
- non-physical loss related issues; or
- *interconnector* control issues; or
- other *power system security* related issues (i.e.: transient stability, etc.)

The Market Notice will include the following **relevant** points:

- the *transmission element* required out of service.
- the *region* in which the *transmission element* is located.
- the *constraint* set name and invoke times.
- the *interconnectors* on the L.H.S. of the *constraint* equations.
- the applicable reason or issue requiring the invoking of *constraint* equations.

## 20. AEMO’s advice on power emergency conditions

AEMO must publish all relevant details promptly after AEMO becomes aware of any circumstance with respect to the *power system* which, in the reasonable opinion of AEMO, could be expected to materially adversely affect *supply* to or from *Registered Participants*. NER 4.8.3(b) specifies some of these circumstances.

AEMO will advise of any planned action that will be taken in response to these circumstances. AEMO will also advise if the decision is to take no action at the current time or to delay action to a future time in response to an emerging risk of such a situation.

Within 15 minutes of having confirmed and verified the occurrence of a significant event a Market Notice should be issued which includes the following information (if known at that time).

- time of event
- general description of event
- identify *Transmission element(s)* involved
- the *Region* in which the *Transmission element(s)* are located
- identify any islands formed and identify the boundaries of those islands.

- indication of volume of *load* shed and in which *region*.
- approximate total amount of *generation* tripped in each *region* (NOT availability but dispatched volume tripped)
- any further risks identified at that time.

If the Market Notice system is not operational, the AEMO Emergency Communications System (Whispir) will be used until the Market Notice system becomes operational.

# Appendix A. Reclassification Criteria – Bushfires

## A.1 Risk to the power system

High intensity fires and smoke combined with hot gases within or near the power line easements pose added risk to the *power system* can lead to an operation of *protection systems* and disconnection of multiple *transmission lines* within single easement or across multiple easements. Fires can also cause extensive damage to plant including towers, poles, insulators, lines etc.

## A.2 Reclassification process

### A.2.1 Bushfire threat to specific easement

AEMO and the TNSPs have developed the following criteria to facilitate the decision-making process associated with reclassification of *non-credible contingency events* as *credible contingency events* during the presence of bushfires. The Bushfire Risk Assessment will be completed by the relevant NSP as part of this process. However, it would normally be expected that the TNSP and AEMO would collaborate in completing Table 3.

The primary focus of the process is the determination of the likelihood of the event.

**Table 3 Factors and weightings to assess impact of bushfires on circuits**

Bushfire Risk Assessment		
Time and Date:		
Transmission Circuits Being Assessed:		
RISK FACTOR	WEIGHTING	NOTES
<u>Fire Information</u> <ul style="list-style-type: none"> <li>From fire service website only</li> <li>Confirmation received from fire service that fire poses a threat</li> </ul>	0 3	If the only source of information is the “raw” data from the website / Indji, then this is not as reliable as a direct conversation with fire service personnel.
<u>Fire Direction &amp; Speed (see Note 1)</u> <ul style="list-style-type: none"> <li>Can be reasonably assessed from available data, anticipated in easement within next hour</li> <li>Insufficient data to assess direction / speed, but fire is within 5 km of the easement</li> <li>Fire does not pose a threat to the easement</li> </ul>	5 0 -10	If wind direction / speed is known, it should be possible for the TNSP to assess the speed and direction of the fire. If it is expected to reach the easement within the next hour, then it poses a high risk. If there is not much data available, then the risk cannot be quantified. If the fire is clearly not going to enter the easement within the next hour, then effectively the assessment can be stopped at this point.
<u>CIRCUIT CHARACTERISTICS</u> <ul style="list-style-type: none"> <li>Adjacent single circuits</li> <li>Double circuits (single towers)</li> </ul>	1 2	
<u>WEATHER</u> Fire Weather Warning level (Note 2) <ul style="list-style-type: none"> <li>Extreme (including total fire ban)</li> </ul>	3	Sourced from Bureau of Meteorology (Bureau).

Bushfire Risk Assessment		
Time and Date:		
Transmission Circuits Being Assessed:		
• Catastrophic (Code Red)	6	
<b>EASEMENT</b> External (Adjacent fuel load)		Grass fires don't usually pose threats to transmission assets. Plantations (e.g. pine trees) are a much greater hazard.
• Grasslands	0	
• Native bushland	2	
• Plantations	4	
<b>OPERATOR ACTIONS</b> TNSP will manually reclose tripped transmission lines within a maximum of 5 minutes.		
• Yes	-2	
• No	0	
Auto-reclose not enabled	3	
<b>Initial WEIGHTING</b>		
<b>Other risk considerations – TNSP:</b> • •		The TNSP can add additional risk factors at this point that they deem pertinent and suggest an appropriate weighting.
<b>Other risk considerations – AEMO:</b> • •		AEMO can add additional risk factors at this point and weight them accordingly.  Additional weighting may be applied if a line has already tripped due to the fire.
<b>Final Total</b>		If this total is <b>13 or greater</b> , then consider reclassification.

Note 1      Bushfires in Australia spread as a thin front of flame, with flames usually about as thick as they are high. Forest fires normally travel at one to three km/hr, have flames 10-20 metres high and thick, and will pass a spot in 30-60 seconds. Severe forest fires travel at up to 12 km/hr, with flames 100-150 metres high and thick. Grass fires generally travel about 3 – 10 km/hr, but speeds of around 25 km/hr have been recorded.

Note 2      Fire Weather warnings – Wind, temperature, humidity and rainfall all combine to affect the behaviour of bushfires. In Australia there is a system of assessing these in conjunction with the state of the available fuels to determine a measure of ‘fire danger’, or the difficulty of putting out any fires which may occur. The Bureau issues two types of advice to alert the public when conditions are likely to be dangerous – Fire Weather Warnings and Total Fire Ban Advices.<sup>10</sup>

<sup>10</sup> <http://www.bom.gov.au/weather-services/fire-weather-centre/fire-weather-services/index.shtml>

Rules to be used in the reclassification process of *non-credible contingency events* as *credible contingency events* due to bushfires, in conjunction with the processes outlined in Table 3:

- (a) Individual assessment records will be created with detailed information for :
  - (i) not to reclassify;
  - (ii) to reclassify; and.
  - (iii) to remove a reclassification.
- (b) The primary focus is on circuit voltages  $\geq 220$  kV but this does not preclude assessments being performed for circuit voltages  $< 220$  kV if reasonably considered to affect *power system security* (for example, constraints are required to manage *power system security*, multiple *generation* is at risk of being disconnected etc).
- (c) If the information being sought on a particular factor is incomplete or indeterminate, then the relevant NSP will make an assessment for that factor until further information becomes available (unless specified otherwise in Table 3).
- (d) If AEMO:
  - (i) was not previously aware of a bushfire in the proximity of transmission circuits and consequently had not performed an assessment as to whether a reclassification was required; and
  - (ii) has been advised of bushfires in that general area

then, if one of these transmission circuits trips and auto re-closes successfully, AEMO would consider reclassifying loss of multiple circuits within an easement as a *credible contingency event* (refer paragraph (f)). When further information becomes available, the relevant NSP would then undertake the normal assessment detailed in Table 3 to assist AEMO in determining whether to maintain or revoke the reclassification.
- (e) If the reclose is unsuccessful and a subsequent manual attempt fails or is not possible, then
  - (i) system security will be reassessed taking into account this unplanned outage; and
  - (ii) an assessment of the need to reclassify multiple losses of some of the remaining circuits in the easement will be undertaken (refer paragraph (f))
- (f) If there are multiple transmission circuits in an easement, the intent of the process is to identify and manage the double circuit or two adjacent single circuits most exposed to the bushfire front. These are deemed to be the critical elements requiring an assessment. The choice of the critical transmission circuits requiring assessment will be subject to changes in conditions and information updates (e.g. if the location of bushfire front changes from one side of the easement to the other side, or if there are unplanned outages of circuits in the easement). The assessment is to account for relative position and line reclose facilities as follows:
  - (i) Bushfire approaching the Easement — TNSP to undertake a Bushfire Risk Assessment on the two transmission lines most exposed to the bushfire front.
  - (ii) Bushfire has entered the Easement — TNSP to undertake a Bushfire Risk Assessment based on reclose facilities on the lines, as follows:
    - (A) Auto-reclose or Manual reclose available: TNSP to undertake a Bushfire Risk Assessment of combinations of any two transmission lines within the easement.
    - (B) Auto-reclose and Manual reclose not available: TNSP to undertake a Bushfire Risk Assessment of all transmission lines within the easement.

