POWER SYSTEM SECURITY GUIDELINES

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VERSION RELEASE HISTORY

Version	Effective Date	Summary of Changes
95	23 September 2019	Multiple changes to Reclassifying Contingency Events section (8) In vulnerable line list: • VIC region: Updated LTTW End Date of Eildon PS – Mt Beauty No.1 and No.2 220 kV Lines. • TAS region: Updated LTTW End Date of: – Farrell–John Butters 220 kV line and Farrell–Rosebery–Newton–Queenstown 110 kV line. – Farrell – Reece No.1 and No.2 220 kV lines Added section (14.3) for transmission line switching for voltage control Change to regulation FCAS requirement (section 16.3) New template applied
94	23 April 2019	In vulnerable line list, VIC region: • Updated LTTW End Date of Eildon PS – Mt Beauty No.1 and No.2 220 kV Lines.
93	21 March 2019	In vulnerable line list, QLD region: • Added Strathmore - Clare South 7208 and Collinsville North - Tee King Creek - Clare South 7128 132 kV Lines. • Removed Bouldercombe – Rockhampton No.7108 and Bouldercombe – Egans Hill No.7221 132 kV lines In vulnerable line line, TAS region: • Added Sheffield - Wesley Vale and Sheffield - Devonport 110 kV lines In vulnerable line list, VIC region: • Updated LTTW End Date of Eildon PS – Mt Beauty No.1 and No.2 220 kV Lines. Change to regulation FCAS requirement (section 19.3)
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

Version	Effective Date	Summary of Changes
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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1. INTRODUCTION

1.1. Purpose and application

These Power System Security Guidelines are made in accordance with NER clause 4.10.1, and form part of the *power system operating procedures*. These Guidelines apply to AEMO and all *registered participants*.

These Procedures have effect only for the purposes set out in the National Electricity Rules (NER). The NER and the National Electricity Law prevail over these Procedures 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 Procedures 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 Procedures.

Table 1 Definitions

Term	Definition
ECS	Emergency Control Scheme
EMMS	Electricity Market Management System
GIC	Geomagnetic Induced Current
GMD	Geomagnetic Disturbance
Guidelines	These Power System Security Guidelines
MNSP	*Market Network Service Provider*
MT Timeframe	Medium term PASA timeframe
PTP	Permission to proceed
PTR	Permission to restore
ST Timeframe	Short term PASA timeframe
VDS	VAr Dispatch Scheduler

1.2.2. Interpretation

The following principles of interpretation apply to these Procedures unless otherwise expressly indicated:

(a) these Procedures are subject to the principles of interpretation set out in Schedule 2 of the National Electricity Law.

1.3. Related Policies and Procedures

Table 2 Related policies and procedures

Policies and Procedure	Title
SO_OP_2000	Glossary
SO_OP_3705	Dispatch

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 Frequency Control Ancillary Services (FCAS) to cater for the loss of an interconnection.
- Constraints on *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.
- Constraints on *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 *Network Service Providers*.
- Constraints on *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.
- Constraints on scheduled *plant* to maintain transmission line flows within secure limits.
- Constraints on scheduled *plant* to maintain *interconnector* or intra-regional flows within secure limits. This may take the general form: Risk <= Satisfactory limit – Secure limit.
- Constraints on 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 these 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 plan agreed between AEMO and relevant registered *participants* (e.g. Contingency plan, *Network Support Agreement* (NSA)).

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)

Under RERT, if there is sufficient notice, AEMO may dispatch or activate suitable *reserve contracts* to address a *power system security* event.

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 clause 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. Involuntary Load Shed

AEMO will instruct *load shedding* as per section 5.3.

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.

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 line*s 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:

1. 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*.
2. Agreed contingency plans are available containing the following:

- Manual or automatic actions to manage overloads due to contingent trip of *generation* on either side of the low capacity interconnection.
- 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 *Network Service Provider* 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

a) 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*.

b) Following a major *power system* emergency, loss of supply to 60% predicted *load* (excluding pot line *loads*) in Qld North[1] or Qld South, affecting one or more power stations satisfies the conditions for declaring *black system* condition for Qld North or Qld South as appropriate.

4.2. Exit a black system when

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. LOAD SHEDDING AND RESTORATION

5.1. Use of Priority Load Shedding Schedules

In accordance with NER clause 4.3.2(f), AEMO must request that the *Jurisdictional System Security Coordinator* for each participating jurisdiction provides AEMO with a schedule setting out the order in which loads in the participating jurisdiction, other than *sensitive loads*, may be shed by AEMO for the system security requirements given in NER clause 4.8.

5.2. Sensitive Loads

NER clause 4.3.2 (k) stipulates that it is AEMO's responsibility to maintain security of supply to *Sensitive loads* advised by the *Jurisdictional System Security Coordinators*.

In accordance with NER clause 4.3.2(l), AEMO can interrupt supply to *sensitive loads* of the type covered in NER clause 4.3.2(f)(1)(i) if it is required for reasons of public safety or *power system security*.

[1] QLD North electrical subnetwork consist of Central and Northern Queensland or all transmission networks north of South pine and Halys substations up to Port Dougles. Refer to Pg 20 of SRAS Guidelines dated 05/09/2014.

Approval of the relevant *Jurisdictional System Security Coordinator* is required for the interruption of *sensitive loads* of the type covered in NER clause 4.3.2(f)(1)(ii) for reasons of public safety or *power system security*.

5.3. Load Shedding actions and responsibilities

In accordance with NER clause 4.3.2(h), AEMO maintains load shedding procedures for each participating jurisdiction under which *loads* will be shed and restored.

TNSPs are responsible for selecting and interrupting suitable *loads* from the Priority Load Shedding Schedules to match the amount of *load* to be shed as advised by AEMO.

AEMO control room staff will take the following action to progressively bring the *power system* to a *reliable operating state*:

- Review the amount of *load* shed and restore *load* in accordance with the Priority Load Shedding Schedules, as *generation* sources become available.
- Obtain sufficient FCAS in accordance with the *Frequency Operating Standard*.
- If required, issue directions to restore the *power system* to *reliable operating state*.

Whenever AEMO issues an instruction to shed load, the instruction must include specific reference to:

- The amount of *load* to be shed,
- Which location e.g. *region* or connection point(s)
- The time at which the instruction is to take effect

The rate of *load* shed (if applicable) or a specific target time to reach the outcome specified

Examples of such instructions

- Immediately shed 200 MW in the *region* XXX
- At 1230 hrs, commence *load shedding* a total of 200 MW in *region* XXX over a 15 min period
- Shed a total of 200 MW of *load* in *region* XXX within the next 30 minutes.
- At Substation XXX shed 100 MW at 20 MW per DI.

5.4. Supply Scarcity

Supply scarcity situations may be predicted in the PASA/Pre-dispatch time frame in which case AEMO will have issued Market Notices informing *registered participants* of the lack of reserve. AEMO may have entered into *reserve contracts* or issued *directions*. If reserve contracts have been established, the relevant contracted reserve will be *dispatched* by AEMO.

