WEM Procedure: Power System Security

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IMPORTANT NOTICE - EXPLANATORY NOTES

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1. Introduction

1.1. Purpose and scope

1.1.1. This WEM Procedure: Power System Security (Procedure) is made in accordance with AEMO's functions under clause 2.1A.2(h) of the Wholesale Electricity Market Rules (WEM Rules).

1.1.2. The *Electricity Industry Act 2004*, the WEM Regulations and the WEM Rules prevail over this Procedure to the extent of any inconsistency.

1.1.3. In this Procedure, where obligations are conferred on a Rule Participant, that Rule Participant must comply with the relevant obligations in accordance with clause 2.9.7A, 2.9.7D or 2.9.8 of the WEM Rules, as applicable.

1.1.4. The purpose of this Procedure is to document:

(a) the process to be followed by Rule Participants in providing Equipment Limit information to AEMO **[clause 3.2.7(a)]**;

(b) the process to be followed by AEMO in establishing and modifying the Technical Envelope, including how AEMO will utilise Equipment Limit information **[clause 3.2.7(b)]**;

(c) the processes to be followed by AEMO to enable it to ensure the SWIS operates according to the Technical Envelope applicable to each SWIS Operating State **[clause 3.2.7(c)]**;

(d) the process to be followed by AEMO to determine Inertia Requirements **[clause 3.2.7(d)]**; and

(e) the process to be followed by AEMO to assess and maintain Power System Stability, including System Strength **[clause 3.2.7(e)].**

1.1.5. Appendix A of this Procedure outlines the head of power clauses that this Procedure is made under, as well as other obligations in the WEM Rules covered by this Procedure.

1.2. Definitions

1.2.1. Terms defined in the Electricity Industry Act 2004, the WEM Regulations and the WEM Rules have the same meanings in this Procedure unless the context requires otherwise.

1.2.2. The following definitions apply in this Procedure unless the context requires otherwise.

Table 1 Definitions

Term	Definition
Emergency Rating	A time-based rating representing the capability of a Network element to operate up to a particular level for a finite duration. It generally has a higher capability and can only be applied for a shorter duration than a Short-Time Rating. The rating may vary according to conditions (e.g., season).
Emergency Rating Duration	A duration associated with an Emergency Rating.
Energy Producing System Limit	A limit informed by the relevant data specified in Table 5.
Facility Limit	A limit applicable to a Market Participant's Facility (excluding a transmission system or a distribution system) beyond which the Facility must not be operated.
Frequency Stability	The ability of the SWIS to maintain Frequency Operating Standards.
Fully Available	Where a Network Reinforcement Scheme has been designed with both primary and backup arrangements and both arrangements are in service

Term	Definition
High Resolution Time-Synchronised Data	Has the meaning given in the WEM Procedure developed under clause 2.35.4.
Lines	A collective term which includes but is not limited to transmission cables and transmission powerlines of all configurations.
Network Operating Guidelines	Information provided by a Network Operator identifying instructions on the operation of Network equipment under different operating conditions.
Network Reinforcement Scheme	A scheme developed, designed and maintained by a Network Operator, which includes runback of supply or inter-tripping, for the purpose of ensuring the Network Limits are not violated.
Non-Thermal Constraint Equation	A Constraint Equation developed for a Non-Thermal Network Limit provided by a Network Operator under clause 2.27A.1.
Normal Rating	A rating at which a Network element can operate continuously for the specified conditions (e.g., season). It may be a dynamic rating calculated continuously according to the expected weather conditions.
Oscillatory Stability	Has the meaning given in the Technical Rules.
Real-Time Facility Limit	A limit informed by the relevant real-time data applicable to a real-time facility limit as specified in Table 5.
Real-Time Market Submission Limit	A limit specified in a Real-Time Market Submission.
Revised Rating	A rating provided by a Rule Participant for a Network element that is a temporary update to a Normal Rating, a Short-Time Rating or an Emergency Rating. The rating may be more or less restrictive than the rating that it replaces.
Revised Rating Condition	A condition associated with a Revised Rating (e.g., a duration, timeframe, temperature range, etc.).
Short-Time Rating	A time-based rating representing the capability of a Network element to operate up to a particular level for a finite duration. The rating may vary depending on conditions (e.g., the season).
Short-Time Rating Duration	Is a duration associated with a Short-Time Rating.
Standing Facility Limit	A limit informed by the relevant standing data applicable to a standing facility limit as specified in Table 5.
Thermal Constraint Equation	Is a Constraint Equation developed for a Thermal Network Limit provided by a Network Operator under clause 2.27A.1.
Thermal Stability	Is the ability of SWIS to operate within Thermal Network Limits defined for each Technical Envelope applicable for each SWIS Operating State.
Transformers	A collective term which includes but is not limited to bus-tie transformers, zone substation power transformers, rapid response transformers, step-up transformers, step-down transformers.
Transient Stability	Has the meaning given in the Technical Rules.
Voltage Stability	Has the meaning given in the Technical Rules.

1.3. Interpretation

1.3.1. The following principles of interpretation apply in this Procedure unless the context requires otherwise.

(a) Clauses 1.3 to 1.5 of the WEM Rules apply in this Procedure.

(b) References to time are references to Australian Western Standard Time.

(c) Terms that are capitalised, but not defined in this Procedure, have the meaning given in the WEM Rules.

(d) A reference to the WEM Rules or WEM Procedures includes any associated forms required or contemplated by the WEM Rules or WEM Procedures.

(e) Words expressed in the singular include the plural and vice versa.

(f) A reference to a paragraph refers to a paragraph of this Procedure.

(g) A reference to a paragraph refers to a paragraph of this Procedure.

(h) A reference to a clause refers to a clause or section of the WEM Rules.

(i) References to WEM Rules in this Procedure in bold and square brackets **[Clause XXX]** are included for convenience only, and do not form part of this Procedure.

(j) Text located in boxes and headed as **E[X]** in this Procedure is included by way of explanation only and does not form part of this Procedure. The Procedure prevails to the extent of any inconsistency with the explanatory notes contained within it.

(k) The body of this Procedure prevails to the extent of any inconsistency with the figures, diagrams, appendices, schedules, annexures or attachments contained within this document.

1.4. Related documents

1.4.1. The documents in Table 2 are associated with this Procedure.

Table 2 Related documents

Reference	Title	Location
WEM Procedure	IMS Interface for Network Operators	WEM Website
WEM Procedure	Network Modelling Data	WEM Website
WEM Procedure	Outages	WEM Website
WEM Procedure	Constraint Formulation	WEM Website
WEM Procedure	Limit Advice Development	Western Power Website
WEM Procedure	Limit Advice Requirements	WEM Website
WEM Procedure	Facility Dispatch Process	WEM Website
WEM Procedure	Medium Term PASA	WEM Website
WEM Procedure	Fully Co-optimised Essential System Services Accreditation	WEM Website
WEM Procedure	Communications and Control Systems	WEM Website
WEM Procedure	Facility Registration, De-Registration and Transfer	WEM Website
	WEMS Submission Specification	WEM Website
	WEMS Submission Validation	WEM Website
Technical Specification	AGC, SCADA Dispatch Instructions, and Fast Start Facility Operational Behaviour	WEM Website
Technical Specification	Operational Data Points for Registered Facilities	WEM Website
	Operating Protocol	WEM Website

2. Equipment Limit Information

E[A] Equipment Limit information

Clause 3.2.7(a) requires AEMO to document the process to be followed by Rule Participants in providing Equipment Limit information to AEMO.

This Procedure identifies two broad groups of Equipment Limit information: Network Limits and Facility Limits.

E[B] Network Limit information

Network Limit information to be provided by a Network Operator includes but is not limited to:

- Thermal Network Limits; and
- Non-Thermal Network Limits (including static Network element voltage limits, stability limits, and other Network Limits such as design or operation limits of Static VAR Compensators and saturated reactors).

The Network Limit information does not include power quality limits such as voltage step, harmonics, flicker and voltage imbalance.

In addition, paragraph 2.1.4 specifies that a Network Operator must provide relevant data in relation to all Network Reinforcement Schemes. The Network Operator may implement Network Reinforcement Schemes on some parts of its networks so that the Network Limits are not exceeded. It is therefore essential for AEMO to understand what these schemes are and how they are intended to operate.

Paragraph 2.1.5 specifies that a Network Operator must provide Network Operating Guidelines to AEMO. The Network Operating Guidelines aim to account for scenarios where:

- there may be supporting information that is essential for AEMO to understand the Network Limit information provided by a Network Operator; or
- there may also be Network Limits that a Network Operator manages using appropriate Network equipment or other mechanisms that do not involve re-dispatching of generation by AEMO, but which AEMO needs to be aware of or to actively monitor.

E[C] Facility Limit information

Facility Limit information to be provided by a Rule Participant includes but is not limited to:

- Energy Producing System Limits (e.g., those provided in Registered Generator Performance Standards or in computer models by a Network Operator);
- Standing Facility Limits (e.g., including those provided in Standing Data for Non-Scheduled Facilities, Interruptible Loads and Demand Side Programmes);
- Real-Time Market Submission Limits (that is, those provided in Real-time Market Submissions for a Facility); and
- Real-Time Facility Limits (e.g., SCADA data provided to AEMO in real-time).