- (g) AEMO will request the TNSP to seek information from the relevant fire authority to identify if the fire crews are using aerial spraying of fire retardants on or over the transmission circuits and if so, AEMO will declare a reclassification of the relevant transmission circuits. In the case where there a number of multiple circuits in the same easement, then paragraph (f) will apply.
- (h) The presence of fire crews in an easement impacted by bushfires is likely to result in the auto re-close being suppressed on those transmission circuits in close proximity to the fire crews. This would impact on the factor in Table 3, Operator Actions – manual re-close.

### A.2.2 Bushfire threat to multiple easements

When there is a risk of multiple *transmission line* easements being impacted by bushfires burning across one or more *regions* AEMO may reclassify loss of multiple *plant* as a *credible contingency event*. This decision will be based on advice from NSPs on the increased likelihood of *transmission lines* tripping due to bushfires.

NSPs will monitor fire locations and their movements. NSPs will advise AEMO's control room promptly if they become aware of:

- fires moving towards easements;
- risk of losing multiple power lines across multiple easements.

NSPs may use multiple tools or resources (at their full discretion) to assess the risk of fires impacting *plant*. These tools/resources may include the Risk Assessment template provided in Table 3. Depending on the extent/area impacted by fires and number of easements at risk, conducting a risk assessment for each individual easement may not be practical under the circumstances, and a decision to reclassify could be based on most current advice/warnings including but not limited to:

- (a) advice from relevant fire authorities on location and movement of fires
- (b) fire weather warnings issued by the Bureau
- (c) severe weather warnings (including speed and direction of winds) issued by the Bureau
- (d) utilising observers on the ground
- (e) use of aircraft / drones to assess conditions on the ground from the air (subject to licence requirements / flight zone permits for operating aircraft / drones in each *region*).

## A.3 Response measures following reclassification

When AEMO has reclassified a *non-credible contingency event* involving multiple identified *transmission* circuits as credible due to bushfire conditions, AEMO will invoke the applicable reclassification constraints required to maintain *power system security* for the simultaneous loss of those circuits or, where there is a threat to multiple easements, take one or more measures in response to the prevailing *abnormal conditions* as detailed in section 8.4.3.

If AEMO identifies any *dispatch* and/or *pre-dispatch* outcomes warranting further attention, AEMO will discuss the outcomes with relevant *Market Participants* and NSPs (as time allows) and determine what options are available to resolve the issue, considering the range of measures in section 8.4.3.

## A.4 Cessation of reclassification

AEMO will cancel a reclassification due to bushfires when advised by NSPs that fires are no longer a threat to *plant*. NSPs may consider the following factors (without limitation) when assessing the threat of bushfires and advising AEMO of status change:

- (a) fire front has moved through with no material risk of further fires considering fuel load
- (b) winds have decreased in intensity or wind/fire direction has changed away from plant easements
- (c) fire has been extinguished
- (d) where threat impacts a specific easement, the conditions are below the threshold specified in Table 3.



## Appendix B. Reclassification Criteria – Lightning threat to double circuit transmission lines

### B.1 Risk to the power system

Under normal conditions the simultaneous trip of both circuits of a double circuit *transmission line* would be considered a *non-credible contingency event*.

During lightning storms AEMO may determine that the occurrence of that *non-credible contingency event* is reasonably possible and AEMO may reclassify that event to be a *credible contingency event*.

Lightning causing the trip of two adjacent single circuit *transmission lines* is considered to be highly unlikely and is generally not taken into consideration for reclassification.

### B.2 Double circuit transmission line categories

Table 4 Lightning assessment definitions

Term	Definition
Lightning trip	Simultaneous three phase trip of a double circuit transmission line during a lightning storm which cannot be attributed to a cause other than lightning and is not an Exceptional Event. Does not include a Successful Single Pole ARC or a trip of all phases of one circuit (only) of a double circuit transmission line.
Successful Single Pole Auto-reclose (ARC)	One three-phase line that undergoes a single pole operation and successful auto reclose, or two three-phase lines that each undergo a single pole protection operation simultaneously but not including a three phase ARC of either line. Lines that successfully single pole ARC are not to be moved from the possible to the probable category or probable to proven category and as a result no reclassification is required.
LTTW	Lightning Trip Time Window which is a rolling time period representing the previous three years or five years depending on the categories of vulnerable transmission lines.
Exceptional Event	Simultaneous trip of a double circuit transmission line during a lightning storm caused by an event that is far beyond what is usual in magnitude or degree for what could be reasonably expected to occur during a lightning storm
Vulnerable	Vulnerable transmission lines are double circuit transmission lines which fall into the categories for Probable or Proven

All double circuit *transmission lines* are categorised as Possible, Probable or Proven with respect of the likelihood of lightning trip. This process is shown in Figure 3.

#### Possible

All events are possible, however, if there is no evidence of the double circuit *transmission line* simultaneously tripping due to lightning during the LTTW, then during lightning storms no action will be taken to reclassify the trip of the double circuit *transmission line* as a *credible contingency event*, since it is not considered ‘reasonably possible’ for reclassification purposes under the NER.

#### Probable

A double circuit transmission line that has experienced a lightning trip during the three years LTTW is categorized as probable.

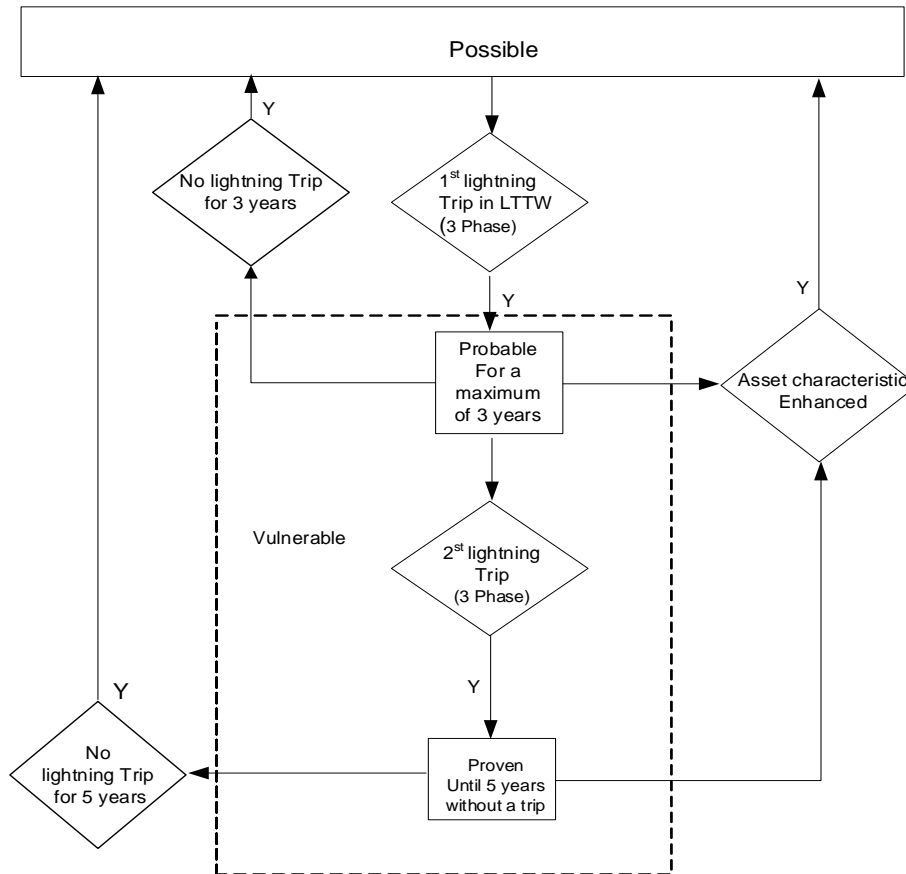
This double circuit line will return to the possible category when there are no further lightning trips in the three years LTTW.