Refer to the Operations Procedure: Intervention and Direction SO_OP3707

AEMO will be responsible for directing *load shedding* across interconnected *regions* in an equitable manner as specified in the *power system security standards* up to the *power transfer* limits of the *network*.

If insufficient *generation*, intra and inter *regional network power transfer capability* is available to allow all demand to be supplied (after taking into account demand side bids in the *market*), at one or more *connection points*, in one or more *regions*, then

- In conjunction with the dispatch of *generation* and demand side capacity through the dispatch processes of the *market*, AEMO may as necessary initiate reductions in demand, supplied from those *connection points* affected by the shortfall. As far as practicable, any reductions <u>in each *region*</u> must occur in proportion to the aggregate notional demand of the effective *connection points* in that *region*, until the remaining demand can be met, such that the *power system* remains or returns (as appropriate) initially to a *satisfactory operating state* and ultimately to a *secure operating state*, as defined in the NER.

- An effective *connection point* is a *connection point* at which continued reduction is effective in reducing the *supply* shortfall, taking into account *network constraints* at all times.
- Any reductions in demand required under these arrangements must take into account *sensitive loads* and priority order advised to AEMO in accordance with the NER.

Notional Demand means the total demand being supplied plus:

- The amount of demand reduced through involuntary *load shedding* as requested by AEMO, and
- The amount of demand reduction due to *mandatory restrictions* imposed by the Jurisdiction, as estimated in the *mandatory restriction schedule*.

AEMO control room staff inform each TNSP of the amount of *load* to be shed in their *region*. In certain circumstances, reducing demand at some *connection points* of the *power system* may not be effective in reducing *supply* shortfall due to power transfer limits of the system. It may then be required to specify an area within a *region* where *load shedding* will be required.

For conditions where an area is identified such that *load shedding* would not be effective in reducing the *supply* shortfall then such areas should be excluded from the determination of the aggregate notional demand.

Example: The Victoria to New South Wales interconnection was operating at maximum capacity into New South Wales. The Queensland to New South Wales interconnection was operating below capacity in both directions. The central Queensland to Southern Queensland intra-regional interconnection was operating at full capacity in the southerly direction.

Following the loss of a large generating unit in the New South Wales *region* the power flow on the Victoria to New South Wales interconnection has resulted in a satisfactory but not secure operating state.

Due to insufficient *generation* or demand side options (in both New South Wales and Queensland) *load shedding* is required in the areas north of the Victoria to New South Wales interconnection. However load shedding in Central or North Queensland would not be effective because the Central Queensland to Southern Queensland intra-regional interconnection was operating at full capacity in the southerly direction.

When determining the proportional notional demands of New South Wales and Queensland for the purpose of equitable sharing of any load shedding only the Southern area demand of Queensland should be considered.

5.5. Load Restoration following a Load Shedding Event

Notwithstanding the requirements imposed on AEMO by NER clause 4.3.2(h) regarding the restoration of load in accordance with the priority *load shedding* schedules for each participating jurisdiction, the following guidelines will be used for *load* restoration following a significant *load shedding* event.

- AEMO will issue *load* restoration instructions to the relevant TNSP.
- The relevant TNSP will coordinate *load* restoration with the DNSPs in that jurisdiction.
- *Load* restoration will occur at a rate at which a secure operating state can be maintained.
- *Load* restoration may not necessarily be in accordance with the priority *load shedding* schedules if it is considered necessary for maintaining a secure operating state or for public safety. In

particular this could be for the purposes of voltage control, frequency control or for the management of *network* limitations.

In order to facilitate *load* restoration at the maximum possible rate a flexible approach to the *load* restoration strategy will be maintained. To this end all possible alternative actions will be considered such as:

- Dispatch of scheduled plant.
- Directions to scheduled plant or market generating units.
- Clause 4.8.9 instructions.
- Reconnection of islanded sub-*networks*.
- Interconnection with adjoining *regions*.

It should be recognised that following significant *load shedding* unforeseen circumstances may arise during the restoration process. This may require switching to an alternate strategy or running two or more strategies in parallel.

The overall goal of the adopted strategy will be to restore as much load as quickly as possible.

AEMO may also consider increasing the raise regulation and lower regulation Frequency Control *Ancillary Services* above the normal levels to cater for the uncertainty with which the load may be restored.

5.6. Load Restoration using the Demand Offset Facility

To facilitate the dispatch of available *scheduled plant* during the restoration of *load*, AEMO may use the Demand Offset Facility (DOF). The DOF increments the Total Demand for a *region* to apply at the end of the *dispatch interval*. The increments are determined by AEMO to reflect the amount of *load* restoration that is expected to take place during that *dispatch interval*.

6. SYSTEM SECURITY PROTOCOL FOR GENERATING UNIT COMMISSIONING OR TESTING

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

6.1. Commissioning program

In accordance with NER clause 5.8.4, the *registered participant* will provide AEMO with the generator commissioning program at least 3 months prior to the commencement of the generator commissioning tests.

In accordance with NER clause 5.8.2, the *registered participant* must co-operate with AEMO and the relevant TNSP(s) to develop procedures to ensure that the commissioning of *generating systems* is carried out in a manner that:

- Does not adversely affect other *registered participants*
- Does not affect *power system security* or quality of *supply* of the *power system*
- Minimises the threat of damage to any other *registered participant's* equipment

6.2. Submission of Offers

During commissioning or testing, *generating 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 should ensure all offers 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 offers with the final plan reflected in the offers 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 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 offers 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 offer is not submitted in sufficient time.

6.3. Load Rejection tests

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

- If the test will result in an unsatisfactory operating state then permission to proceed for the test will be withheld by AEMO.
- If the test results in the secure limit being exceeded but the secure limit is restored within 10 minutes (equivalent to 2 Dispatch Intervals), AEMO will grant permission to proceed for the test.
- Sufficient ramp rates and telemetered rate of change (ROC) for the generating unit to reach 0 MW within one DI is required. If the required ROC is not reflected in the offers for that generating 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 *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 *dispatch interval* (DI) immediately prior to the DI in which the test will take place.

- If the test is not reflected in the offers for that *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 *generating unit* to reach 0 MW within one DI. 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[2] unless the telemetered ROC is 0 MW/min. In this case the telemetered ROC will be ignored and the offered ROC used instead.
- If sufficient telemetered ROC down cannot be entered by theGenerator, 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* is 23 MW/min, then the ROC down should be set to 0 MW/min by the *Generator*. This is to ensure that EMS ignores the telemetered ROC and uses the offered ROC.
- If AEMO are still receiving non zero telemetered values for ROC down after the *Generator* 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.
- 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

[2] An offered rate of change greater than the registered rate of change will be rejected by the *AEMO* EMMS. To enable testing Generators should ensure a suitable rate of change has been registered.