Note that Facility Limits, as defined in Table 1, include limits for a non-generating facility, such as an Interruptible Load and a Demand Side Programme.

In addition, while they may not be utilised directly to establish the Equipment Limits, AEMO may use the following data to verify the limits:

- recorded SCADA data, High Resolution Time-Synchronised Data, under clause 2.36A.4A; and
- computer models provided under clause 2.28.3A.

2.1. Provision of Equipment Limit information

2.1.1. A Network Operator must provide the relevant Network Limit information specified in Table 3 to AEMO in accordance with the timing, processes, forms and formats described in:

(a) for data described in clause 2.28.3A, the WEM Procedure: IMS Interface for Network Operators;

(b) for data specified in clause 2.28.20, the WEM Procedure: Network Modelling Data;

(c) for Limit Advice under clause 2.27A.2, the WEM Procedure: Limit Advice Requirements;

(d) for any revised limits in relation to an Outage, the WEM Procedure: Outages developed under clause 3.18.4; and

(e) for Generator Performance Standards provided by a Network Operator to AEMO via a Generator Register, clause 3A.7.3.

2.1.2. A Market Participant must provide the relevant Facility Limit information specified in Table 3 to AEMO in accordance with the timing, processes, forms and formats described in:

(a) for real-time SCADA data, the WEM Procedure: Communications and Control Systems developed under clause 2.35.4;

(b) for Standing Data, clause 2.34;

(c) for Real-Time Market Submissions, clause 7.4; or

(d) for any limits in relation to an Outage, the WEM Procedure: Outages developed under clause 3.18.4.

2.1.3. A Rule Participant must provide the following data to AEMO, by the time and in the manner specified in the WEM Procedures developed under clauses 2.36A.5 and 2.28.20, whichever is applicable:

(a) real-time SCADA data;

(b) recorded SCADA data; and

(c) high-resolution time synchronised data.

2.1.4. A Network Operator must provide the following data in relation to all Network Reinforcement Schemes, unless otherwise agreed between AEMO and Network Operator:

(a) triggers of a scheme, which include but are not limited to, the quantity of measurements, location of the measurements, and the conditions that trigger the scheme; and

(b) sequence of events following triggering of a scheme, which include but are not limited to removal of any Network elements,

in accordance with the process outlined in the WEM Procedure: Network Modelling Data and the WEM Procedure: Limit Advice Requirements, or as notified to the AEMO control room as per the process outlined in the Operating Protocol developed under clause 3.1A.1.

2.1.5. A Network Operator must provide AEMO with all relevant Network Operating Guidelines, as well as any updates, to enable AEMO to understand limitations associated with the operation of Network equipment under different operating conditions, by the time and in the manner specified in the WEM Procedure: IMS Interface for Network Operators.

2.1.6. AEMO may request additional information in relation to the Network Operating Guidelines specified in paragraph 2.1.4, or any other additional information from a Network Operator where AEMO identifies potential limitations, and the Network Operator must comply with such requests by following the process outlined in the WEM Procedure: IMS Interface for Network Operators.

2.1.7. Where AEMO believes additional information is required in order to clarify the information provided in Table 3, or believes additional information is required to that listed in Table 3 in order to support Power System Security, AEMO may request additional Equipment Limit information from a Rule Participant. AEMO must make the request in writing to the Rule Participant and include the following in the request:

(a) the additional information required;

(b) reasons for requesting the additional information;

(c) the manner and form it must be provided in; and

(d) any other information AEMO may determine is necessary to include in the request.

2.1.8. Notwithstanding the requirements described in this paragraph, where AEMO has identified inconsistencies in any of the data, AEMO may:

(a) notify the relevant Rule Participants, request up-to-date information for the relevant data; and

(b) until the Rule Participants provide the requested up-to-date information, use the information available to AEMO, such that it does not introduce, escalate or minimise AEMO's capability of maintaining Power System Security.

2.1.9. AEMO may specify a timeframe in which the information requested under paragraphs 2.1.7 or 2.1.8 must be provided by.

2.1.10. A Rule Participant must provide the information by the timeframe specified in AEMO's request under paragraph 2.1.9, unless otherwise agreed by AEMO.

Table 3 Equipment Limit data to be provided for different categories of Equipment Limit information

Category	Data requirement	Example power system element(s)	Source(s)
Thermal Network Limits	• Normal Ratings; • Where applicable, any Short-Time Ratings covering all temperatures and conditions with Short-Time Rating Duration; • Where applicable, any Emergency Ratings covering all temperatures and conditions with Emergency Rating Duration; • Revised Ratings with Revised Rating Conditions.	For elements as agreed between AEMO and a Network Operator, which include but are not limited to: • Lines; or • Transformers.	Limits provided: • in accordance with the process outlined in the WEM Procedure: Network Modelling Data; • in accordance with the process outlined in the WEM Procedure: Outages; or • via notification to the AEMO control room as per the process outlined in the Operating Protocol developed under clause 3.1A.1.
Non-Thermal Network Limits: stability limits	• Any Limit Advice in relation to Non-Thermal Network Limits: stability limits, provided by Network Operator under clause 2.27A.1 of the WEM Rules; or requested by AEMO and provided by Network Operator under clause 2.27A.4(b).	SWIS, as required to maintain Power System Security.	Limits: • in accordance with the WEM Procedure: Limit Advice Requirements; or • notified to the AEMO control room as per the process outlined in the Operating Protocol developed under clause 3.1A.1.
Non-Thermal Network Limits: static Network element voltage limits	For both low and high operation around nominal voltage: • Normal Ratings; and • Emergency Ratings. And as required: • Revised Ratings and Revised Rating Conditions.	For elements as agreed between AEMO and a Network Operator, which include but are not limited to: • busbars; • circuit breakers; • isolators; • Lines; • Transformers; • distributed generation; and • distribution feeders.	Limits • provided in the network modelling data provided in accordance with the WEM Procedure: Network Modelling Data; or • notified to the AEMO control room as per the process outlined in the Operating Protocol developed under clause 3.1A.1.
Non-Thermal Network Limits: other Network element limits	• Any Normal Ratings, including: – any protection limits; – any applicable limits that do not result in the removal of a Network element from operational service. And as applicable: • any Short-Time Ratings; • Emergency Ratings; • Revised Ratings;	For elements as agreed between AEMO and a Network Operator, which include but are not limited to: • capacitor banks; • reactors; • reactive power devices such as STATCOMs and Static VAR Compensators; or • quadrature boosters.	Limits: • provided in the network modelling data provided in accordance with the WEM Procedure: Network Modelling Data; or • notified to the AEMO control room as per the process outlined in the Operating Protocol developed under clause 3.1A.1.
Energy Producing System Limits for a Facility	• As specified in Appendix 12 of the WEM Rules and the guideline developed under clause 3A.7.3; or	• Transmission Connected Generating Systems in relation to clause 3A.5.1; and • Generating Systems that do not have Registered Generator Performance Standards.	Limits: • recorded in Registered Generator Performance Standards; or • in the computer models provided by a Network Operator under clause 2.28.3A.

Category	Data requirement	Example power system element(s)	Source(s)
	• the computer models provided by a Network Operator[1] under clause 2.28.3A.		
Standing Facility Limits	As specified in Appendix 1 of the WEM Rules or as provided by Rule Participants for Medium Term PASA purposes.	Facilities in relation to clause 2.34.2.	Limits recorded in Standing Data or provided in accordance with the WEM Procedure: Medium Term PASA.
Real-Time Market Submission Limits	As specified in clauses 7.4 and 7.4A.	Facilities in relation to clause 7.4.1.	Limits as provided in Real-Time Market Submissions, and Withdrawal Profile submissions for Demand Side Programmes.
Real-Time Facility Limits	• As described in Technical Specifications: Operational Data Points for Registered Facilities • Schedule Generators SCADA input requirement in Table 3 of the Technical Specification: Automatic Generation Control, SCADA Dispatch Instructions, and Fast Start Facility Operational Behaviour. • Non-Scheduled Generator SCADA Output List requirement described in Table 6 of the Technical Specification: Automatic Generation Control, SCADA Dispatch Instructions, and Fast Start Facility Operational Behaviour. • Limitations on Demand Side Programme dispatch based on previously dispatched quantities.	Relevant Facilities	Limits as provided via SCADA data, recorded by AEMO (in relation to Demand Side Programmes) or notified to the AEMO control room as per the process outlined in the WEM Procedure: Facility Dispatch Process.

[1] Note that Appendix 12 of the WEM Rules is only applicable to Transmission Connected Generating Systems. For Facilities where the requirements under Appendix 12 of the WEM Rules do not apply, AEMO receives their Limit information in the form of computer models by a Network Operators.

2.2. Recording Equipment Limit information

2.2.1. AEMO must record Equipment Limit information provided under this Procedure in its systems, as considered appropriate for the relevant category outlined under Table 3.

3. Technical Envelope and SWIS Operating States

3.1. Establishing and modifying the Technical Envelope

E[D] Background

E[D1] Requirements

The WEM Rules require AEMO to document:

- the process to be followed by AEMO in establishing and modifying the Technical Envelope, including how AEMO will utilise Equipment Limit information **[clause 3.2.7(b)]**; and
- the processes to be followed by AEMO to enable it to ensure the SWIS operates according to the Technical Envelope applicable to each SWIS Operating State **[clause 3.2.7(c)]**.