### **Proven**

- Lines where the TNSP has advised AEMO of a deterioration in relevant characteristics to the extent that the line should be categorized as proven.
- There have been **two** lightning trips during the first three years LTTW.
- Double circuit transmission lines previously categorised as proven will remain in proven category until the circuits have gone five years without a trip (i.e. each further trip restarts the five years count). If the circuits do not trip for five years, the circuits will return to possible.

A double circuit line categorised as probable or proven can return to the possible category if it is demonstrated the asset characteristics have been improved to make the likelihood of a lightning trip no longer reasonably likely to occur.

Figure 3 Double circuit transmission line categories



### B.2.1 Vulnerable transmission lines

A double circuit *transmission line* in this category is eligible to be reclassified as a *credible contingency event* during a lightning storm if a cloud to ground lightning strike is detected within a specified distance of the vulnerable lines.

The list of current vulnerable lines is published on AEMO’s website and may be updated from time-to-time. It can be accessed using this link:

<https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation/power-system-operating-procedures/list-of-vulnerable-transmission-lines>

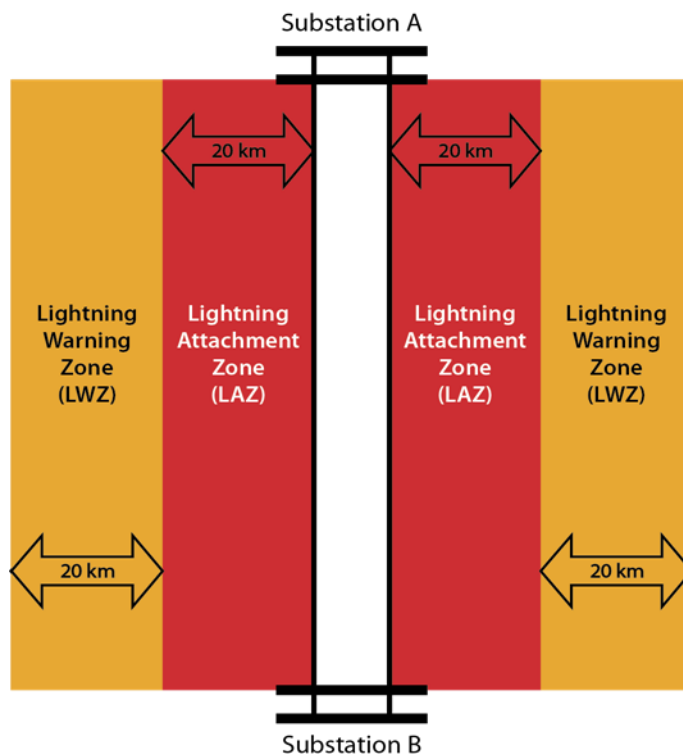
### B.2.2 Lightning detection zones

The Global Positioning and Tracking System (GPATS) is used to provide detection and location of cloud to ground lightning strikes. GPATS delivers ‘live’ data with a refresh rate of 1 second and provides full coverage of the *transmission system*.

Two (2) zones have been defined for the vulnerable *transmission lines* as shown in Figure 4.

- **lightning attachment zone (LAZ):** 20 km either side of the vulnerable double circuit transmission line, and
- **lightning warning zone (LWZ):** 20 km either side of the of the LAZ.

**Figure 4** Lightning detection zones for vulnerable lines

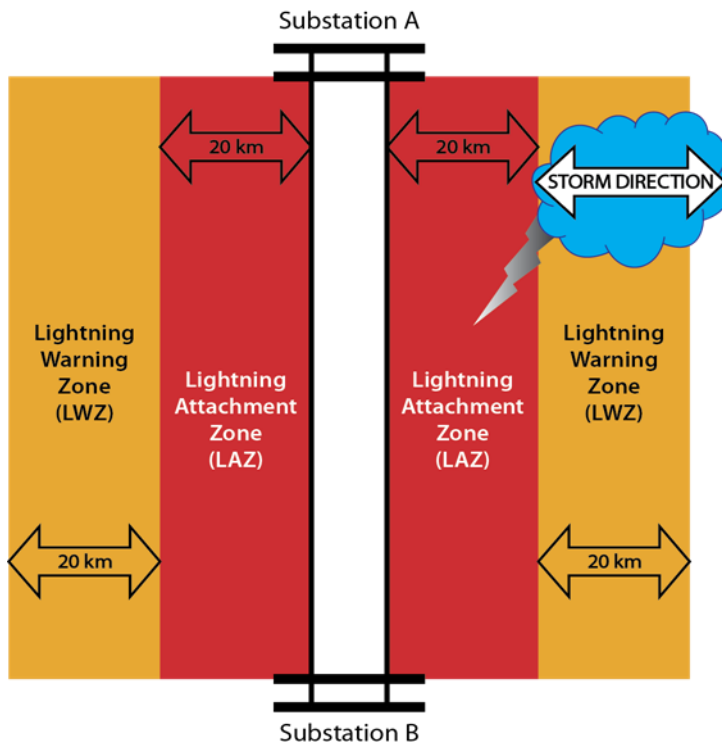


### B.2.3 Reclassification criteria

#### Lightning detected within the LAZ

If lightning is detected within the LAZ as depicted in Figure 5; AEMO will immediately reclassify the loss of the vulnerable double circuit *transmission lines* and if necessary apply a reclassification *constraint*.

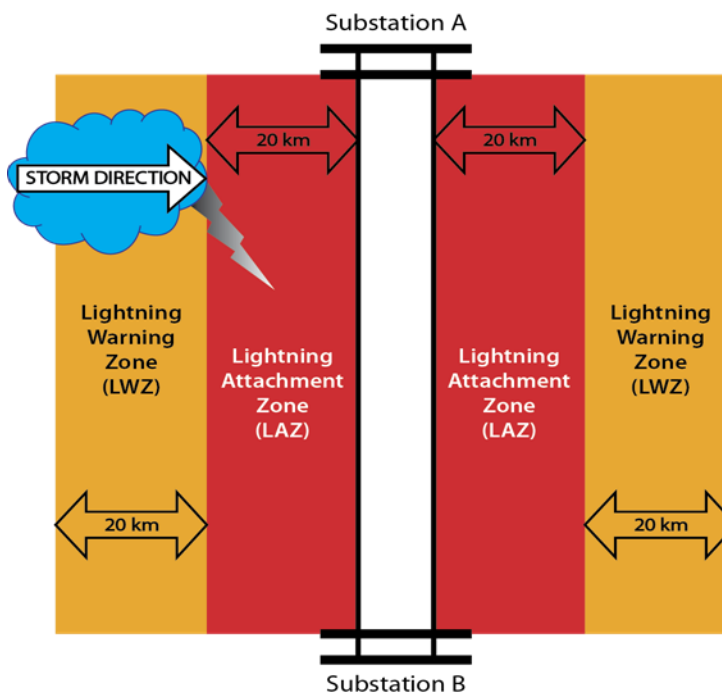
Figure 5 Lightning detected within the Lightning Attachment Zone (LAZ)



**Lightning detected within the LWZ and moving towards lines**

If lightning is detected within the LWZ only **and** the lightning storm is moving **towards** the vulnerable double circuit *transmission* line as depicted in Figure 6 – AEMO will reclassify the loss of the vulnerable double circuit *transmission* lines.