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 any number of abnormal conditions, some of which are listed below;

- Reduced *transmission* capacity between *generating systems* and *load* centres
- Reduced *interconnector transmission* capacity
- Separation of parts of the *network* into islands
- *Generation* and *Loads* relying on single connections resulting in larger than normal *credible contingencies*

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 contingency 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 with parties involved in the execution of the plan. This will typically be AEMO, TNSPs and DNSPs. 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. Affected *Market Participants* may also be required to be notified.

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

Generally, a *credible contingency event* can be regarded as the unplanned tripping of any single item of *network* or *generation* equipment. 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 the surrounding 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 clause 4.2.3(a), a contingency event means 'an event affecting the *power system* which AEMO expects would be likely to involve the failure or removal from operational service of one or more *generating units* and/or *transmission elements*'.

In relation to a contingency event:

1. AEMO will consider the failure or removal from operational service of a *network element* in the *distribution system* as part of the *contingency event*, if that has a material effect on security of the *transmission network*.

   Example (1)

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

2. *AEMO* will consider the *disconnection* of *load* as part of the *contingency event* if the *disconnection* of the *load* has a material effect on security of the *transmission network*.

   Example (2)

   If the *disconnection* of *load* at the same time as the trip of a *tranmission element* has no greater impact on security of the *transmission network* than the trip of the *tranmission 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*.

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

- The trip of any busbar in the *transmission network*
- The trip of more than one *tranmission element*
- The trip of more than one *network element* in circumstances as described in AEMO interpretation of contingency event item (1) above
- 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)
- The trip of multiple *generating units*
- 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*
- A combination of *transmission* plant, scheduled *generating units* or *load*, where that combination is not normally considered likely.

7.3. Non-Credible Contingency Event Reporting

When a *non-credible contingency event* occurs, a Market Notice must be issued within two hours containing the following information:

- Time event occurred
- *Region*
- Elements that tripped (e.g. *generating units*, *network elements, load)*

8. RECLASSIFYING CONTINGENCY EVENTS

Reclassification of a *non-credible contingency event* to a *credible contingency event* may be necessary at times to adequately reflect current or expected conditions. Abnormal conditions may result in reclassification. The reclassification is based upon an assessed increase in the likelihood of a trip of equipment to occur, the occurrence of which is normally considered to be relatively low. If AEMO determines that the occurrence of the non-credible event is more likely, then AEMO must consider the event, which will potentially lead to reclassification (based on a series of criteria explained below).

The reclassification of a *non-credible contingency event* to a *credible contingency event* is to be advised to participants by the issue of a Market Notice.

Abnormal conditions are conditions posing added risks to the *power system* including, without limitation, severe weather conditions, lightning storms and bush fires. Whenever AEMO receives information on abnormal conditions AEMO will discuss the situation with the relevant TNSP to determine whether any *non-credible contingency event* is more likely to occur because of the existence of the abnormal condition. If abnormal conditions exist near a regional boundary, all relevant TNSPs will be consulted.

8.1. AEMO **Responsibilities**

AEMO is responsible for determining and declaring a *non-credible contingency event* to be a *credible contingency event*.

AEMO will notify all *Market Participants* of any reclassifications as soon as is practicable.

Following the re-classification, AEMO will ensure that it fulfils its *power system security* obligations to achieve and maintain the *secure operating state* of the *power system* for the revised *technical envelope*.

Every six months, AEMO will issue a report setting out its reasons for all decisions to re-classify *non-credible contingency events* to be *credible contingency events*. The report will include an explanation of how AEMO applied the relevant criteria used in the decision to reclassify these events. The report may also include AEMO's analysis of re-classification trends during the relevant period and its appraisal of the appropriateness and effectiveness of the relevant criteria that were applied in the case of each reclassification decision.

8.2. Registered Participant, Network Service Provider and System Operator Responsibilities

In accordance with NER clause 4.8.1 *registered participants* must promptly advise AEMO or a relevant *System Operator* of any circumstance which could be expected to adversely affect the secure operation of the *power system* or any equipment owned or under the control of the *registered participant* or a *network service provider*.

For AEMO to discharge its *power system security* obligations, the *network service provider* (NSP) must cooperate with and assist AEMO by providing information that the NSP is aware of in a timely manner on present or anticipated threats to *power system security*.

A *System Operator* must carry out the rights, functions and obligations in respect of which it has been engaged or appointed by AEMO.

A *System Operator* must, to the extent the *System Operator* is aware, keep AEMO fully and timely informed as to:

- The state of the security of the *power system*
- Any present or anticipated risks to *power system security* such as bushfires

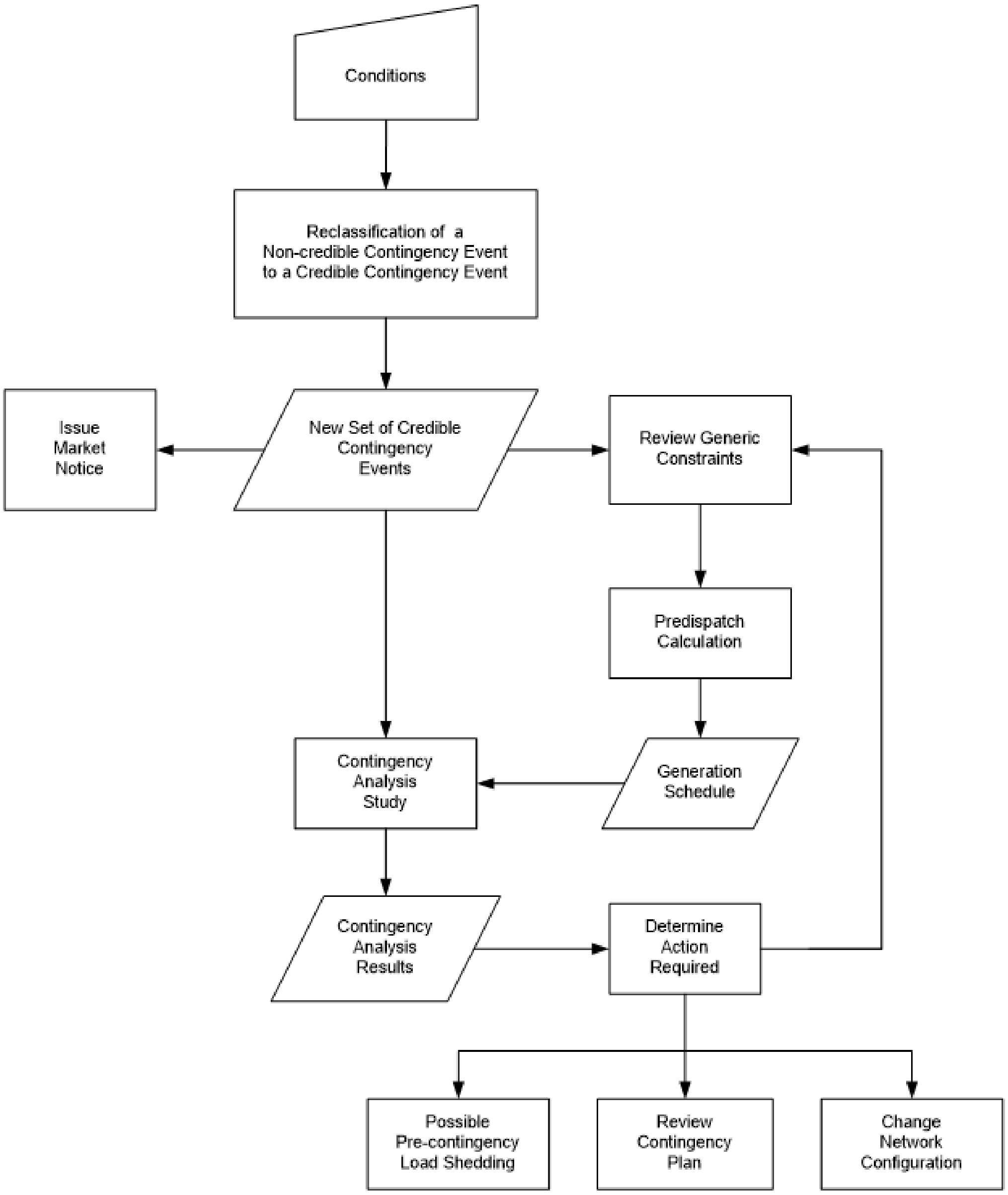
The information is to be provided by the NSP and *System Operator* to the extent it is aware of, or as requested by AEMO. Regular updates to the information will be required until the reclassification is revoked by AEMO.