AEMO addresses the requirements of clauses 3.2.7(b) and 3.2.7(c) by documenting this in paragraph 2.2:

- the processes to establish the Technical Envelope in paragraph 3.1, including how AEMO uses the Equipment Limits:
  - which processes they are used in;
  - how AEMO uses them in each process; and
  - how AEMO uses them in each operating state.
- the principles to follow in modifying the Technical Envelope;
- the processes to follow where inconsistencies are identified in the Equipment Limits; and
- the process to follow in order to operate SWIS according to the Technical Envelope.

E[D2] Technical Envelope and Equipment Limits

Technical Envelope has the meaning given in clause 3.2.5.

Paragraph 4 specifies how AEMO utilises Equipment Limit information in each of the processes relevant to power system operation and operational planning, to define the Technical Envelope for each SWIS Operating State. These processes include:

- real-time operation, including monitoring and analysis;
- operational planning, including Outage planning;
- Constraint Equation formulation for Network Constraints; and
- Central Dispatch Process, including Dispatch Algorithm and other internal algorithms.

In addition, the same Equipment Limits are also used in other non-real-time operation and planning processes that support AEMO in operating the SWIS within the Technical Envelope, which are detailed in paragraphs 3.2 to 3.9.

E[D3] Operating within the Technical Envelope

When defining operational limits (Limit Advice/Constraint Equations) it is necessary to try and model the power system as it is expected to behave under different operating conditions. As it is not possible to model exactly every possible operating condition, AEMO and Network Operators generally adopt a probabilistic approach when determining operational limits.

A Network Operator, for example, determines the Limit Advice of a Non-Thermal Limit Equation based on a particular confidence level (refer to the WEM Procedure: Limit Advice Development maintained by the Network Operator), resulting from analysis of a set of varied operating conditions, and then applies an additional Limit Margin to account for potential errors in the analysis. That is, the Limit Equation covers variability of operating conditions with allowance for error.

Similarly, AEMO has also adopted a probabilistic approach when determining the Operational Margin for its Constraint Equations, in accordance with the WEM Procedure: Constraint Formulation. Consequently, it is possible that, in real-time, AEMO may identify via its real-time monitoring tools and processes that an operational limit is potentially breached for the next Credible Contingency Event based on actual operating conditions. When this occurs, AEMO will intervene (either via adjustment of dispatch or via directions) to ensure the operational limit is not breached.

E[D4] SWIS Operating States

SWIS Operating State has the meaning given in the WEM Rules, that is, "one or any of the Reliable Operating State, Satisfactory Operating State, Secure Operating State or Emergency Operating State". The scope of this Procedure includes only Satisfactory Operating State, Secure Operating State and Emergency Operating State. The treatment of the Reliable Operating State is addressed separately in AEMO's WEM Procedure: Reliability Implementation Standard developed under clause 3.3.2 of the WEM Rules.

In addition, each of the relevant SWIS Operating States has its meaning given in the WEM Rules as follows:

- Satisfactory Operating State in clause 3.4.1;
- Secure Operating State in clause 3.4.2;
- Reliable Operating State in clause 3.3.1; and
- Emergency Operate State in clause 3.5 of the WEM Rules.

The SWIS Operating States are not mutually exclusive, and it is normal for the SWIS to be in multiple states concurrently. The following table provides examples of realistic SWIS Operating States at any given time. As additional context:

- Satisfactory Operating State and Secure Operating State are correlated, that is, when the SWIS is not in a Satisfactory Operating State, it cannot be in a Secure Operating State; the SWIS, however, can be in a Satisfactory Operating State without being in a Secure Operating State.
- If a limit is breached or forecast to be breached following a Credible Contingency Event, AEMO has 30 minutes to address the issue before the SWIS is no longer considered to be in the Secure Operating State.
- It is possible for the SWIS to be in an Emergency Operating State while being in a Secure Operating State (e.g., forecast shortages that have not eventuated yet).
- While the Reliable Operating State and Emergency Operating States may arise in conjunction with other Operating States, each is governed by its own standards and requirements.

Table 4 Examples of SWIS Operating States

States	Examples
Secure, Reliable and Satisfactory	Everything is currently within limits and will remain within limits following the next Credible Contingency Event.
Secure, Satisfactory but not Reliable (manual Load shedding to keep secure)	A transmission line would otherwise be overloaded for the next Credible Contingency Event, but AEMO has manually shed Load to avoid this scenario.
Reliable and Satisfactory, but not Secure	A transmission line would otherwise be overloaded for the next Credible Contingency Event. AEMO may manually shed Load to avoid this, but it will take longer than the allowable 30 minutes.
Reliable and Satisfactory, but not Secure, and in an Emergency Operating State	A transmission line would otherwise be overloaded for the next Credible Contingency Event. AEMO may manually shed Load to avoid this, but it will take longer than the allowable 30 minutes, and there is a gas fuel shortage for the SWIS.
Reliable and not Satisfactory or Secure, and in an Emergency Operating State	A transmission line is actively overloading as a result of multiple concurrent unplanned Outages resulting from an out-of-control bushfire, but no manual Load shedding has yet been initiated.
Satisfactory, not Secure, not Reliable and in an Emergency Operating State	A transmission line would otherwise be overloaded for the next Credible Contingency Event. AEMO has manually shed Load to minimise the overload, but there is insufficient shed-able Load to completely avoid the overload.

Emergency Operating State, not Reliable, Not Secure, Not Satisfactory	A transmission line is currently overloading as a result of multiple concurrent unplanned outages resulting from an out-of-control bushfire, and manual Load shedding has been initiated to minimise the overloads.

3.1.1. AEMO must use the Equipment Limit information specified in Table 3 to establish the Technical Envelope applicable for each SWIS Operating State in accordance with Table 5.

3.1.2. In accounting for the SWIS Operating Standards when establishing the Technical Envelope, AEMO must:

(a) in relation to SWIS frequency, respect the limits in the SWIS Frequency Operating Standards in accordance with the requirements of Chapter 3B; and

(b) in relation to SWIS voltages, respect the more conservative of:

(i) where applicable, the limits identified by a Secure Operational Voltage Envelope, as per paragraph 4.3;

(ii) the voltage limits provided by a Network Operator as specified in Table 5; and

(iii) the voltage limits specified in the Technical Rules.

E[E] Voltage management

Clause 3.1.2 specifies that 'the voltage standards for a Network in the SWIS are as defined in the Technical Rules that apply to that Network'. The voltage standards may be post-contingent static voltage limits or a dynamic voltage envelope within which a Network must remain within following a Credible Contingency Event, subject to any other planning criteria specified in the Technical Rules.

Conventionally, based on a set of assumptions about generation dispatch, a Network Operator undertakes the following approaches to meet the voltage standards:

- defining and operating a selected location to within the pre-defined pre-contingent voltage operating range, which typically include mechanisms such as:
  - manual or automatic switching of reactive power equipment;
  - manual or automatic transformer tapping;
  - operation of dynamic reactive power equipment; and
  - manual operations of Network equipment;
- defining the voltage, power factor or reactive setpoint that an Energy Producing System must operate to; or
- implementing Network Reinforcement Schemes to operate post-contingency.

The generation dispatch scenarios are anticipated to become less predictable in the fully co-optimised energy and Essential System Services markets. While the approaches remain valid in assisting a Network Operator to meet the voltage standards in most circumstances, there may be specific generation dispatch scenarios under which Power System Security and Power System Reliability may not be maintained. This may be indicated by a binding Constraint Equation in the Pre-Dispatch Schedule Horizon or a Week-Ahead Schedule Horizon.

Under such circumstances, AEMO may use information from the Pre-Dispatch Schedule and Week-Ahead Schedule, and (in consultation with a Network Operator) will determine a Secure Operational Voltage Envelope for a selected location on the Network (clause 3.1A.9). The concept of Secure Operational Voltage Envelopes is detailed in Explanatory Notes E[I].

3.1.3. In accounting for Essential System Service Standards when establishing the Technical Envelope, AEMO must ensure that, subject to clause 3.12.2, quantities of Frequency Co-optimised Essential System Services are scheduled, or able to be scheduled, in accordance with the processes specified in the WEM Procedure: Frequency Co-Optimised Essential System Services Accreditation, while taking into account any Credible Contingency Event.

3.1.4. In addition, when establishing the Technical Envelope, AEMO must:

(a) take into account any information provided by Network Operators in accordance with the WEM Procedure: Network Modelling Data, identifying parts of the SWIS that are not designed to be operated in accordance with the planning criteria in the Technical Rules;

(b) use the processes described in paragraph 5 to take into account any Inertia limits in areas of the SWIS; and

(c) use the processes described in paragraph 6 to take into account any stability limits for the SWIS.