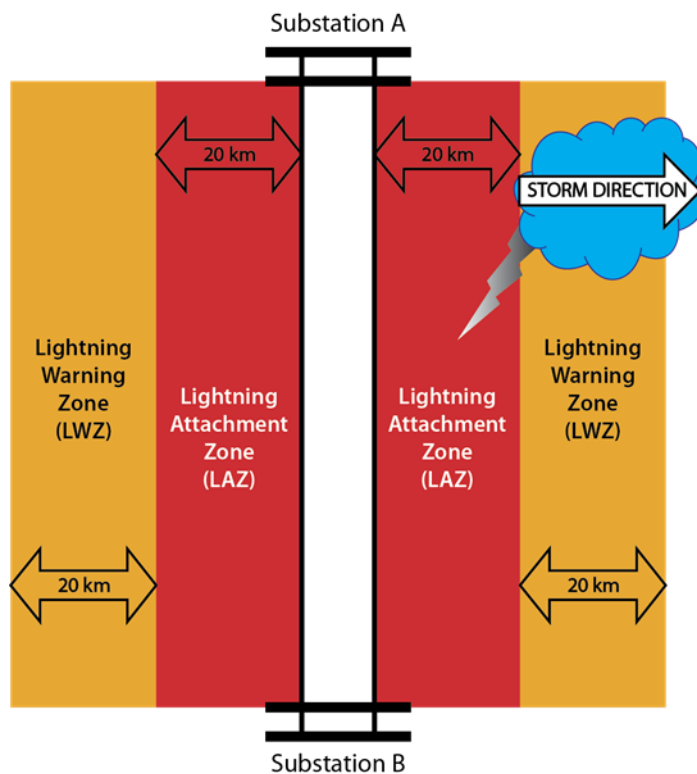
Figure 6 Lightning detected within the Lightning Warning Zone (LWZ) and is moving towards the lines



### Lightning detected within the LWZ and moving away from lines

If lightning is detected within the LWZ only **and** the lightning storm is moving **away** from the vulnerable double circuit *transmission line* as depicted in Figure 7, AEMO will not reclassify but will continue to monitor the situation and manage any change in circumstance depending on where the lightning is detected

Figure 7 Lightning detected within the Lightning Warning Zone (LWZ) and is moving away from the lines



## B.3 Reclassification process

- In conjunction with the criteria outlined above the following rules will be applied in the decision-making process.
- If there are multiple *transmission* circuits in an easement, AEMO will consider it reasonably possible that the *non-credible contingency event* may impact both circuits of a double circuit *transmission line*, but not adjacent single circuits.
- If there are multiple double circuit *transmission lines* in an easement, AEMO will consider it reasonably possible that the *non-credible contingency event* may impact only one double circuit *transmission line* at any point in time. AEMO will decide which double circuit to reclassify based on its reasonable opinion of which simultaneous trip poses the more critical risk to the *power system*.
- Individual records will be created for each assessment.
- If the information being sought on a particular factor is incomplete or indeterminate, then AEMO will assume the worst-case scenario for that factor until further information becomes available.
- If a vulnerable transmission circuit trips and auto re-closes successfully, AEMO would declare an immediate reclassification if the presence of lightning can be verified in either the LAZ or LWZ.

## B.4 Response measures following reclassification

When AEMO has reclassified a *non-credible contingency event* involving multiple identified transmission circuits as credible due to lightning conditions, AEMO will invoke the applicable reclassification constraints required to maintain *power system security* for the simultaneous loss of those circuits.

If AEMO identifies any *dispatch* and/or *pre-dispatch* outcomes warranting further attention, AEMO will discuss the outcomes with relevant *Market Participants* and TNSPs (as time allows) and determine what options are available to resolve the issue, considering the range of measures in section 8.4.3.

## B.5 Cessation of reclassification

When a period of 30 minutes has elapsed from the last detected cloud to ground lightning strike in an exclusion zone (either the LAZ or LWZ) then the reclassification will be cancelled.

## Appendix C. Reclassification Criteria – Specific risks relating to plant operation

### C.1 Reclassification criteria and assessment process

#### C.1.1 Following a non-credible event

If a *non-credible contingency event* has occurred in relation to any *plant*, AEMO must determine if this event is to be re-classified as a *credible contingency event on the basis that a recurrence is reasonably possible under the prevailing conditions*.

AEMO will take all reasonable steps to seek information to support its determination. Specifically, AEMO will seek information about whether the condition that caused the *non-credible contingency event* has been resolved.

If AEMO is unable to obtain the appropriate level of information or assurance to determine that a recurrence of the *non-credible contingency event* is not reasonably possible, then AEMO will reclassify that event as a *credible contingency event*. Where possible, AEMO will make this determination before the relevant *plant* is returned to service.

### C.2 Other threats to identified plant

Reclassification due to ‘other’ specific risks relating to the operation of identified *plant* may include but is not limited to the following (i.e. these are examples only):

#### C.2.1 Multiple plant disconnection

Upon receiving advice of a threat that may result in the simultaneous or sequential *disconnection* of multiple *plant*, AEMO will assess the advice and may make a decision to reclassify a *non-credible contingency event* to a *credible contingency event*.

In making this determination AEMO will take advice from the TNSP and other relevant *Registered Participants* with regards to the likelihood of multiple *plant* disconnections.

Examples of threats to *plant* operation that could lead to simultaneous or sequential disconnection or shutdown of *plant* include and are not limited to:

- Reduction in *plant* facility redundancy, for example, but not limited to:
  - Air compressor system redundancy
  - Auxiliary supply system redundancy
- Environmental factors such as forecast or actual floods, landslides etc.
- Cyber security.

**Note:** It should be noted that these are examples only and not an exhaustive list of threats that could lead to simultaneous or sequential disconnection or shutdown of *plant*.

#### C.2.2 Impact of pollution on transmission line insulators

AEMO will take advice from the TNSP with regard to the likelihood of multiple *transmission line disconnections* arising from the effects of pollution on the transmission line insulators. Based on



this advice AEMO will initiate a reclassification of a *non-credible contingency event* to a *credible contingency event*.

### C.2.3 Impact of severe winds on specific transmission structures

AEMO will take advice from the TNSP with regard to the likelihood of multiple *transmission line disconnections* where forecast wind speeds may exceed the design withstand limits of certain *transmission* structures. Based on this advice AEMO will initiate a reclassification of a *non-credible contingency event* to a *credible contingency event*.

### C.2.4 Impact of protection or control systems malfunction

AEMO will take advice from the relevant *Registered Participant* with regard to the likelihood of multiple *disconnections* or sudden reductions in output or power flow arising from the impact of protection or control systems malfunction on *plant*. Based on this advice AEMO will initiate a reclassification of a *non-credible contingency event* to a *credible contingency event*. AEMO may request that the faulty protection system is removed from service, if in-service protection is not compliant with the NER S5.1.9 protection systems and fault clearance times.

## C.3 Response measures following reclassification

In order to satisfy AEMO's *power system security* obligations during reclassification, AEMO will invoke the applicable reclassification constraints required to maintain *power system security* for the simultaneous loss of the identified *power system plant*.

If the loss of multiple *generating units/production units* will result in *transmission* limits being exceeded, then the *generating units/production units* under threat will be constrained to a level where satisfactory limits are not exceeded post contingent.

If AEMO identifies any other *dispatch* and/or *pre-dispatch* outcomes warranting further attention, AEMO will discuss the outcomes with relevant *Market Participants* and TNSPs (as time allows) and determine what options are available to resolve the issue, considering the range of measures in section 8.4.3.

## Appendix D. Reclassification Criteria – Severe winds (including tropical cyclones)

### D.1 Risk to the power system

Severe wind events are associated with severe weather<sup>11</sup> and tropical cyclones<sup>12</sup>. Severe weather events include severe thunderstorms, tornados, east coast lows, tropical severe thunderstorms. Severe weather events and tropical cyclones typically manifest into damaging / destructive winds or violently rotating column of air in contact with land or water. Risks to the *power system* include:

- Wind-borne debris becoming entangled with overhead power lines.
- Excessive loading on the towers, poles and power lines leading to damage/collapse of electricity infrastructure.
- Damage to generating plant (solar and wind farms).
- Widespread wind farm turbine cut-out.
- Multiple transmission faults causing disconnection of multiple *transmission elements*, loads or other *plant*, or disconnection or rapid reduction in output of multiple *generating units/production units*.

### D.2 Reclassification process

If AEMO receives information on severe wind conditions, AEMO will determine whether a *non-credible contingency event* is more likely to occur in the actual or forecast wind-related *abnormal conditions*.

Risk assessment of severe wind conditions to *network elements* includes consideration of severe weather warnings<sup>13</sup> and cyclone warnings<sup>14</sup> published by the Bureau. For reference, wind classifications by the Bureau are included in Table 5 below.