Whilst the responsibility for keeping the network in a secure operating state lies with AEMO, it is acknowledged that the NSP will have considerably more knowledge of its network so should be included in the consultation process before deciding on the best course of action.

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 actions required by *AEMO* for a reclassification event.

Figure 1 Summary of action required for reclassification of an non-credible contingency event to a credible contingency event.



8.3. Reclassification due to Bushfires

Abnormal conditions such as bushfires may pose added risks to the *power system* and result in the tripping of both circuits of a double circuit *transmission line* or two adjacent single circuit *transmission lines*. The presence of abnormal conditions and an assessment of the risk posed to the *power system* may result in AEMO determining a non-*credible contingency event* to be a *credible contingency event*.

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 NSP and AEMO would collaborate in completing this table.

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 of assessment:		
Transmission circuits being assessed:		
RISK FACTOR	WEIGHTING	NOTES
Fire Information • From fire service website only • Confirmation received from fire service that fire poses a threat	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.
Fire Direction & Speed • Can be reasonably assessed from available data, anticipated in easement within next hour • Insufficient data to assess direction / speed, but fire is within 5km of easement • Fire does not pose a threat to the easement	5 0 -10	If wind direction / speed is known, it should be possible for the NSP 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.
CIRCUIT CHARACTERISTICS • Adjacent single circuits • Double circuits (single towers)	1 2	
WEATHER Fire Weather Warning level[2] • Severe • Extreme (including total fire ban) • Catastrophic (Code Red)	2 4 6	Sourced from Bureau of Meteorology.
EASEMENT External (Adjacent fuel load) • Grasslands • Native bushland • Plantations	0 2 4	Grass fires don't usually pose threats to transmission assets. Plantations (e.g. pine trees) are a much greater hazard.

Bushfire Risk Assessment		
OPERATOR ACTIONS NSP will manually reclose tripped transmission lines within a maximum of 5 minutes. • Yes • No Auto-reclose not enabled	 -2 0 3	
Initial WEIGHTING		
Other risk considerations – NSP: • •		The NSP can add additional risk factors at this point that they deem pertinent and suggest an appropriate weighting.
Other risk considerations – AEMO: • •		AEMO can add additional risk factors at this point and weight them accordingly. Additional weighting may be applied is a line has already tripped due to the fire.
Final Total		If this total is 13 or greater, 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 of Meteorology issues two types of advice to alert the public when conditions are likely to be dangerous – Fire Weather Warnings and Total Fire Ban Advices.

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 Table 3, the following rules will be applied in the decision making process and include:

1) Individual records will be created with detailed information for each assessment conducted in the following circumstances.
   a) Assessment not to apply a reclassification
   b) Assessment to apply a reclassification.
   c) Assessment to remove a reclassification.
2) The primary focus is in circuit voltages ≥220 kV but this does not exclude assessments being performed for circuit voltages <220 kV if there is a material impact on system security.
3) 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).
4) If AEMO:
   – 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
   – has been advised of bushfires in that general area

   Then, if one of these transmission circuit trips and auto re-closes successfully, AEMO would declare a reclassification.

   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.

   If the reclose is unsuccessful and a subsequent manual attempt fails or is not possible, then
   – System security will be reassessed taking into this unplanned outage and
   – An assessment of the need to reclassify multiple losses of some of the remaining circuits in the easement will be undertaken (refer Rule 5)
5) 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).
6) AEMO will request the NSP 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 Rule 5 will apply.
7) 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.
8) AEMO will revoke the reclassification when the likelihood to reclassify reduces below the threshold specified in Table 3.

When AEMO has re-classified, invoked the re-classification constraints and identified any Dispatch and/or PreDispatch outcomes warranting further attention, AEMO will discuss the outcomes with *Market Participants* and NSPs and determine what options are available to resolve the issue.

The content of the AEMO Market Notices will focus on the reclassified contingency, what actions have been taken to maintain *power system security* but will not comment on the subject of connection point *supply* reliability as this area is in the NSP domain.

8.3.1. Review of each reclassification event triggered by bushfires

AEMO will review each reclassification event triggered by the presence of bushfires to ensure that the criteria developed under these Guidelines is appropriate and effective in its application to the reclassification of the simultaneous trip of a double circuit *transmission line* resulting from bushfires as a *credible contingency event*.

In accordance with NER 4.2.3B(b) every two years after the date of establishment of the bushfire reclassification criteria, AEMO must undertake a review of that criteria.

8.4. Reclassification due to Lightning

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.

8.4.1. 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.
Successful Single Pole ARC	One of two or Two lines that undergo a simultaneous single pole protection operation and auto reclose successfully 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 2.

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 and the lines are shielded by an Optic Fibre Ground Wire (OPGW) or Overhead Earth Wire (OHEW), 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.