Table 5 Technical Envelope as established by the Equipment Limits for each SWIS Operating State

Limit Category	Satisfactory and Secure	Emergency
Thermal Network Limits	• Up to the Normal Rating. • If applicable, between the Normal Rating and Short-Time Rating (inclusive) for a duration no longer than the Short-Time Rating Duration. • Where a Revised Rating has been provided by a Network Operator: – if the Revised Rating is less restrictive than the Normal Rating, between the Normal Rating and the Revised Rating (inclusive), subject to meeting the Revised Rating Conditions (e.g., maximum applicable duration); or – if the Revised Rating is more restrictive than the Normal Rating, up to the Revised Rating, subject to meeting the Revised Rating Conditions (e.g., maximum applicable duration).	As for Satisfactory and Secure, with allowance to utilise Emergency Ratings with Emergency Duration where available and deemed necessary by AEMO.
Non-Thermal Network Limits: stability limits	• Where Limit Advice has been provided, as per the Limit Advice provided by Network Operators, including any revisions accounting for temporary arrangements as specified in Table 3.	
Non-Thermal Network Limits: static Network element voltage limits	For both low and high ratings: • up to or down to (as applicable) the Normal Ratings; • where a Revised Rating has been provided by a Network Operator: – if the Revised Rating is less restrictive than the Normal Rating, between the Normal Rating and the Revised Rating (inclusive), subject to meeting the Revised Rating Conditions (e.g., maximum applicable duration); or – if the Revised Rating is more restrictive than the Normal Rating, between the Normal Rating and the Revised Rating (inclusive), subject to meeting the Revised Rating Conditions (e.g., maximum applicable duration); and • any other applicable ratings that are less restrictive than Normal Ratings and more restrictive than Emergency Ratings, and that are not Revised Ratings, for no longer than the applicable duration.	As for Satisfactory and Secure, with allowance to utilise Emergency Ratings with Emergency Duration, where available and deemed necessary by AEMO.

Limit Category	Satisfactory and Secure	Emergency
Non-Thermal network Limits: Other Network element limits	• Up or down to the maximum or minimum quantities that can be provided; and • where alternative ratings and conditions are provided by a Network Operator: – if the alternative rating is less restrictive than the continuous maximum or minimum quantity, between the continuous quantity and the alternative quantity (inclusive) subject to the specified conditions; or – if the alternative rating is more restrictive than the continuous maximum or minimum, down to the alternative rating, subject to the specified conditions.	As for Satisfactory and Secure, with allowance to utilise (as relevant for the equipment): • any Emergency Ratings with duration (as applicable); • any protection limits; or • any other applicable limits, where available and deemed necessary by AEMO.
Energy Producing System Limits	As per the information in Registered Generator Performance Standards or computer models provided by a Network Operator as specified in Table 3.	
Standing Facility Limits	Operating limits recorded in Standing Data (excluding overload or emergency limits) such as: • maximum sent-out capacity; • maximum withdrawal capacity; • minimum time to synchronisation; • minimum dispatchable loading level; • Standing Maximum Upwards Ramp Rate; and • Standing Maximum Downwards Ramp Rate.	As for Satisfactory and Secure, with allowance to utilise short-term operating limits (as relevant for the equipment) identified in Standing Data, such as: • overload Injection capacity; • overload Withdrawal capacity; • minimum stable loading; • emergency upwards ramp rate; or • emergency downwards ramp rate, where available and deemed necessary by AEMO.
Real-Time Market Submission Limits	Limits as provided in Real-Time Market Submissions or Withdrawal Profile submissions for Demand Side Programmes as specified in Table 3.	
Real-Time Facility Limits	Limits as identified by SCADA, recorded by AEMO, manually determined and overridden by AEMO based on real-time observation, or notified to the AEMO control room as specified in Table 3.	

E[F] Table 5 Supplementary Notes

E[F1] Satisfactory and Secure Operating State

For the Satisfactory and Secure SWIS Operating State in Table 5, the various ratings and their applicable duration, and data (real-time SCADA and Real-Time Market Submissions) are all of the following:

- the limits that the SWIS must operate within, in order for the SWIS to be considered in that SWIS Operating State;
- the limits that the SWIS must continue to operate within, in order for the SWIS to be considered in that SWIS Operating State; and
- the limits beyond which the SWIS is considered not to be in that SWIS Operating State.

For the SWIS to be considered in a Satisfactory Operating State, in real-time operation, it must be within any of the ratings listed in Table 5, for the applicable duration. For example, despite being under multiple Outages as a result of an extreme weather condition and having breached the Normal Ratings of the Thermal Network Limits, the SWIS is considered to be in a Satisfactory Operating State if it is within and up to the Short-Time Ratings for no longer than the Short-Time Rating Duration.

For the SWIS to be considered in a Secure Operating State, in real-time operation, it is considered in the context of the next Credible Contingency Event, and AEMO's intervention that could reasonably take place within 30 minutes following that event, but the same principles apply. AEMO's intervention may include those listed in clause 3.4.4.

In the example above, if the loading of a transmission line would exceed the Short-Time Ratings for the next Credible Contingency Event, and there are no means for AEMO to reduce the loading within 30 minutes after the event, despite being in a Satisfactory Operating State, the SWIS is considered not in a Secure Operating State.

E[F2] Emergency Operating State

AEMO may declare an Emergency Operating State in accordance with clauses 3.51 and 3.51A. While AEMO may undertake any actions required to restore and maintain Power System Security (including those specified in clauses 3.4.4(c), 3.4.4(d), 3.4.4(f) and 3.5.5), clause 3.5.4 states that AEMO must not require Registered Facilities to operate inconsistently with their Equipment Limits for the Emergency Operating State. In Table 5, AEMO has specified that the SWIS must not operate outside the Emergency Ratings or, between Short-Time Ratings or Revised Ratings and up to the Emergency Ratings, for longer than the specified Emergency Rating Duration.

4. Operating the SWIS according to the Technical Envelope

4.1. Network Limit Usage

4.1.1. Where multiple Network Limits are available, when monitoring and operating the SWIS, AEMO may utilise Network Limit information in the following processes:

(a) real-time operation of the SWIS;

(b) operational planning (including Outage planning); and

(c) formulation of Constraint Equations,

in accordance with Table 6, as well as with the Technical Envelope applicable to each SWIS Operating State as specified in Table 5.

Table 6 Usage of Network Limit information

Process	Limit Category	Utilisation of Network Limits
Real-time operation: **Monitoring and analysis, including consideration of the next Credible Contingency Event**	• Thermal Network Limits • Non-Thermal Network Limits: static Network element voltage limits • Non-Thermal network Limits: other Network element limits	**For monitoring real-time quantities** (including following Forced Outage events), in the following order, and based on the applicable SWIS Operating State: • Revised Ratings (where more restrictive than Normal Ratings) – accounting for applicable Revised Rating Conditions Otherwise, in the following order: • Normal Ratings for the applicable conditions • Revised Ratings (where less restrictive than Normal Ratings) – accounting for the applicable Revised Rating Conditions • Short-Time Ratings – accounting for the applicable Short-Time Rating Duration • Emergency Ratings – accounting for the applicable Emergency Duration **For assessment of Power System Security following the next Credible Contingency Event**, subject to any applicable Network Reinforcement Scheme limits, in the following order, and based on the applicable SWIS Operating State: • Revised Ratings (where more restrictive than Normal Ratings) – accounting for the applicable Revised Rating Conditions Otherwise, in the following order: • Normal Ratings for the applicable conditions • Revised Ratings (where less restrictive than Normal Ratings) – accounting for the applicable Revised Rating Conditions • Short-Time Ratings – where AEMO considers it will be able to return to operation in accordance with Normal Ratings or Revised Ratings (as applicable) following the Credible Contingency Event, within the applicable Short-Time Rating Duration • Emergency Ratings – where AEMO considers it will be able to return to operation in accordance with Normal Ratings or Revised Ratings (as applicable) following the Credible Contingency Event, within the applicable Emergency Duration