**Table 5 Wind classifications**

Wind Classification	Wind Gusts (km/h)	Cyclone Category	Sustained Wind (km/h)
Damaging	Below 125	1	63 – 88
Destructive	125 – 164	2	89 – 117
Very Destructive	165 – 224	3	118 – 159

Whilst most *networks* are very resilient and designed to withstand strong winds, most damage occurs due to wind-borne debris becoming entangled with overhead lines. Under such circumstances, AEMO should take reasonable measures to control such contingencies. However, such events often give rise to emergency situations where *load shedding* could limit

<sup>11</sup> <http://www.bom.gov.au/weather-services/severe-weather-knowledge-centre/>

<sup>12</sup> <http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/>

<sup>13</sup> <http://www.bom.gov.au/weather-services/severe-weather-knowledge-centre/warnings.shtml>

<sup>14</sup> <http://www.bom.gov.au/tsunami/?ref=fr>

the capability of emergency services (e.g. water pumps becoming unavailable during flooding). Advice from the relevant *Registered Participant* should be sought in order to balance these conflicting requirements.

### D.3 Wind vulnerable lines

A small number of *transmission lines* (including double circuit *transmission lines*) have lower wind ratings compared to the standard design used in their region. These *transmission lines* are classified as wind vulnerable lines.

When AEMO receives BOM severe weather warning alerts, it will reclassify the simultaneous trip of more than one affected wind vulnerable line as a *credible contingency event* and invoke relevant constraints when the severe wind condition is imminent:

1. after it has confirmed the classification of the severe wind condition and the affected district with the BOM; AND
2. the severe wind condition exceeds the reclassification trigger level advised by the relevant TNSP.

If the BOM severe weather warning alert specifies the time period a severe wind condition is anticipated, AEMO will reclassify the relevant wind vulnerable lines for that period.

If the start time and duration are not specified in the BOM weather warning alert, AEMO will attempt to ascertain start time and the duration of the anticipated severe wind condition from the BOM. If start time is not available and the severe wind condition is not imminent at the time, AEMO will seek more accurate information before taking the above action.

The list of current wind vulnerable lines is published on AEMO's website and may be updated from time-to-time. It can be accessed using this link:

<https://aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation/power-system-operating-procedures/list-of-wind-vulnerable-transmission-lines>

### D.4 Response measures following reclassification

AEMO may take one or more measures in response to prevailing severe wind conditions as detailed in Section 8.4.3.

### D.5 Cessation of reclassification

AEMO will cancel a reclassification due to severe wind conditions when there is no longer added risk to the power system (taking into consideration information such as, cancellation of severe wind warnings/alerts, issued by the Bureau.<sup>15</sup>).

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<sup>15</sup> <http://www.bom.gov.au/australia/warnings/index.shtml>

## Appendix E. Reclassification Criteria – Geomagnetic disturbances

### E.1 Risk to the power system

Solar storms produce geomagnetic disturbances (GMD) that may pose added risks to the *power system* resulting from the introduction of Geomagnetic Induced Current (GIC).

Severe GMD events are forecast with associated notifications issued by the Bureau. The event involves the observation of a coronal mass ejection associated with a solar flare anticipated to impact the Earth within 48 hours. Heightened awareness of the *power system*, by AEMO and *Registered Participants* is recommended during this period.

There are two risks that result from the introduction of GICs to the *power system*:

- (a) Loss of reactive power support, due to harmonic current, combined with increased reactive power consumption by transformers, which could lead to voltage instability and power system collapse, and
- (b) Damage to power system assets, typically associated with transformers.

### E.2 Reclassification process

The Bureau’s Space Weather branch<sup>16</sup> (IPS Radio and Space Services) has developed a Severe Space Weather Service (SSWS) aimed at forecasting severe space weather events considered most hazardous to critical infrastructure such as the Australian *power system*.

The model produces forecasts (watch messages) based on solar data only (providing lead times > 12 hours) and updated forecasts with increased probability that utilise additional solar wind data but with a decreased warning lead time of only 30-60 minutes.

AEMO has developed the criteria outlined in Table 6 to facilitate the decision making process and manage power system security in the unlikely event of a GMD forecast which is large enough to adversely affect the *power system*. Table 6 below tabulates notifications from SSWS for both warning and watch events, the available lead time before the storm reaches earth and the suggested AEMO actions. AEMO will initiate the mitigating actions outlined in Section E3 below in response to the notifications from the SSWS.

**Table 6 SSWS notifications - Summary of notifications, timeframes and AEMO actions**

NOTIFICATION from SSWS	ETA (Forecast lead time)	ETD (Warning lead time)	AEMO Actions
Severe Space Weather Watch	12hrs+	TBA	<ol style="list-style-type: none"> <li>1. Issue a Market Notice</li> <li>2. Increased awareness for next 48 hours</li> <li>3. Maintain increased awareness of GIC monitored equipment</li> </ol>

<sup>16</sup> <https://www.sws.bom.gov.au/?ref=fttr>

NOTIFICATION from SSWS	ETA (Forecast lead time)	ETD (Warning lead time)	AEMO Actions
<b>Short Duration GIC Warning</b>	NOW	30-60 mins.	<ol style="list-style-type: none"> <li>1. Issue a Market Notice</li> <li>2. Maximise dynamic reactive reserves across the power system</li> <li>3. AEMO instruct restoration of transmission outages</li> <li>4. Maintain increased awareness for more warnings 24hrs</li> <li>5. Maintain increased awareness of GIC monitoring equipment</li> </ol>
<b>Sustained GIC activity Warning</b>	30-60 mins	6-12 hrs	<ol style="list-style-type: none"> <li>1. Issue a Market Notice</li> <li>2. Maximise reactive reserves across the power system</li> <li>3. Instruct the restoration of transmission outages</li> <li>4. TNSP may re-rate transformers (possibility of instructing for load shedding)</li> <li>5. TNSP may advise intent to take transformer out of service due high impact of GIC. May have to instruct load shedding to maintain security</li> <li>6. Maintain increased awareness of GIC monitoring equipment levels</li> <li>7. Maintain increased awareness &amp; monitor for "Event End"</li> </ol>
<b>Severe Space Weather Event End</b>	NOW	NOW	<ol style="list-style-type: none"> <li>1. Issue Market Notice</li> <li>2. Return power system to normal operations</li> <li>3. Maintain increased awareness of GIC monitoring equipment levels</li> <li>4. Maintain increased awareness and monitor for any further "Warnings" and/or "Cancellations" notices</li> </ol>

### E.3 Response measures following reclassification

AEMO may initiate the following actions in response to a **severe** GMD on SSWS advice:

- Instruct the restoration of out of service *transmission* lines and *transformers* as well as discontinue planned *transmission outages*, including<sup>17</sup>:
  - interconnectors*,
  - equipment impacting on main system *transformer* loadings.
- Maximise reactive power reserves across the power system.
- Request TNSPs to advise of revised *transformer* ratings, allowing the *transformer* to operate at cooler temperatures, to prepare for the onset of stray flux heating from the GIC.
- Request TNSPs to advise of their intent to take *transformer(s)* out of service due to the high impact of the GIC.
- AEMO may take other measures in response to prevailing *abnormal conditions* as detailed in Section 8.4.3.

<sup>17</sup> This action allows the GIC to be split between more transmission lines and transformers and also lowers the 50 Hz loading per transformer. This enables the transformers to run cooler and hence have more headroom for GIC heating effects and less saturation effects.

## E.4 Cessation of reclassification

AEMO will cancel reclassification due to solar storms when AEMO considers that there is no longer any added risk to the *power system*. AEMO will take into consideration relevant information and advice, including notifications issued by SSWS:

- (a) “Severe space weather CANCELLATION” - cancellation notice is issued when the threat period is over or in the unlikely event that a “Watch” message has been incorrectly issued.
- (b) “Severe space weather EVENT END” – event end notice is issued when both solar data and solar wind data indicate GMD event has ended.