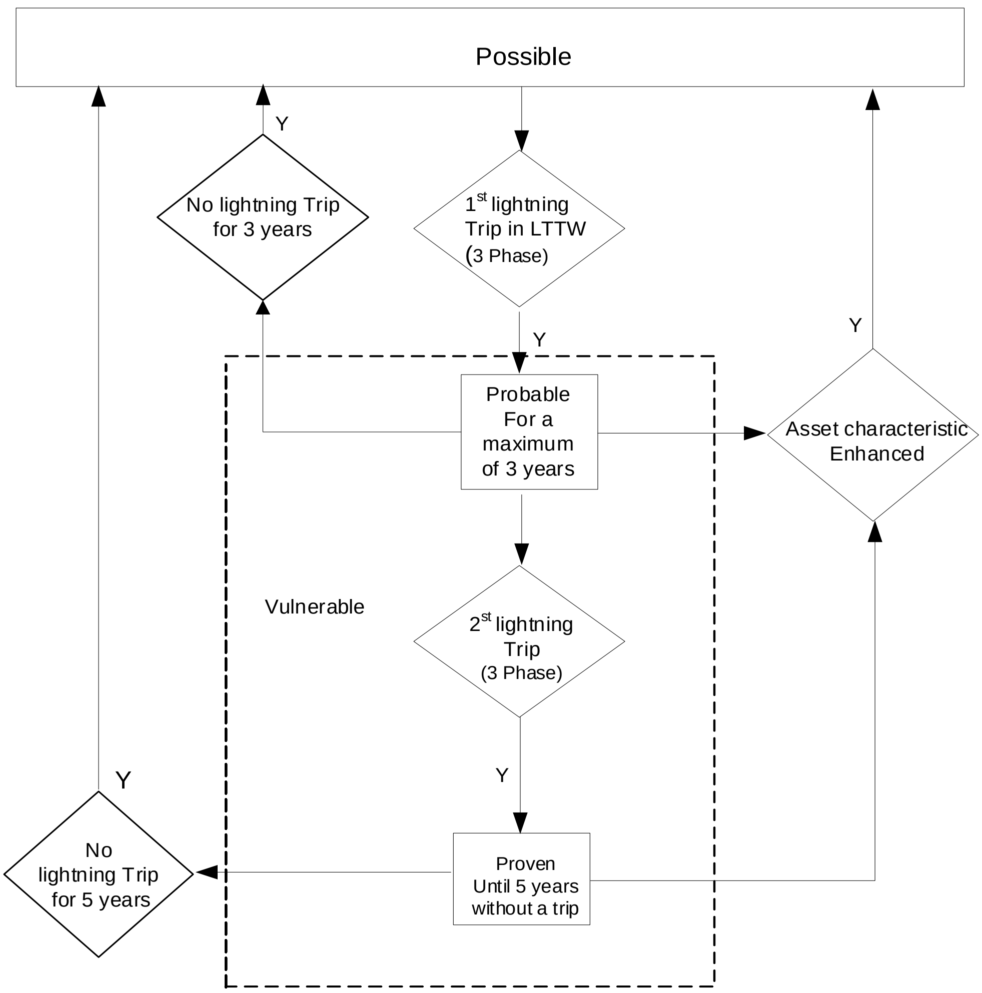
This double circuit line will return to the possible category when there are no further lightning trips in the three years LTTW.

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 categorized 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 categorized 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 2 Double Circuit Transmission Line Categories



8.4.2. 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 vulnerable lines is shown in Table 5 below.

Table 5 Vulnerable Transmission Lines

Region	Double Circuit Transmission Lines	LTTW	End Date	Reason for Classification	Category (Probable or Proven)
New South Wales / Queensland	Dumaresq - Bulli Creek No. 8L and No. 8M 330 kV lines	25/08/2021	N/A	Tripped once in past 3 years	Probable
Queensland	Collinsville North – Proserpine No.7125 and No.7126 132 kV Lines	N/A	15/02/2023	Tripped in 5-year LTTW	Proven
Queensland	Tarong – Chinchilla No. 7183 and 7168 132 kV lines	N/A	20/02/2023	Tripped in 5-year LTTW	Proven
Queensland	Ross – Chalumbin No.857 and No.858 275 kV lines	N/A	21/01/2020	Tripped twice in 3-year LTTW (2015)	Proven
Queensland	Chalumbin – Turkinje No.7165 and No.7166 132 kV lines	N/A	27/01/2021	Tripped twice in 3-year LTTW (2014 & 2016)	Proven
Queensland	Moranbah – Goonyella[3] No.7369 and No.7370 132 kV lines	N/A	06/12/2019	Tripped twice in 3-year LTTW (2012 & 2014)	Proven
Queensland	Collinsville – Stoney Creek No.7306 and Collinsville – Newlands No.7121 132 kV lines	N/A	05/02/2021	Tripped twice in 3-year LTTW (2016)	Proven
Queensland	Goonyella - North Goonyella Tee - Stoney Creek No. 7122 and the Goonyella - Newlands No. 7155 132 kV Line	26/02/2021	N/A	Tripped once in past 3 years	Probable
Queensland	Strathmore - Clare South No.7208 and Collinsville North - Tee King Creek - Clare South No.7128 132 kV Lines	09/01/2022	N/A	Tripped once in past 3 years	Probable
Tasmania	Chapel St – Liapootah No.1 and No.2 220 kV lines	N/A	Indefinite	No Shielding	Proven
Tasmania	Farrell – Reece No.1 and No.2 220 kV lines	N/A	21/08/2024	Tripped in 5-year LTTW	Proven
Tasmania	Farrell - Sheffield No.1 and No.2 220 kV lines	N/A	24/11/2022	Tripped in 5-year LTTW	Proven

[3] Due to augmentation works relating to No.7122 and No.7155 132 kV lines the previous reclassification of these lines as vulnerable is now applicable to No.7369 and No.7370 132 kV lines respectively between Moranbah and Goonyella. The original No.7122 is now between T212 (Goonyella) and T178 (Stony Creek) with a tee to T137 (Nth Goonyella) and No.7155 is now between T212 and T069 (Newlands). No.7369 and No.7370 contains the sections of No.7122 and No.7155 that initiated the original reclassification

Region	Double Circuit Transmission Lines	LTTW	End Date	Reason for Classification	Category (Probable or Proven)
Tasmania	Farrell–John Butters 220 kV line and Farrell–Rosebery–Newton–Queenstown 110 kV line	N/A	21/08/2024	Tripped in 5-year LTTW	Proven
Tasmania	Norwood – Scottsdale – Derby and Norwood – Scottsdale 110 kV lines	30/12/2019	N/A	Tripped once in past 3 years	Probable
Tasmania	Sheffield – Devonport and Sheffield – Wesley Vale 110 kV lines	18/02/2022	N/A	Tripped once in past 3 years	Probable
Tasmania	Tungatinah - New Norfolk tee Meadowbank No. 1 and No. 2 110 kV Lines	N/A	Indefinite	No Shielding	Proven
Victoria	Dederang – Glenrowan No.1 and No.3 220 kV lines	N/A	08/04/2022	Tripped twice in past 3 years (2015 & 2017)	Proven
Victoria	Eildon PS – Mt Beauty No.1 and No.2 220 kV lines	N/A	02/05/2024	Tripped in 5-year LTTW	Proven
Victoria	Hazelwood PS – Rowville No.1 and No.2 220 kV lines	09/12/2021	N/A	Tripped once in past 3 years	Probable