Process	Limit Category	Utilisation of Network Limits
	• Non-Thermal Network Limits: stability limits	**For monitoring real time quantities** (including following Forced Outage events), use the Limit Advice by the Network Operator, which have been formulated into Constraint Equations, including application of Operating Margins, in accordance with the WEM Procedure: Constraint Formulation.
Operational planning	• Thermal Network Limits • Non-Thermal Network Limits: static Network element voltage limits • Non-Thermal network Limits: other Network element limits	**For Power System Security evaluations (including Outage evaluations),** when considering the next Credible Contingency Event, subject to any applicable Network Reinforcement Scheme limits, in the following order, and based on the applicable SWIS Operating State: • Revised Ratings (where more restrictive than Normal Ratings) – accounting for the applicable Revised Rating Conditions Otherwise, in the following order: • Normal Ratings for the applicable conditions • Revised Ratings (where less restrictive than Normal Ratings) – accounting for the applicable Revised Rating Conditions • Short-Time Ratings, only where – AEMO has exhausted all other options to reschedule an Outage and considers that the risk to Power System Security is higher if the Outage were not to proceed; and – AEMO considers it will be able to return to operation in accordance with Normal Ratings or Revised Ratings (as applicable) following a Credible Contingency Event, within the Short-Time Duration • Emergency Ratings, only where – AEMO has exhausted all other options to reschedule the Outage and considers that the risk to Power System Security is higher if the Outage were not to proceed; and – AEMO considers it will be able to return to operation in accordance with Normal Ratings or Revised Ratings (as applicable) following the Credible Contingency Event, within the Emergency Duration
Formulation of Constraint Equations: **Thermal Constraint Equations**	• Thermal Network Limits • Non-Thermal network Limits: other Network element limits	**Constraint Equations in the Dispatch Interval:** • Normal Ratings if the Constraint Equation describes a Network condition that does not consider the next Contingency Event. – With allowance for any Revised Ratings applied in real-time, including in relation to a Planned Outage or Forced Outage. • Short-Time Ratings (where available) if the Constraint Equation describes a Network condition that considers the next Contingency Event. – With allowance for any Revised Ratings applied in real-time, including in relation to a Planned Outage or Forced Outage. **Constraint Equations in the Dispatch Schedule Horizon:** • Normal Ratings if the Constraint Equation describes a Network condition that does not consider the next Contingency Event. – Includes Revised Ratings applied in real-time, including in relation to a Planned Outage or Forced Outage. • Short-Time Ratings (where available) if the Constraint Equation describes a Network condition that considers the next Contingency Event. – Includes Revised Ratings applied in real-time, including in relation to a Planned Outage or Forced Outage. **Constraint Equations in the Pre-Dispatch Horizon, Week-Ahead Horizon and Medium Term PASA assessment period:** • Normal Ratings if the Constraint Equation describes a Network condition that does not consider the next Contingency Event. • Short-Time Ratings (where available) if the Constraint Equation describes a Network condition that considers the next Contingency Event.
Formulation of Constraint Equations:	• Non-Thermal Network Limits: static Network element voltage limits	**Constraint Equations in the Dispatch Interval:** • Normal Ratings if the Constraint Equation describes a Network condition that does not consider the next Contingency Event. – With allowance for any Revised Ratings applied in real-time, including in relation to a Planned Outage or Forced Outage

Process	Limit Category	Utilisation of Network Limits
Non-Thermal Constraint Equations (steady-state or transient)		• Short-Time Ratings (where available) if the Constraint Equation describes a Network condition that considers the next Contingency Event. – With allowance for any Revised Ratings applied in real-time, including in relation to a Planned Outage or Forced Outage **Constraint Equations in the Dispatch Schedule Horizon:** • Normal Ratings if the Constraint Equation describes a Network condition that does not consider the next Contingency Event. – Includes Revised Ratings applied in real-time, including in relation to a Planned Outage or Forced Outage • Short-Time Ratings (where available) if the Constraint Equation describes a Network condition that considers the next Contingency Event. – Includes Revised Ratings applied in real-time, including in relation to a Planned Outage or Forced Outage **Constraint Equations in the Pre-Dispatch Schedule Horizon, Week-Ahead Schedule Horizon and Medium Term PASA assessment period:** • Normal Ratings if the Constraint Equation describes a Network condition that does not consider the next Contingency Event. • Short-Time Ratings (where available) if the Constraint Equation describes a Network condition that considers the next Contingency Event.
	• Non-Thermal Network Limits: stability limits	Constraint Equations formulated as per the Limit Advice from the Network Operator including operating margins in accordance with the WEM Procedure: Constraint Formulation.

4.1.2. In real-time operation of the SWIS, when assessing Power System Security with respect to the next Credible Contingency Event, if AEMO identifies that a Network Reinforcement Scheme may be triggered, then the following limits apply in relation to Thermal Network Limits and relevant Non-Thermal Network Limits:

(a) Where the Network Reinforcement Scheme is Fully Available, AEMO may account for the assumed operation of the Network Reinforcement Scheme, and may monitor whether power system parameters remain within the available Normal Ratings, Revised Ratings, Short-Time Ratings or Emergency Ratings, as applicable; or

(b) Where the Network Reinforcement Scheme is not Fully Available for longer than the duration determined by AEMO under paragraph 4.1.5, AEMO may assume that the Network Reinforcement Scheme may not operate, and may decide not to take into account its assumed operation when monitoring whether power system parameters remain within the available Normal Ratings, Revised Ratings, Short-Time Ratings or Emergency Ratings, as applicable.

4.1.3. In operational planning of the SWIS, when assessing Power System Security with respect to the next Credible Contingency Event (including Outage evaluations), AEMO must (in the following order):

(a) where possible, avoid operation above the trigger point for the Network Reinforcement Scheme; and

(b) when AEMO has exhausted all other options to reschedule an Outage and considers that the risk to Power System Security is higher if the Outage were to not proceed, where possible, allow the Outage to proceed and request the Network Operator to use best endeavours to ensure that the Network Reinforcement Scheme is Fully Available.

4.1.4. In formulating the Constraint Equations:

(a) Constraint Equations monitoring equipment that is protected by a Network Reinforcement Scheme may allow for the expected or actual operation of the Network Reinforcement Scheme in determining any remaining quantity contributing towards the applicable limit; or

(b) additional Constraint Equations may be created that do not allow for the operation of Network Reinforcement Schemes for use by AEMO when the Network Reinforcement Scheme is not Fully Available.

4.1.5. In determining the allowable duration for which a Network Reinforcement Scheme may not be Fully Available for the purposes of paragraph 4.1.2, AEMO may consider factors including, but not limited to:

(a) the impact to the SWIS of the Network Reinforcement Scheme not operating, such as potential for damage or instability;

(b) historical performance of the Network Reinforcement Scheme;

(c) actual or likely operating conditions; and

(d) other information provided by the relevant Network Operator.

4.1.6. In addition, AEMO may utilise the Network Limits in offline analysis, including but not limited to:

(a) reviewing Limit Advice, undertaken under paragraph 5 of the WEM Procedure: Limit Advice Requirements;

(b) power system incident investigation, undertaken under clause 3.8.1; or

(c) any other offline power system analysis.

4.1.7. Where the Network Reinforcement Scheme is Fully Available and monitoring indicates that the trigger for the scheme will be breached following a Credible Contingency Event, AEMO must assume that the Network Reinforcement Scheme will protect the equipment adequately.

E[G] Table 6 Supplementary Notes

E[G1] Operational planning

Typically, operational planning includes but is not limited to:

- Outage planning;
- PASA assessments;
- assessing commissioning tests of Energy Producing Systems; or
- any other forward-looking, short-term operational planning activities.

E[G2] Rating levels

In general, AEMO applies Network equipment ratings in its real-time operation of the SWIS in accordance with the following:

- Normal Ratings are applied in relevant Constraint Equations, where the Constraint Equation is intended to protect a piece of equipment continuously, i.e., in real-time and not just for the next Contingency Event.
- If provided by a Network Operator, Short-Time Ratings are applied in relevant Constraint Equations, where the Constraint Equation is intended to protect a piece of equipment following the next Contingency Event. If not available from a Network Operator, the Short-Time Rating is assumed to be equivalent to the Normal Rating.
- If provided by a Network Operator, Emergency Rating is applied under post-contingent conditions, for a very limited duration.

Each of the above ratings may be static or dynamic. Where dynamic ratings have been provided by a Network Operator for any of the ratings above, AEMO applies them in its real-time operation in accordance with the advice provided by the Network Operator.

E[G3] Network Reinforcement Schemes

In certain instances, a Network Operator may implement a Network Reinforcement Scheme, in preference to reinforcing the Network, to protect a Network element (or a set of Network elements) so that relevant Normal Ratings are not violated following a Credible Contingency Event. Note that most Network Reinforcement Schemes are designed to operate post-contingency.

Examples of Network Reinforcement Schemes include but are not limited to:

- a runback scheme to reduce MW output of an Energy Producing System, in order to manage thermal overload on a transmission line;
- an inter-tripping scheme to connect or disconnect Network equipment, in order to manage voltage levels on the Network; or
- an inter-tripping scheme to disconnect an Energy Producing System or a Load, in order to manage Power System Stability.

As it is one of the last-resort mechanisms used to protect the Network following a Contingency Event, the Network Reinforcement Schemes are typically duplicated to ensure they operate successfully when required.

In the event one of the Network Reinforcement Schemes is out of service for longer than the allowed duration by AEMO or is not duplicated, AEMO may assume the scheme will not operate as designed in real-time operation. That is, in relation to Thermal Network Limits or relevant Non-Thermal Network Limits, AEMO may use the next less restrictive ratings: Normal or Revised Ratings.

E[G4] Constraint formulation

In the Constraint formulation process ahead of real-time operation, AEMO formulates different sets of Constraint Equations to account for different SWIS Network conditions, e.g., Network configuration and next Credible Contingency Event. For each Constraint Equation, there are multiple variations that AEMO must formulate for application in different schedule horizons or assessment period:

- Dispatch Schedule Horizon;
- Pre-Dispatch Schedule Horizon;
- Week-Ahead Schedule Horizon; and
- Medium Term PASA assessment period.

For all schedule horizons and assessment periods, AEMO uses Normal Ratings and Short-Time Ratings in Thermal Constraint Equations, in accordance with the Network Condition the Thermal Constraint Equations apply to, and Non-Thermal Network Limit information provided by a Network Operator in Non-Thermal Constraint Equations, unless otherwise advised by Network Operator.

In addition, for the Dispatch Schedule Horizon only, AEMO also formulates the Constraint Equations so as to reflect the revised limits applied by AEMO's control room to the relevant ratings or Non-Thermal Network Limit in real-time.