## Appendix F. Reclassification Criteria – Floods

### F.1 Risk to the power system

Riverine flooding is the most common type of flooding in Australia. Major flooding, where rivers break their banks and inundate urban and rural areas could lead to widespread damage/loss of plant. Impacts to the power system include:

- flooding of *generation* plant (e.g. solar farms) leading to loss of multiple *generation*
- flooding of network plant (e.g. substations) leading to loss of multiple plant
- flooding of tower/pole footings under high velocity flows can lead to collapse of towers / poles
- flooding / heavy rain impacting fuel reserves (e.g. flooding of coal mine or coal reserves stack) or delivery of fuel (coal or diesel) due to blocked roads/railways
- constraining of hydro *generation* due to high dam / river levels and floods to the areas downstream of the dam
- potential for minimum system load scenario due to sudden changes in *generation* and/or load

### F.2 Reclassification process

AEMO will work in co-ordination with Asset Owners to make decisions associated with reclassification of *non-credible contingency events* as *credible contingency events* during the presence of floods.

On becoming aware of an increased threat to the *power system* due to floods (through advice provided by *Registered Participants* or otherwise), AEMO will decide based on available information, whether *non-credible contingency events* involving multiple *plant* should be reclassified as a *credible contingency event*.

*Registered Participants* may use multiple tools or resources (at their full discretion) to assess the risk of floods impacting their *plant*. These tools / resources may include:

- advice from relevant authorities on flood warnings, flood locations, current and expected water levels and direction of movement of water (e.g. three tiered classification scheme used by the Bureau noted below)
- proximity of *network* and *generation plant* and coal mine / reserve stack to water catchments/major river systems that may be at risk of overflow / spillage
- utilising observers on the ground
- use of aircraft / drones to assess conditions on the ground from the air (subject to licence requirements / flight zone permits for operating aircraft / drones in each region)
- use of local council flood maps to identify most vulnerable areas at risk of flooding including roads / railway prone to flooding which could restrict access to plant and/or delivery of fuel to *generation* centres

The Bureau uses a three-tiered classification scheme that defines flooding as minor, moderate or major at key river height stations. Each classification is defined by the water level that causes certain impacts upstream and downstream of the station.<sup>18</sup> Flood Watch provides early advice of developing situations that may lead to flooding. A Flood Warning is issued when flood is likely to occur or is already occurring.

### F.3 Response measures following reclassification

AEMO may take one or more measures in response to prevailing *abnormal conditions* as detailed in Section 8.4.3.

### F.4 Cessation of reclassification

AEMO will cancel reclassification due to floods when advised by Asset Owners that floods are no longer a threat to *plant*. Asset Owners may consider the following factors (without limitation) when assessing the threat of floods and advising AEMO of status change:

- (a) water levels are retreating and no longer pose a risk to assets
- (b) cancellation of Flood Warnings issued by the Bureau

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<sup>18</sup> <http://www.bom.gov.au/australia/flood/knowledge-centre/>



## Appendix G. Reclassification Criteria – Widespread Pollutants

### G.1 Risk to the power system

Pollutants can form in many ways, for example, dust storms<sup>19</sup> or sandstorms often blown into an area by strong winds from thunderstorms. Periods of severe and widespread drought can dramatically increase the likelihood of major dust storms, particularly during the summer months.

Bushfires can generate large volumes of ash or smoke which is spread over large areas covering multiple states.

Humidity coupled with pollutant build-up within the powerline easements or build-up of pollutants on insulators can lead to flash over and operation of protection systems and disconnection of multiple power lines.

Pollutants build up around solar *generation* centres can lead to loss of multiple *generating units* or significant reduction in *generation* output.

### G.2 Reclassification process

AEMO will work in co-ordination with Asset Owners to make decisions associated with reclassification of *non-credible contingency events* as *credible contingency events* during the presence of widespread pollutants around *network* or *generation* assets.

On becoming aware of an increased threat to the *power system* due to widespread pollutants (through advice provided by *Registered Participants* or otherwise), AEMO will decide, based on available information, whether *non-credible contingency events* involving multiple *plant* should be reclassified as a *credible contingency event*.

Asset Owners may use multiple tools or resources (methods to be used are at full discretion of Asset Owners) to assess the risk of pollutants impacting *plant*. These tools/resources may include and are not limited to:

- (a) advice from relevant authorities on widespread pollutants, for example, Dust Storm Warnings issued by the Bureau
- (b) utilising observers on the ground

### G.3 Response measures following reclassification

AEMO may take one or more measures in response to prevailing *abnormal conditions* as detailed in Section 8.4.3.

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<sup>19</sup> <http://www.bom.gov.au/nsw/sevwx/facts/dust.shtml>

## G.4 Cessation of reclassification

AEMO will cancel reclassification due to widespread pollutants when advised by relevant *Registered Participants* that pollutants are no longer a threat to *plant*. *Registered Participants* may consider the following factors (without limitation) when assessing the threat of pollutants and advising AEMO of status change:

- (a) cancellation of warnings/alerts issued by the Bureau indicating threat of dust / sand storms, bushfire air pollution / clouds has passed
- (b) winds have decreased in intensity or wind direction has changed and there is no longer risk of pollutants impacting *plant*

## Appendix H. Reclassification Criteria – Landslides

### H.1 Risk to the power system

Landslides could occur at any time where ground is unstable. In some areas risk of landslides increases following extended periods of rain. Bushfires can also cause long-last impacts increasing the chance of flooding due to loss of plants and roots that are natural landslide stoppers.

Landslides could lead to widespread damage/loss of:

- plant
- fuel supplies (e.g. delivery of coal or diesel fuel is impacted due to blocked roads/railways)
- interruption of large industrial *load* facilities
- collapse of coal ash tailings dams impacting *transmission* and *generation* infrastructure

### H.2 Reclassification process

On becoming aware of an increased threat to the *power system* due to landslides (through advice provided by *Registered Participants* or otherwise), AEMO will decide, based on available information, whether *non-credible contingency events* involving multiple *plant* should be reclassified as a *credible contingency event*.

### H.3 Response measures following reclassification

AEMO may take one or more measures in response to prevailing *abnormal conditions* as detailed in Section 8.4.3.

### H.4 Cessation of reclassification

AEMO will cancel reclassification due to landslides when AEMO considers (based on available information) that there is no longer added risk to the *power system*.

## Appendix I. Reclassification Criteria – Sudden or unexpected changes in solar generation

### I.1 Risk to the power system

Solar *generation* output can change rapidly due to events such as:

- cloud cover - when sunlight hits low clouds a lot of light (and heat) is reflected into space
- solar eclipse - when the moon moves between the sun and earth
- dust / sand storm or bushfire smoke / ash – a wall of dust / smoke and debris that is often blown into an area by strong winds from thunderstorms or bushfires. Periods of severe and widespread drought can dramatically increase the likelihood of major dust storms, particularly during the summer months (this issue is covered in more detail in Appendix H)

The reduction in solar irradiation, due to these events, will directly affect the output of photovoltaic (PV) *generating plant* and rooftop solar. Rapid and large changes in solar *generation* output can lead to supply/demand imbalance (i.e. large and sudden *frequency* deviations), overloading (and potential permanent damage) of power lines, *voltages* exceeding secure *power system* operating limits, and possible minimum system load scenarios.

### I.2 Reclassification process

#### Solar Eclipse

On becoming aware of an increased threat to the *power system* due to solar eclipse (through advice provided by *Registered Participants*, the Bureau, general media or otherwise), AEMO will decide, based on available information, whether *non-credible contingency events* involving multiple *plant* should be reclassified as a *credible contingency event* giving regard to relevant factors, including:

- the path of the eclipse;
- areas that will be experiencing total or partial eclipse and estimated reduction in solar irradiance;
- time of day (with regard to likely impact on solar *generation*); and
- anticipated ramping up or down of solar *generation* at the onset and end of the eclipse.

#### Cloud Cover

It is acknowledged that cloud cover events cannot be actively managed in a targeted manner through existing real time operational processes and systems. Further work is required in collaboration with the Power System Security Working Group and wider energy industry to identify and evaluate technological developments that could enable real time management of sudden changes in solar *generation* output, for example to:

- (a) automatically flag oscillating *generation/load* events on the power system
- (b) track cloud cover location / size / movements through radar observation or other forecasting methods / alerts that may become available (e.g. monitoring of metro areas with large clusters of DPV, Renewable Energy Zones and solar *generation centres*, etc.)