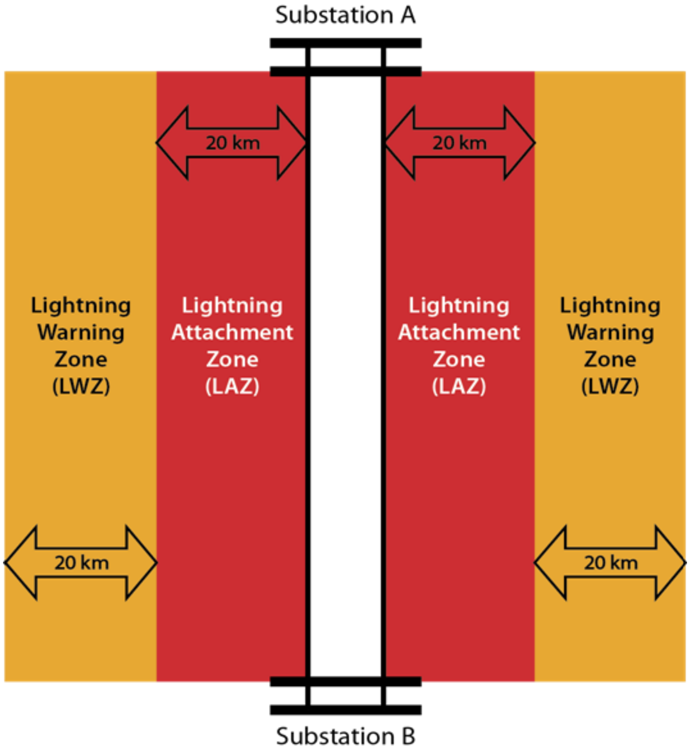
8.4.3. Lightning Detection Zones

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*. The 2 zones constitute the lightning exclusion zones and are depicted in Figure 3.

- 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 3 Lightning exclusion zone for vulnerable lines

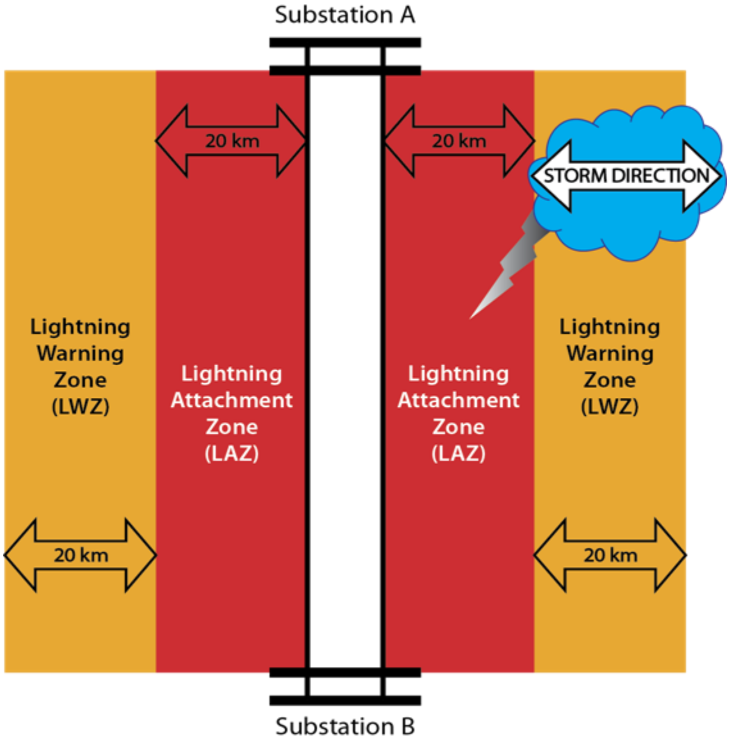


8.4.4. Reclassification Criteria

8.4.4.1. Lightning detected within the LAZ

If lightning is detected within the LAZ as depicted in Figure 4; AEMO will immediately reclassify the loss of the vulnerable double circuit *transmission lines* and if necessary apply a reclassification *constraint*.

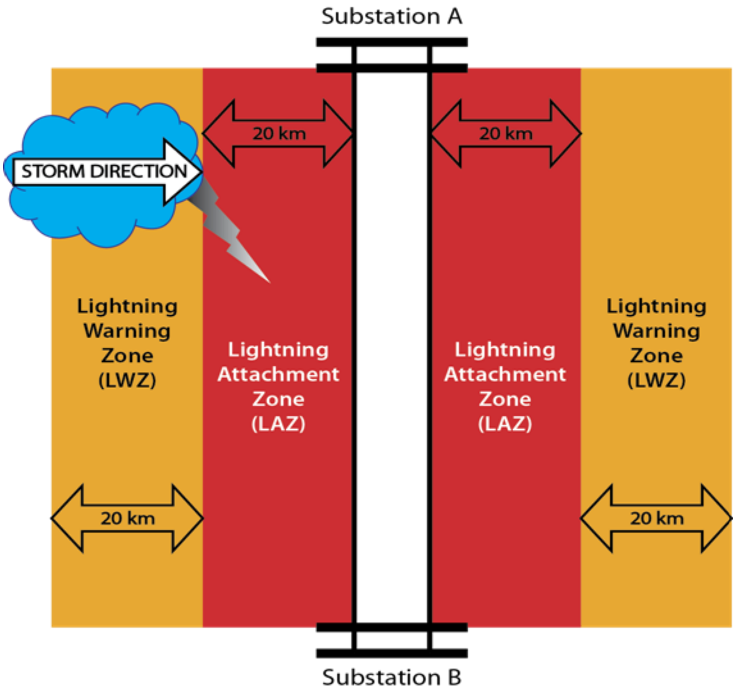
Figure 4 Lightning detected within the Lightning Attachment Zone (LAZ)



8.4.4.2. 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 5 – *AEMO* will reclassify the loss of the vulnerable double circuit *transmission lines*.

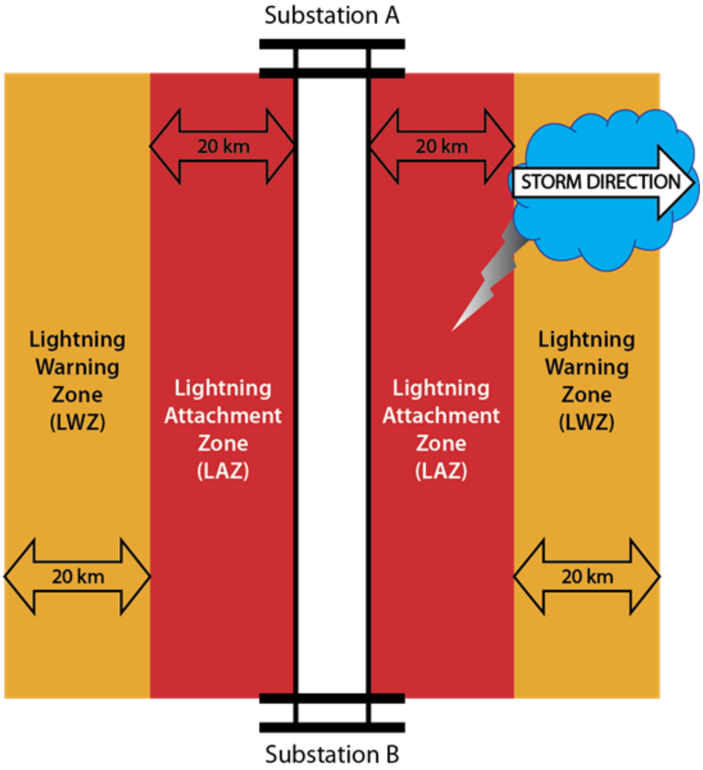
Figure 5 Lightning detected within the Lightning Warning Zone (LWZ) and is moving towards the lines



8.4.4.3. 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 6, 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 6 Lightning detected within the Lightning Warning Zone (LWZ) and is moving away from the lines



8.4.5. Rules to be used in the Lightning Reclassification Process

In conjunction with the criteria outlined above the following rules will be applied in the decision-making process.