Furthermore, in some circumstances, the relevant Network Limits in a Constraint Equation may be disregarded during real-time operation. These circumstances include but are not limited to:

- AEMO relaxes Constraints in accordance with clause 7.2.6 of the WEM Rules; and
- AEMO formulates and uses Alternative Network Constraint Equations under clause 7.5.2 of the WEM Rules.

For additional information about the Constraint formulation process, refer to the WEM Procedure: Constraint Formulation.

4.2. Facility Limit Usage

4.2.1. Where multiple Limits are available for the Facilities, when monitoring and operating the SWIS AEMO may utilise the limit information in the following processes:

(a) real-time operation of the SWIS;

(b) formulation of Constraint Equations;

(c) operational planning (including Outage planning); and

(d) Central Dispatch Process,

in accordance with Table 7, as well as with the Technical Envelope applicable to each SWIS Operating State as specified in Table 5.

Table 7 Usage of Facility Limit information

Process	Limit Category	Utilisation of Facility Limits
Real-time operation: **Monitoring and analysis, including consideration of the next Credible Contingency Event**	• Energy Producing System Limits • Standing Facility Limits • Real-Time Facility Limits	**For monitoring real time quantities and assessment of Power System Security following the next Credible Contingency Event** (including following Forced Outage events), from highest to lowest priority where the limits have been provided (and based on the applicable SWIS Operating State): • Real-Time Facility Limits – as notified by a Rule Participant to AEMO's control room in accordance with the process specified in the WEM Procedure: Facility Dispatch Process – via SCADA • Standing Facility Limits – via Standing Data • Energy Producing System Limits (where applicable) – via Registered Generator Performance Standards or information in computer models
Operational Planning	• Energy Producing System Limits • Standing Facility Limits • Real-Time Facility Limits	**For Power System Security evaluations (including Outage Evaluations)** when considering the next Credible Contingency Event, from highest to lowest priority where the limits have been provided (and based on the applicable SWIS Operating State): • Real-Time Facility Limits – via snapshot of SCADA limits based on AEMO's determination of an equivalent timeframe for the evaluation • Real-Time Market Submission Limits – via Real-Time Market Submissions relevant to Pre-Dispatch Schedule Horizon or Week-Ahead Schedule Horizon • Standing Facility Limits – via Standing Data or requirements specified in WEM Procedure: Medium Term PASA • Energy Producing System Limits (where applicable) – via Registered Generator Performance Standards or information in computer models
Constraint Equation formulation for Network Constraints	• Energy Producing System Limits • Standing Facility Limits	**Where a Thermal or Non-Thermal Constraint Equation requires a generator limit to be taken into account**, from highest to lowest priority where the limits have been

Process	Limit Category	Utilisation of Facility Limits
	• Real-Time Market Submission Limits • Real-Time Facility Limits • Network Reinforcement Scheme Limits	provided (and based on the applicable SWIS Operating State): **Constraint Equations in the first Dispatch Interval in a Dispatch Schedule Horizon:** • Real-Time Facility Limits and Network Reinforcement Scheme Limits where applicable – via SCADA limits or as notified to AEMO's control room in the case of discretionary Constraint Equations – via information provided under the WEM Procedure: Network Modelling Data and the WEM Procedure: Limit Advice Requirements; or as notified to AEMO's control room in accordance with the process specified in the WEM Procedure: Facility Dispatch Process (refer to Table 3). • Real-Time Market Submission Limits – via Real-Time Market Submissions • Standing Facility Limits – via Standing Data • Energy Producing System Limits (where applicable) – via Registered Generator Performance Standards or information in computer models **Constraint Equations in the Dispatch Schedule Horizon:** • Real-Time Market Submission Limits – via Real-Time Market Submissions • Standing Facility Limits – via Standing Data • Energy Producing System Limits (where applicable) – via Registered Generator Performance Standards or information in computer models **Constraint Equations in the Pre-Dispatch Horizon and Week-Ahead Horizon:** • Real-Time Market Submission Limits – via Real-Time Market Submissions • Standing Facility Limits – via Standing Data • Energy Producing System Limits (where applicable) – via Registered Generator Performance Standards or information in computer models **Constraint Equations in the Medium Term PASA Horizon:** • Standing Facility Limits – via Standing Data or Medium Term PASA requirements • Energy Producing System Limits (where applicable) – via Registered Generator Performance Standards or information in computer models
Central Dispatch Process **Dispatch Algorithm (including formulation of equations for energy, Essential System Services, and any other non-Network Constraints), real-time Dispatch and directions**	• Energy Producing System Limits • Standing Facility Limits • Real-Time Market Submission Limits • Real-Time Facility Limits	**For use within the Dispatch Algorithm when formulating Dispatch Targets and Dispatch Caps**, in accordance with the WEM Procedure: Dispatch Algorithm, and is based on: • Real-Time Facility Limits – via SCADA limits • Real-Time Market Submission Limits – via Real-Time Market Submissions • Standing Facility Limits

Process	Limit Category	Utilisation of Facility Limits
		– via Standing Data • Energy Producing System Limits (where applicable) – via Registered Generator Performance Standards or information in computer models **When implementing Dispatch Instructions**, from highest to lowest priority where the limits have been provided (and based on the applicable SWIS Operating State): • Real-Time Facility Limits – via SCADA limits • Real-Time Market Submission Limits – via Real-Time Market Submissions • Standing Facility Limits – via Standing Data • Energy Producing System Limits – via Registered Generator Performance Standards or information in computer models **When directing Participants,** from highest to lowest priority where the limits have been provided (and based on the applicable SWIS Operating State): • Real-Time Facility Limits – via SCADA limits or notification to the AEMO controller • Real-Time Market Submission Limits – via Real-Time Market Submissions • Standing Facility Limits – via Standing Data • Energy Producing System Limits – via Registered Generator Performance Standards or information in computer models – relevant industry standards[2] or information in computer models

[2] The industry standards may include but are not limited to Australian Standards, other common methods or practices presented by the Institute of Electrical and Electronics Engineers and the Council on Large Electric Systems (CIGRE).

E[H] Table 7 Supplementary Notes

E[H1] Real-time operation

In defining the limit information to use in its real-time monitoring system, AEMO uses real-time, telemetered limit information from SCADA where possible (e.g. ramp rate limits, and maximum and minimum sent-out capability). There may be occasions where a Rule Participant notifies AEMO's control room in accordance with the process specified in the WEM Procedure: Facility Dispatch Process, of changes to its Facility's limits. AEMO must use the revised limits as advised by the Rule Participant, in preference to those informed by the SCADA.

Where the information is not available from the SCADA (e.g. reactive power capability curves), AEMO uses information from other sources, in accordance with the priority order in Table 7.

E[H2] Operational Planning

In its operational planning, including Outage planning, AEMO typically uses snapshots of the real-time power system (which would include the SCADA limits at that time) to conduct forward-looking, short-term security analysis.

AEMO may use limit information available from Pre-Dispatch Schedule Horizon or Week-Ahead Schedule Horizon, to provide more accurate assumptions about the Facilities and the power system conditions in its analysis. Where required, AEMO may also use information from other sources to support the analysis.

E[H3] Constraint Equation formulation

Where applicable, AEMO uses the Facility Limits in its Constraint Equation formulation in accordance with the following priority:

- Real-Time Facility Limits (via SCADA)
- Real-Time Market Submission Limits (via Real-Time Market Submissions)
- Standing Facility Limits (via Standing Data)
- Energy Producing System Limits (via Registered Generator Performance Standards or information in computer models)

AEMO only uses Real-Time Facility Limits in the first Dispatch Interval in the Dispatch Schedule Horizon. In addition, AEMO does not use Real-Time Market Submission Limits in the Constraint Equations applicable in the Medium Term PASA assessment period because the information is and has become irrelevant as the look-ahead period increases.

E[H4] Central Dispatch Process

The Dispatch Algorithm within the Central Dispatch Process is designed to utilise information from SCADA, Real-Time Market Submissions, Standing Data and Registered Generator Performance Standards concurrently to formulate Dispatch Targets and Dispatch Caps (refer to the WEM Procedure: Dispatch Algorithm).

The Dispatch Targets and Dispatch Caps are sent to the Automatic Generation Control System (AGC) to implement operational controls of the relevant Registered Facilities. In its implementation of the operational controls, AEMO uses the real-time limits of the Facilities. Where the real-time limits are not available, AEMO may use the limit information submitted in Real-Time Market Submissions for a given Dispatch Interval, followed by Standing Data and other sources.

Where AEMO considers it necessary to issue a direction under the WEM Rules with respect to the operation of a Facility, it will use the Facility's limits known to AEMO in real-time where available. Where not available, it will use those in Real-Time Market Submissions, Standing Data, and other sources, in accordance with the priority order specified in Table 7).

4.2.2. AEMO may use the information provided in the Generator Performance Standards and Standing Data in the following processes (and as AEMO otherwise considers appropriate in relation to other processes):

(a) verifying Standing Data using information provided in the Generator Performance Standards;

(b) verifying information provided in the Generator Performance Standards using Standing Data;

(c) reviewing Limit Advice, undertaken under paragraph 5 of the WEM Procedure: Limit Advice Requirements;

(d) power system incident investigation, undertaken under clause 3.8.1; and

(e) any other offline power system analysis.