### **I.3 Response measures following reclassification**

Actions to prepare for solar eclipse may include:

- (a) procuring additional regulating raise and regulating lower FCAS
- (b) maximise availability of fast start/ramping gas and hydro *generating units* to fill in any deficit in *reserves*
- (c) engaging with customers to reduce electricity usage where safe to do so during eclipse hours

Further measures may be developed for cloud cover events pending availability of real time monitoring.

### **I.4 Cessation of reclassification**

AEMO will cancel reclassification due to eclipse when solar eclipse passes (noting likely end time through advice provided by the Bureau or otherwise) and there is no longer added risk to the power system.

Cloud cover pending availability of real time monitoring.

## Appendix J. Reclassification Criteria – Earthquakes and tsunamis

### J.1 Risk to the power system

While historical seismicity in Australia has been relatively low, larger magnitude earthquakes do occur in Australia. Major earthquakes are usually followed by aftershocks that can cause significant damage to energy infrastructure. Geoscience Australia (GA) indicates the country records at least one magnitude 5 earthquake every year and a magnitude 6 approximately every ten years.<sup>20</sup> Earthquakes originating in oceans could trigger tsunamis and cause catastrophic damage to energy infrastructure along the coastlines.

### J.2 Reclassification process

#### Earthquakes

Currently, there are no means of predicting accurately when an earthquake is likely to occur, however aftershocks are common after a major earthquake. GA operates the National Earthquake Alerts Centre<sup>21</sup> to provide monitoring, analysis and alerting of significant earthquakes to the emergency management sector. GA provides up to date information on latest earthquakes in Australia and surrounding regions<sup>22</sup>

#### Tsunamis

The Joint Australian Tsunami Warning Centre (JATWC) was established to detect, monitor, verify and warn the community of the existence of tsunamis in our region and possible threats to Australian coastal locations and offshore territories<sup>23</sup>. JATWC is operated by the Bureau and Geoscience Australia (GA). The major objective of the JATWC is to provide emergency managers with a minimum of 90 minutes warning of a likely tsunami impact on mainland Australia.

#### Reclassification

AEMO in collaboration with Asset Owners will review any warnings issued by the Bureau, JATWC and GA in relation to major earthquake, size and likelihood of aftershocks or potential of tsunamis impacting the Australian coastline. A decision to reclassify will take into consideration the following:

- (a) threat level
  - (i) the tsunami has the potential to cause inundation to low-lying coastal areas with need for major evacuation (land threat)

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<sup>20</sup> <https://knowledge.aidr.org.au/resources/ajem-april-2019-earthquakes-happen-in-australia-but-are-we-prepared/>

<sup>21</sup> <https://www.community-safety.government.gov.au/data-and-products/neac>

<sup>22</sup> <https://earthquakes.ga.gov.au/>

<sup>23</sup> <http://www.bom.gov.au/tsunami/about/jatwc.shtml>

- (ii) the tsunami is confined to dangerous rips and currents and some localized overflow onto the immediate foreshore with no need for major evacuation (marine threat)
- (b) predicted tsunami path or size of earthquake aftershocks, likely impact zones and location of *network* assets and *generating plant* within impact zones
- (c) speed and height of sea waves

### J.3 Response measures following reclassification

AEMO may take one or more measures in response to prevailing *abnormal conditions* as detailed in Section 8.4.3.

### J.4 Cessation of reclassification

AEMO will cancel reclassification due to earthquake/tsunami by consulting with Asset Owners and having regard to advice / cancellation of warnings issued by the Bureau, JATWC and GA.

## Appendix K. Reclassification Criteria – Large scale social unrest

### K.1 Risk to the power system

Risks to the power system include:

- (a) major industrial action impacting operations of the *market* or power system
- (b) vandalism or sabotage of significant power system assets
- (c) humanitarian crisis impacting operations etc.

### K.2 Reclassification process

- (a) On becoming aware of an increased threat to the *power system* due to large scale social unrest (through advice/warnings provided by the Government, police, relevant authority or otherwise), AEMO will decide, based on reasonably available information, whether *non-credible contingency events* involving multiple *plant* should be reclassified as a *credible contingency event* giving regard to: size / scale of unrest / conflict
- (b) high risk areas, reports of likely asset damage

### K.3 Response measures following reclassification

AEMO may take one or more measures in response to prevailing *abnormal conditions* as detailed in Section 8.4.3.

### K.4 Cessation of reclassification

AEMO will cancel reclassification due to large scale social unrest when AEMO considers, based on reasonably available information, that there is no longer added risk to the *power system*. AEMO will have regard to any advice / warnings issued by the Government, police, and other relevant authorities.



## Appendix L. Reclassification Criteria – Cyber attack

### L.1 Risk to the power system

Cyber attacks can manifest in different forms, vary significantly in the form of penetration and impact, and can be difficult to control and eradicate. The Security of Critical Infrastructure (SoCI) Act requires that regulated entities employ a risk management plan based on a relevant document such as the Australian Energy Sector Cyber Security Framework (AESCSF).<sup>24</sup> Risks to the *power system* depend on the target(s) of the attack and the nature and extent of interdependencies for *power system* equipment and operability, and could include:

- AEMO/ *Registered Participant* IT infrastructure or communications systems compromised leading to loss/denial/manipulation of view/control of:
- key power system parameters causing plant to operate above secure levels;
- supply/demand balance causing inability to monitor *power system frequency* and presenting increased risks to *power system security for contingency events*.
- compromised *control systems* leading to loss/denial/manipulation of view/control of, *plant operability* or *plant safety*
- widespread loss of *load* or *generation*
- reliance on voice communications with *Registered Participants* and customers.

### L.2 Reclassification process

On becoming aware of an increased threat to the *power system* due to an actual or credible threat of cyber attack, AEMO will decide whether *non-credible contingency events* involving multiple *plant* should be reclassified as a *credible contingency event* having regard to:

- (a) advice/alerts by Australian Cyber Security Centre
- (b) cyber security advice received by AEMO, *Registered Participants* and relevant customers
- (c) potential scale of impact, e.g organisation-wide, industry-wide, primary or backup systems
- (d) criticality of systems at risk

### L.3 Response measures following reclassification

AEMO may take one or more measures in response to prevailing *abnormal conditions* as detailed in Section 8.4.3.

### L.4 Cessation of reclassification

AEMO will cancel reclassification due to cyber attack when AEMO considers, based on available information, that there is no longer added risk to the power system. AEMO will also have regard to advice and warnings issued by all relevant authorities.

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<sup>24</sup> <https://aemo.com.au/en/initiatives/major-programs/cyber-security/aescsf-framework-and-resources>