- A decision to reclassify a *non-credible contingency event* to a *credible contingency event* will be based on cloud to ground lightning strikes only.
- 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:
  - AEMO has reclassified a *non-credible contingency event* to a *credible contingency event* due to the detection of cloud to ground lightning in the LWZ, and has commenced a Ramping down of power transfer levels; and
  - the vulnerable *transmission* circuit trips and auto re-closes successfully

  then AEMO would cease ramping and immediately apply the reclassification *constraint* to that vulnerable transmission circuit.
- 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.

AEMO will issue a Market Notice specifying the details of the reclassification event in accordance with NER clause 4.2.3A.

8.4.6. Cessation of a 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.

8.4.7. Review of each Reclassification Event Triggered by the Presence of Lightning

AEMO will review each reclassification event triggered by lightning to ensure that the criteria developed under these Guidelines is appropriate and effective in its application to the reclassification of the simultaneous trip of a double circuit *transmission line* resulting from a *cloud to ground* lightning strike as a *credible contingency event*.

In accordance with NER 4.2.3B(b) every two years after the date of establishment of the Lightning Trip reclassification criteria, AEMO must undertake a review of that criterion.

8.5. Reclassification due to severe weather conditions

If *AEMO* receives information on severe weather conditions, *AEMO* will discuss the situation with the relevant NSP(s) to determine whether a *non-credible contingency event* is more likely to occur.

Risk assessment of severe weather conditions to network elements includes consideration of severe weather warnings published by the Bureau of Meteorology (BOM). For reference, wind classifications by the BOM are included in Table 6 below.

Table 6 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 the capability of emergency services (e.g. water pumps becoming unavailable during flooding). Advice from the NSP should be sought in order to balance these conflicting requirements.

8.6. Reclassification due to "Other" Threats

Reclassification due to 'other' threats may include but is not limited to the following;

- Multiple generating unit disconnection

  Upon receiving advice that a threat exists, AEMO will make a decision on reclassification of a *non-credible contingency event* to a *credible contingency* event. AEMO may request sectionalising of *generators* with transmission in an attempt to minimise the impact on the *power system*.

  In making this determination AEMO will take advice from either the TNSP or the generator with regards to the likelihood of multiple generating unit or *transmission line disconnections*.

- 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.

- Impact of Protection or Control Systems Malfunction

  AEMO will take advice from the TNSP / Generator with regard to the likelihood of multiple transmission line or generating unit *disconnection* 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*.

8.6.1. Power system security Obligations during reclassification – Transmission Limits

In order to satisfy AEMO*'s power system security* obligations during reclassification, if the loss of multiple *generating units* will result in *transmission* limits being exceeded, then the *generating units* under threat will be constrained to a level where satisfactory limits are not exceeded post contingent.

8.6.2. Power system security Obligations during reclassification – FCAS

In order to satisfy AEMO's *power system security* obligations during reclassification, actions will be applied as per section 16.4.

A reclassification Market Notice will be issued but will not necessarily advise of the specific type of threat or provide details of the threat.

8.7. Reclassification Following a Non-Credible Event

If a *non-credible contingency event* has occurred, AEMO must determine if this event is to be re-classified as a *credible contingency event*.

AEMO will take all reasonable attempts to seek information to determine if a future occurrence of this *non-credible contingency event* is reasonably possible under the prevailing conditions.

Specifically, AEMO will seek information to determine if the condition that caused the *non-credible contingency event* has been resolved.

If AEMO is unable to obtain the appropriate level of information to determine if the *non-credible contingency event* is no longer reasonably possible, then AEMO will reclassify that event as a *credible contingency event*. AEMO will make this determination when the plant is returned to service.

9. MANAGEMENT OF SOLAR STORMS - GEOMAGNETIC DISTURBANCES (GMD)

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

Severe GMD events are forecast and notifications issued by the Bureau of Meteorology (BOM) as summarised in Section 9.1 Severe Space Weather Forecasts for significant GICs. 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, *Generators* and *Network Service Provider*s, is recommended during this period of time.

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

- 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
- Damage to *power system* assets, typically associated with *transformers*.

AEMO may initiate the following actions in response to a severe GMD on Australian Bureau of Meteorology's advices;

1) AEMO may instruct the restoration of out of service transmission lines and transformers as well as discontinue planned *transmission outages*, including[5] :
   a) *Interconnectors*,
   b) Equipment impacting on main system *transformer* loadings,
2) AEMO will maximise reactive reserves across the *power system*.
3) 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.
4) Request TNSPs to advise of their intent to take out of service *transformer(s)* due to the high impact of the GIC.

In circumstances where a low intensity GMD is received but GIC is at alarm levels, as supplied by the TNSP, AEMO will take actions as if a severe GMD advice has been received.

9.1. Severe Space Weather Forecasts for significant GICs

The Australian Bureau of Meteorology's Space Weather branch (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 will initiate the mitigating actions outlined above in response to the notifications from the SSWS as summarised in the following tables:

Table 7 below tabulates notifications from SSWS for both warning and watch events, the available lead time before storm reaches earth and the suggested AEMO actions.

[5] 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.

Table 7 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	1. Issue a Market Notice; 2. Increased awareness for next 48 hours 3. Maintain increased awareness of GIC monitored equipment
Short Duration GIC Warning	NOW	30-60 mins.	1. Issue a Market Notice; 2. Maximise dynamic reactive reserves across the power system; 3. AEMO instruct restoration of transmission outages; 4. Maintain increased awareness for more warnings 24hrs 5. Maintain increased awareness of GIC monitoring equipment
Sustained GIC activity Warning	30-60 mins	6-12 hrs	1. Issue a Market Notice; 2. Maximise reactive reserves across the power system; 3. Instruct the restoration of transmission outages 4. TNSP may re-rate transformers (possibility of instructing for load shedding) 5. TNSP may advise with the intent to take transformer OOS due high impact of GIC. May have to instruct load shedding to maintain security 6. Maintain increased awareness of GIC monitoring equipment levels 7. Maintain increased awareness & monitor for "Event End"
Severe Space Weather Event End	NOW	NOW	1. Issue Market Notice; 2. Return power system to normal operations; 3. Maintain increased awareness of GIC monitoring equipment levels 4. Maintain increased awareness and monitor for any further "Warnings" and/or "Cancellations" notices

10. REVISION OF THE 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).

10.1. Basslink reclassification

AEMO should not invoke Basslink loss of link (LOL) time = 650 ms (F-I_BL_650) constraint with the current reclassification on trip of Basslink *interconnector* and any *transmission line* in Tasmania in place. This applies to Basslink flows in either direction.