4.2.3. AEMO may validate Real-Time Market Submissions using Standing Data to ensure that the Dispatch Algorithm does not formulate Dispatch Instructions for Registered Facilities outside of the specified Standing Facility Limits.

4.2.4. A Market Participant must ensure that its Real-Time Market Submissions for its Registered Facilities respect any limitations on generation output that ensure stable operation, for the expected ambient temperature and operating conditions, and must ensure that its Real-Time Market Submissions are consistent with any information recorded in Registered Generator Performance Standards, where relevant.

4.3. Secure Operational Voltage Envelopes

4.3.1. In assessing whether there is sufficient capability to maintain voltages within the required limits following a Credible Contingency Event, AEMO may determine that, based on expected operating conditions, system voltages for a part of the SWIS must be maintained within certain boundaries (Secure Operational Voltage Envelope).

4.3.2. In making the assessment under paragraph 4.3.1, AEMO may consider factors including, but not limited to:

(a) expected dispatch outcomes;

(b) expected Network configuration;

(c) expected Planned and Forced Outages;

(d) whether Constraint Equations are binding as a result of Network voltages; and

(e) information from Network Operators.

E[I] Secure Operational Voltage Envelopes

Clause 3.1A allows AEMO to determine a Secure Operational Voltage Envelope within which a Network Operator must operate a part of its Network.

The process of voltage management requires coordination between generators and network equipment to adjust reactive power levels effectively. Often Network equipment is more static in nature (e.g., switched capacitor and reactors and transformer tap changers) whereas generation equipment provides for a more dynamic response.

While the maintenance of steady state voltages requires reactive power support from generators as well as from Network equipment, in general the Network should be operated such that the reactive output of a generator is not operating at close to the full extent of its allowable operating range in order to maintain steady state voltages. This ensures that there is sufficient dynamic capability remaining to cater for the next Credible Contingency Event, and ensure voltages remain within limits.

The specification of a Secure Operational Voltage Envelope for a Network Operator can assist in ensuring that the network is operated in a way to allow generators to maintain some dynamic reactive range. However, this assessment requires knowledge of the generators that are likely to be in service, what their likely outputs will be, and what the network configuration and reactive device availability will be.

AEMO may also specify a Secure Operational Voltage Envelope where it identifies that a Constraint Equation would otherwise be binding, and a more effective outcome is to ensure network voltages are within a certain range.

In addition, there may be some upper or lower limits that the Network Operator cannot go beyond in order to ensure that downstream distribution voltages remain within limits as well. Therefore, this assessment also needs to consider information from Network Operators.

4.4. Operating the SWIS according to the Technical Envelope applicable to each SWIS Operating State

E[J] Operating the SWIS

Paragraph 4.4 addresses the relevant obligations by classifying operation of the SWIS in real-time into two broad categories:

- monitoring and analysis of the SWIS in real-time; and
- operational planning activities (including in timeframes close to real-time).

E[J1] Real-time monitoring and operation

The requirements to monitor and analyse the SWIS in real-time are specified in the WEM Rules and paragraphs 4.4.1 and 4.4.2.

The SWIS in real-time is partially operated by Central Dispatch Process by AEMO, via Constraint Equations. These equations include both those implemented for the purpose of Essential System Services, and those in response to Network Constraints. Some of these processes are detailed in other WEM Procedures, and therefore only referred to in this Procedure.

In addition, AEMO, in coordination with other Rule Participants, makes adjustments to other elements of the SWIS such as reactive power and voltage levels, and Network configuration to ensure that the SWIS operates within limits and will continue to do so for the next Credible Contingency Event.

E[J2] Operational planning

In addition to monitoring in real-time, AEMO uses different planning mechanisms to avoid operation outside of the Technical Envelope. These include:

- Operational Power System Security assessment – estimating whether the SWIS is likely to remain operating within the Technical Envelope based on assumptions of future operating conditions;
- Outage planning – evaluating, and re-evaluating, Outages to determine if they can proceed while ensuring operation inside the Technical Envelope;
- Short Term PASA - assessing whether potential or likely variations in operating conditions in the short term may lead to operation outside of the Technical Envelope (based on expected market outcomes); and
- Medium Term PASA - assessing whether potential or likely variations in operating conditions in the medium term may lead to operation outside of the Technical Envelope (based on equipment availability).

AEMO may also apply operating margins to Equipment Limits in these processes to account for uncertainty of forecasts and models.

E[J3] Emergency Operating State

When the SWIS is in an Emergency Operating State, AEMO's objective of operating the SWIS is to return the SWIS from the Emergency Operating State as soon as practicable, while seeking to maintain operation within the Technical Envelope in Table 5 in the interim.

There are various conditions under which AMEO may declare an Emergency Operating Sate (refer to the WEM Procedure developed under clause 3.5.1A of the WEM Rules). Depending on the condition, AEMO may take any appropriate actions that are allowed under the WEM Rules to achieve the objective.

4.4.1. For the purposes of real-time operation of the SWIS, where AEMO's real-time monitoring systems are available, AEMO must use those systems to:

(a) monitor for violations of the Technical Envelope, including Equipment Limits as specified in Table 5, Table 6 and Table 7; and

(b) monitor for potential violations of the Technical Envelope following a Credible Contingency Event, taking into account the priority order for Equipment Limits specified in Table 5, Table 6 and Table 7.

4.4.2. Where AEMO's real-time monitoring systems are not available, AEMO may use assumptions about the expected operation of the SWIS based on previously received information, or direct Rule Participants to provide information about current or future operation of their Facilities or Networks and may use worst-case assumptions of Credible Contingency Events to support an assessment of potential violations of Equipment Limits.

4.4.3. For the purposes of operational planning of the SWIS, including when conducting Outage Evaluations and PASA assessments, AEMO must determine whether there will be:

(a) potential violations of the Technical Envelope, including Equipment Limits as specified in Table 5, Table 6 and Table 7; or

(b) potential violations of the Technical Envelope following a Credible Contingency Event, taking into account the priority order for Equipment Limits specified in Table 5, Table 6 and Table 7.

4.4.4. In order to determine whether the SWIS is or will be in a Secure Operating State, AEMO must consider:

(a) whether the SWIS is or will be operating outside of the Technical Envelope for the Secure Operating State as described in Table 5 following the occurrence of a Credible Contingency Event; and

(b) whether actions can be taken within 30 minutes to return to operating within that Technical Envelope following the Credible Contingency Event occurring.

4.4.5. In making a determination under paragraph 4.4.4, AEMO may allow for uncertainty such as imperfect predictability of future operating states and errors in computer models, forecasts and measurements, through the use of mechanisms, including but not limited to:

(a) applying Operating Margins in Constraint Equations under clause 2.27A.10(b)(i) and in accordance with the WEM Procedure: Constraint Formulation;

(b) applying planning margins when conducting operational planning studies;

(c) applying warning margins when monitoring real-time Network Thermal Limits;

(d) modelling different operating scenarios based on expected variations to operating conditions; and

(e) modelling worst-case expected operating conditions in offline power system analysis to determine operating limits where real-time monitoring data is not available.

4.4.6. In making a determination under paragraph 4.4.4, AEMO may make assumptions about the expected or likely operation of the SWIS, including but not limited to:

(a) Energy Producing System Injection patterns and availability;

(b) Essential System Service requirements and provision;

(c) Contingency Events that are likely to be re-classified as Credible Contingency Events;

(d) voltage and reactive power levels;

(e) Network configuration and availability of Network elements; and

(f) potential Island conditions.

E[K] Assessments close to real-time

Where AEMO conducts operational planning assessments that are relatively close to real-time, snapshots of current real-time conditions or previous days with similar conditions can be used as a starting point to develop these assumptions.

4.4.7. Where AEMO determines under paragraph 4.4.1, 4.4.2 or 4.4.3 that the SWIS is not, or will not be, operating within the Technical Envelope applicable for the SWIS Operating State, including as a result of a Credible Contingency Event, AEMO must act to maintain or restore operation within the Technical Envelope, which may include, but is not limited to, actions such as:

(a) applying or removing Constraint Equations to the Dispatch Algorithm as part of the Central Dispatch Process, including utilising Alternative Network Constraint Equations where Fully Co-optimised Network Constraint Equations are determined to be insufficient;

(b) requesting updated equipment ratings from a Network Operator, including Revised Ratings, Short-Time Ratings or Emergency Ratings;

(c) determining or revising a Secure Operational Voltage Envelope;

(d) directing a Network Operator to re-configure its network, or to operate its equipment in a particular way, for example:

  (i) a reactive device to be placed into or out of service;

  (ii) adjusting the reactive power output of a device; or

  (iii) creating an open point on the Network;

(e) directing a Market Participant to operate its Facility in a particular way, for example:

  (i) adjusting or limiting the active power output of a component of the Facility;

  (ii) adjusting the reactive power output of a component of the Facility;

  (iii) a component of the Facility to be placed into or out of service; or

  (iv) operating a component of the Facility in a different mode;

(f) rejecting an Outage;

(g) recalling an Outage;

(h) directing a Network Operator to shed Load; and

(i) directing a Network Operator to disconnect a Facility from its Network.