## Version release history

Version	Effective Date	Summary of Changes
<a href="#">104</a>	<a href="#">20 March 2024</a>	<a href="#">Updated 7.2 Definition of a Non-Credible Contingency Event relating to multiple generating units</a>
103	06 November 2023	<p>Updated Basslink Technical Envelope (Section 10).</p> <p>Added Section 9, Communication System Outages.</p> <p>Added a section on wind vulnerable lines and the associated action in Appendix D.</p> <p>Frequency Operating Standard changes effective 9 October 2023 including:</p> <ul style="list-style-type: none"> <li>- removal of the limit for accumulated time error (Section 16)</li> <li>- replaced term "supply scarcity" with "system restoration" (Section 16).</li> </ul>
102	09 March 2023	<p>Revised/removed sections 8 and 9 and added new appendices to consolidate and extend reclassification criteria, following the National Electricity Amendment (Enhancing operational resilience in relation to indistinct events) Rule 2022 No.1.</p> <p>Updated definition of contingency event (section 7) following above rule change.</p> <p>Minor drafting and standardisation improvements</p>
101	6 Feb 2023	<p>Amendments to "Factors and Weightings to Assess Impact of Bushfires on Circuits" based on the Australian Fire Danger Rating System came into effect from September 2022.</p> <p>Updated section 4.1 (Declare a black system) to remove reference to QLD North and South electrical sub-networks.</p> <p>Reversal of Basslink reclassification on 1 February 2023.</p>
100	13 May 2022	<p>Table 5 - Vulnerable Transmission Lines; and Table 6 - Special Reclassification of Transmission Lines during lightning were removed from SO_OP_3715 and published on AEMO's website:  <a href="https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation/power-system-operating-procedures/list-of-vulnerable-transmission-lines">https://www.aemo.com.au/energy-systems/electricity/national-electricity-market-nem/system-operations/power-system-operation/power-system-operating-procedures/list-of-vulnerable-transmission-lines</a></p> <p>Table references updated.</p>
99	21 January 2022	<p>Vulnerable Transmission Line information for Eildon PS – Mt Beauty No.1 and No.2 220 kV lines in Table No.5 updated.</p> <p>Update to LTTW end date for Collinsville North – Proserpine No.7125 and No. 7126 132 kV line.</p> <p>Added Collinsville – Stoney Creek No.7306 and Collinsville – Newlands No.7121 132 kV lines to QLD Vulnerable Transmission Lines in Table 5.</p>
98	24 October 2021	<p>Updated for Wholesale Demand Response.</p> <p>Rule changes were made in June 2020 and the relevant schedules commence operation on 24 October 2021.</p>
97	1 October 2021	<p>Updated Table 5 Vulnerable Transmission Lines to remove Dumaresq – Bulli Creek 8L &amp; 8M due to expiry of the of LTTW period. Terminology updated for Five Minute Settlements Rule commencing from 1 October 2021.</p>
96	7 April 2021	<p>Updated Section 2.5 Reliability and Emergency Reserve Trader</p> <p>Updated Section 5 Manual Load Shedding and Restoration</p> <p>Updated Section 8.3 Reclassification due to Bushfires</p> <p>Updated Section 8.4 Table 4 Lightning Assessment Definitions</p> <p>Updated Section 8.4.1 on the description of "Possible" double circuit transmission line category by removing reference to the availability of shielding.</p> <p>In vulnerable line list in NSW region:</p> <ul style="list-style-type: none"> <li>• Added Bayswater – Mt piper No. 5A3 and Mt Piper – Wollar No. 5A5 500 kV lines.</li> <li>• Added Lismore – Mullumbimby tee Dunoon 9U6 and 9U7 132 kV Lines.</li> </ul> <p>In vulnerable line list in TAS region:</p> <ul style="list-style-type: none"> <li>• Added Lindisfarne – Sorrell and Lindisfarne – Sorrell – Triabunna_Tee 110 kV lines.</li> </ul>

Version	Effective Date	Summary of Changes
		<ul style="list-style-type: none"> <li>Added Lindisfarne — Mornington Tee — Rokeby No 1 and 2 110 kV Lines.</li> <li>Updated the category and relevant information of Tungatinah – New Norfolk tee Meadowbank No. 1 and No. 2 110 kV lines as non-shielded lines are no longer in Proven category by default.</li> <li>Removed Tungatinah - New Norfolk tee Meadowbank No. 1 and No. 2 110 kV Lines (end of Lightning Trip Time Window).</li> <li>Removed Goonyella - North Goonyella Tee - Stoney Creek No. 7122 and the Goonyella - Newlands No. 7155 132 kV Lines (end of Lightning Trip Time Window). Updated LTTW End Date of Farrell – Reece No. 1 and No. 2 220 kV lines.</li> <li>Removed Chapel St – Liapootah No. 1 and No. 2 220 kV lines as these lines have not tripped since 16 December 2014 and non-shielded lines are no longer in Proven category by default.</li> <li>Removed Norwood – Scottsdale – Derby and Norwood – Scottsdale 110 kV lines (end of Lightning Trip Time Window).</li> </ul> <p>In vulnerable line list in QLD region:</p> <ul style="list-style-type: none"> <li>Removed Chalumbin – Turkinje No. 7165 and No. 7166 132 kV lines as these lines have not tripped in the past five years.</li> <li>Removed Moranbah – Goonyella No. 7369 and No. 7370 132 kV lines as these lines have not tripped in the past three years.</li> <li>Removed Collinsville – Stoney Creek No.7306 and Collinsville – Newlands No.7121 132 kV lines as these lines have not tripped in the past five years.</li> <li>Added Condabri North – Condabri Central No.7400 and No.7401 132 kV lines.</li> <li>Updated LTTW date for Ross – Chalumbin No. 857 and No. 858 275 kV lines. The previous LTTW End Date was 21 January 2020. On 25 January 2020 the lines tripped again due lightning</li> </ul> <p>Updated LTTW date for Tarong – Chinchilla No. 7183 and 7168 132 kV lines. The previous LTTW End Date was 20 February 2023. On 28 October 2020 the lines tripped again due lightning.</p>
		<p>Added Table 6 Special reclassification of transmission lines during lightning.</p> <p>Removed Section 14.3 Transmission line switching for voltage control.</p> <p>Added Section 14.3 System Strength and Inertia.</p> <p>Updated Section 16 Control of Power System Frequency and Time Error.</p> <p>Minor editorial changes.</p>
95	23 September 2019	<p>Multiple changes to Reclassifying Contingency Events section (8)</p> <p>In vulnerable line list:</p> <ul style="list-style-type: none"> <li>VIC region: Updated LTTW End Date of Eildon PS – Mt Beauty No.1 and No.2 220 kV Lines.</li> <li>TAS region: Updated LTTW End Date of: <ul style="list-style-type: none"> <li>Farrell–John Butters 220 kV line and Farrell–Rosebery–Newton–Queenstown 110 kV line.</li> <li>Farrell – Reece No.1 and No.2 220 kV lines</li> </ul> </li> </ul> <p>Added section (14.3) for transmission line switching for voltage control</p> <p>Change to regulation FCAS requirement (section 16.3)</p> <p>New template applied</p>
94	23 April 2019	<p>In vulnerable line list, VIC region:</p> <p>Updated LTTW End Date of Eildon PS – Mt Beauty No.1 and No.2 220 kV Lines.</p>
93	21 March 2019	<p>In vulnerable line list, QLD region:</p> <ul style="list-style-type: none"> <li>Added Strathmore — Clare South 7208 and Collinsville North — Tee King Creek — Clare South 7128 132 kV Lines.</li> <li>Removed Bouldercombe – Rockhampton No.7108 and Bouldercombe – Egans Hill No.7221 132 kV lines</li> </ul> <p>In vulnerable line, TAS region:</p> <ul style="list-style-type: none"> <li>Added Sheffield — Wesley Vale and Sheffield — Devonport 110 kV lines</li> </ul> <p>In vulnerable line list, VIC region:</p> <ul style="list-style-type: none"> <li>Updated LTTW End Date of Eildon PS – Mt Beauty No.1 and No.2 220 kV Lines.</li> </ul> <p>Change to regulation FCAS requirement (section 19.3)</p>

Version	Effective Date	Summary of Changes
92	31 December 2018	In vulnerable line list Queensland region: removed Chinchilla — Columboola No.7349 and No.7350 132 kV lines. Victoria region: added Hazelwood PS – Rowville No.1 and No.2 220 kV lines Minor edits.
91	04 September 2018	In vulnerable transmission line list Updated the category of Tungatinah — New Norfolk tee Meadowbank No. 1 and No. 2 110 kV Lines Added Dumaresq — Bulli Creek No. 8L and No. 8M 330 kV lines
90	01 March 2018	In vulnerable transmission line list Queensland region: updated LTTW End Date of Collinsville North – Proserpine No.7125 and No.7126 132 kV lines Updated LTTW End Date of Tarong – Chinchilla No.7168 and No.7183 132 kV lines Added Goonyella — North Goonyella Tee — Stoney Creek No.7122 and Goonyella — Newlands No.7155 132 kV Line Tasmania region: Added Tungatinah — New Norfolk tee Meadowbank No. 1 and No. 2 110 kV Lines
89	25 January 2018	In vulnerable transmission line list: Updated LTTW End Date of Collinsville North – Proserpine No.7125 and No.7126 132 kV lines. Removed Coffs Harbour to Raleigh 9W3 and Coffs Harbour to Boambee 9W8 132 kV lines Removed Coffs Harbour to Raleigh 9W3 and Boambee to Nambucca 9W7 132 kV lines in NSW

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