There is no need for additional FCAS when the technical envelope for Basslink LOL time is revised, and no need to issue a Market Notice.

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 of 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 PreDispatch run, to provide the necessary inputs to the ramping constraint. Once a suitable 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 3	Network Outage Constraint ramping also extends for six dispatch 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 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 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 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 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 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 outage*s.

Table 8 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 8 Interconnector Rate of Change

Direction of flow prior to reduction	Max reduction in flow per dispatch interval	
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
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 *tranmission 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 *tranmission 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 *tranmission 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 *tranmission 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 *tranmission 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 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 clause 4.3.1 defines the responsibility AEMO has for system security.

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

NER clause 4.6.5 defines AEMO's responsibility to determine, in consultation with the *Network Service Provider*s, 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 clause 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 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 from the TNSP 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 by the *Network Service Provider*s and to a target voltage range.

Adequate reactive reserves are maintained to ensure the security of the transmission system in the event of a credible contingency.

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 voltage controls
- Synchronous condensers
- Static VAr compensators (SVC)
- Shunt and series capacitors
- Shunt reactors
- Transformer tap changing

In addition to these facilities AEMO has entered into Reactive Power Ancillary Service Agreements with TNSPs and Generators.

14.1. Reactive Reserve

The amount of reactive 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*, *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 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 network*.
- 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. Transmission line switching for voltage control

If voltage security issues are experienced during real time operation, one transmission line per region may be de-energised for voltage control. If further actions are required, options for direction will be considered. If no direction options are available, more transmission lines may be de-energised.

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 modeling 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 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:

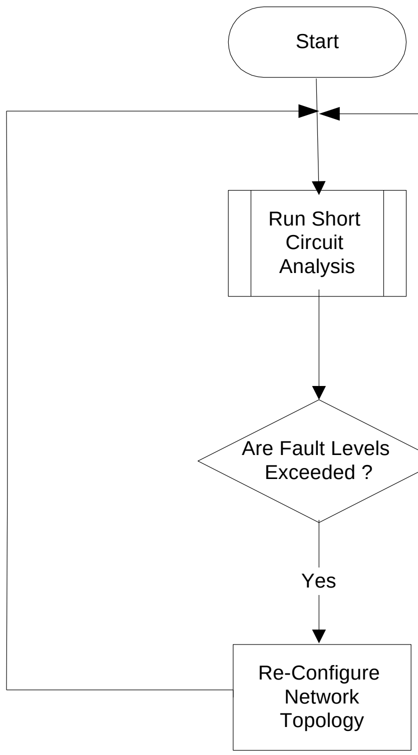
- In consultation with the *Network Service Providers*, determine the short circuit fault current level at all *busbars* of the *power system*.
- Ensuring that there are processes in place, which allow the determination of short circuit fault currents levels in real time.
- Identifying any bus which could potentially be exposed to a short circuit fault current exceeding the fault current ratings of the circuit breakers associated with that *busbar*.
- 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 min 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.

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 were 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 7 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 were 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 the short circuit breaking capacity of any CB, connected to that location, is 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 provide 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 time error according to the *Frequency Operating Standard* (FOS). 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 offers are not sufficient to meet the *power system* requirements.
- Issue directions to participants to control the frequency and the time error according to the FOS
- Issue Clause 4.8.9 Instructions for *load shedding* to control *frequency* according to the FOS.
- AEMO will not shed *load* to meet the time error standard but may direct *generation* if the time error increases beyond the Time Error Standard.

16.2. Frequency Control

AEMO dispatches Frequency Control *Ancillary Services* 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. This is known as the regulation duty.
- Ensure *power system frequency* variations resulting from various contingencies are controlled to the requirements of the *frequency operating standard*.

16.3. Regulation and time error control

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

In the *dispatch* time frame, AEMO will determine the amount of regulation FCAS for Mainland based on the time error. FCAS *constraints* will automatically set regulation FCAS requirement to 220/210 MW (raise/lower) if the time error is within the +/- 1.5 second band. For every 1 second deviation outside this time error band an extra 60 MW of regulation FCAS per 1 second deviation outside the band will be automatically added until an upper limit of 350 MW is reached.

Dispatch raise requirement (Mainland) = Min (350, 220 + (-1 x Min (-1.5, Time Error) – 1.5) x 60)

Dispatch lower requirement (Mainland) = Min (350,210 + (Max (1.5, Time Error) – 1.5) x 60)

The time error used is the average value of the QLD and NSW time error values from AEMO's Energy Management System.

Regulation for Tasmania is nominally set to 50 MW.

If the time error reaches +/- 10 seconds for Tasmania and AEMO reasonably believes that the time standard may be exceeded then AEMO may increase the amount of Regulation FCAS.

In the event of a regional separation, AEMO will realign the time error of the separated region after it has been synchronised to the rest of the *power system*. If multiple *regions* separate, AEMO will set an appropriate time error based on the event.

AEMO must issue a Market Notice after making adjustments to the time error.

16.4. Control of Frequency during Periods of Supply Scarcity

If following a contingency event there is insufficient FCAS available to cover the loss of a generating 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.
- If any of the above actions result in *load shedding*, AEMO will apply the supply scarcity *frequency operating standard*.

The *frequency operating standard* allows for a wider *frequency* range to apply during periods of supply scarcity. This revised *frequency* standard only applies to the mainland part of the NEM.

17. USE OF NETWORK SUPPORT AND CONTROL ANCILLARY SERVICE

Network support and control *ancillary services* (NSCAS)[6] 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:

- Maintain the *transmission network* within its current, *voltage* or stability limits following a *credible contingency event*; or
- Enhance the value of *spot market* trading in conjunction with the central dispatch process.

There are three 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.

[6] NSCAS was previously referred to as Network Control Ancillary Service (NCAS). AEMO has a number of existing NCAS contracts in place. These contracts will be *dispatch*ed as if they were NSCAS contracts until these contracts expire

NSCAS may also be dispatched to provide a market benefit providing the benefit gained exceeds the cost of dispatching the service.

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 9 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 *tranmission element* required out of service.
- The *Region* in which the *tranmission 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 clause 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.

Following the occurrence of a significant event:

Within 15 minutes of having confirmed and verified the 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 *Tranmission element*(s) involved
- The *Region* in which the *Tranmission 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.