4.4.8. In selecting the appropriate actions to take to address a given issue under paragraph 4.4.7, AEMO may prioritise appropriate actions for a given issue, that minimise the disruption to the power system.

E[L] Actions to maintain or restore operation within the Technical Envelope

In selecting the appropriate actions to take to address a given issue, the actions that result in disruption to the power system, from low to high, typically follow this order:

- the use of existing Constraint Sets from the Constraints Library;
- seeking Revised Ratings from Rule Participants;
- directing a Network Operator to reconfigure the Network, adjust system voltages or operation of equipment;
- rejecting an unapproved Outage; and
- use of Alternative Network Constraint Equations,

ahead of utilising more disruptive measures such as rejecting approved Outages, recalling Outages that have commenced, or disconnecting Load or equipment.

4.4.9. In determining actions necessary to maintain or restore the Technical Envelope under paragraph 4.4.7, AEMO may coordinate with a Network Operator to develop a plan in accordance with clause 3.2A.

E[M] Development of a plan with a Network Operator

Clause 3.2A allows AEMO to coordinate with a Network Operator to develop a plan to manage Power System Security and Power System Reliability. In the context of this Procedure, it is envisaged that this could entail activities such as:

- plans for shedding or restoring Load in various stages;
- adjustment of system voltages;
- different ways of operating network equipment; and
- other supporting activities that the Network Operator may be able to take based on available mechanisms at their disposal.

4.4.10. In addition, AEMO may support the process specified in paragraphs 4.4.1, 4.4.2 or 4.4.3 by:

(a) reviewing Non-Thermal Limit Advice in accordance with the WEM Procedure: Limit Advice Requirements;

(b) where Limit Advice have not been provided by a Network Operator, where applicable, confirming that Non-Co-Optimised Essential System Services are in place to manage a Network Constraint;

(c) undertaking a general review of Constraints Equations in accordance with the WEM Procedure: Limit Advice Requirements.

(d) undertaking post-dispatch outcome analysis, including statistical analysis to establish the possible margin of error, which may include the Operating Margin in the Constraint Equations;

(e) publishing the annual report under clause 2.27B.6;

(f) undertaking general offline power system analysis in accordance with paragraph 6, to establish the Power System Stability margin, including the margin required to account for uncertainty in the analysis; and

(g) power system incident investigation, undertaken under clause 3.8.1.

5. Inertia Requirement Determination

5.1.1. Where a Planned Outage or Separation Event has the potential to create an Island, AEMO may determine the Inertia Requirements for the operation of the Island based on the following:

(a) an assessment of Frequency Stability in the Island, considering factors including but not limited to:

(i) available Inertia from each Energy Producing System in the Island when in-service;

(ii) the potential load demand in the Island;

(iii) load relief;

(iv) the worst-case single Credible Contingency Event in the Island;

(v) available headroom of any relevant Energy Producing Systems in the Island that are capable of responding to a frequency event;

(vi) potential load shedding within an Island; and

(vii) any applicable margins as deemed appropriate by AEMO; and

(b) AEMO may undertake periodic reviews to determine the appropriateness of the input assumptions based on recorded SCADA and High Resolution Time-Synchronised Data.

5.1.2. AEMO may determine the Inertia Requirements for an Island under paragraph 5.1.1 based on an assessment in real-time, a set of offline power system analysis undertaken periodically, or both.

5.1.3. Where the Inertia Requirements are determined via a real-time assessment, AEMO may:

(a) base the assessment on the next worst-case single Credible Contingency Event within the Island; and

(b) identify a list of actions to be undertaken in order to maintain Frequency of the Island to within the Frequency Operating Standards.

5.1.4. Where the Inertia Requirements are determined via offline power system analysis, AEMO may:

(a) undertake the studies based on a set of power system conditions that give rise to the worst-case Inertia Requirements; and

(b) identify a list of actions to be undertaken in order to maintain the Island to within the Frequency Operating Standards.

5.1.5. AEMO may assess the Inertia Requirements of an Island prior to approving an Outage Plan where that Outage will result in the formation of the Island and may reject the Outage Plan if there is a potential shortfall in the Inertia Requirements, in accordance with the WEM Procedure: Outages.

5.1.6. In identifying a list of actions to be undertaken under paragraph 5.1.3(b) or 5.1.4(b), AEMO must take into consideration the following:

(a) using reasonable endeavours to maintain the Island to the Frequency Operating Standards, as required under clause 3B.1.1;

(b) incorporating any appropriate delays to minimise the potential for over-reaction to sporadic incidents;

(c) considering the Inertia of each available Energy Producing System in determining which Energy Producing System to synchronise and the order of synchronisation;

(d) available demand in the Island to support the stable operation of each Energy Producing System;

(e) the output of each Energy Producing System in relation to the impact on frequency in the Island if it were to fail; and

(f) where and how the Island will be re-synchronised to the SWIS.

6. Power System Stability Assessment and Maintenance

E[N] Power System Stability in the SWIS

E[N1] Power System Security and Power System Stability

Clause 3.2.7(e) requires AEMO to specify "the process to be followed by AEMO to assess and maintain Power System Stability, including System Strength".

Power System Security and Power System Stability have the meanings given in Chapter 11 of the WEM Rules as follows:

- Power System Security: Means the safe scheduling, operation and control of the SWIS in accordance with the Power System Security Principles.
- Power System Stability: Means when the SWIS will return to an acceptable steady-state operating condition following a disturbance.

The Power System Security Principles are described further in clause 3.4.3 of the WEM Rules, which includes: "sufficient capability should be maintained at applicable locations in the SWIS to meet the applicable Power System Stability Requirements, including any System Strength Requirements". Power System Stability Requirements are defined in the WEM Rules as "the requirements identified to maintain Power System Stability, as determined by the processes specified in the WEM Procedure referred to in clause 3.2.7 [this Procedure]".

A power system that is unstable may not always be insecure. The following examples illustrate how Power System Security and Power System Stability relate to one another:

- A power system may be identified as unstable immediately following a Credible Contingency Event. It is considered secure if AEMO intervenes and the power system is able to return to a Satisfactory Operating State within 30 minutes.
- A power system may be identified as unstable following a Contingency Event. It is considered secure if the event is a Non-Credible Contingency Event.

E[N2] Definitions and criteria

The terminology, classification and definition of Power System Stability are not consistent across the power industry. One of the most common technical references used in the power industry is "Definition and Classification of Power System Stability", published by the IEEE/CIGRE Joint Task Force on Stability Terms and Definitions in 2004. In Sections II and III of that document, Power System Stability is classified as follows, with each defined in detail in the document:

- rotor angle stability:
  - small-angle disturbance angle stability (short-term);
  - transient stability or large-disturbance rotor angle stability (short-term);
- frequency stability (short-term or long-term);
- voltage stability:
  - large-disturbance voltage stability (short term or long term);
  - small-disturbance voltage stability (short-term or long term).

The Technical Rules classify and define Power System Stability differently. The Technical Rules classify the following Power System Stability elements: transient rotor angle stability, oscillatory rotor angle stability, and voltage stability (short term, temporary over-voltages and long term).

Maintaining Frequency Stability is not a direct obligation of a Network Operator. It is therefore not described in the Technical Rules.

To ensure consistent understanding of Power System Stability in the WEM, and where a definition is not given in the WEM Rules, AEMO has adopted the definitions and criteria provided in the Technical Rules (refer to paragraph 6.1.4).

In addition, to meet the definition of Power System Stability in the WEM Rules in full, AEMO has included Thermal Stability, Frequency Stability and System Strength (as required under clause 3.2.7(e)) in Paragraph 6.1.2.

6.1.1. In assessing and maintaining Power System Stability, AEMO must:

(a) include an assessment of the types of Power System Stability specified in paragraph 6.1.2;

(b) define the criteria for determining whether each type of Power System Stability specified in paragraph 6.1.2 is stable in accordance with paragraph 6.1.4; and

(c) where an offline power system analysis is undertaken, follow the principles in paragraph 6.1.7.

6.1.2. AEMO must assess and maintain the following types of Power System Stability:

(a) Thermal Stability;

(b) Transient Stability;

(c) Oscillatory Stability;

(d) Voltage Stability, excluding:

(i) voltage step change;

(ii) voltage harmonics;

(iii) voltage flicker; and

(iv) negative phase sequence voltages;

(e) Frequency Stability; and

(f) System Strength.

6.1.3. AEMO may include an assessment of the following requirements, if AEMO determines that violation of such requirements would result in disconnection or failure of a Network element or generating system:

(a) fault level requirements;

(b) voltage step requirements; or

(c) any other relevant requirements.

6.1.4. AEMO must use the following principles when determining the criteria for each type of Power System Stability:

(a) adopt the definition or the criteria where they are prescribed in the WEM Rules or Technical Rules;

(b) where the definition or the criteria in the WEM Rules and Technical Rules are not consistent, use the WEM Rules in priority to the Technical Rules, unless otherwise agreed by AEMO and a Network Operator;

(c) where not prescribed in the WEM Rules or Technical Rules, identify a definition or a criteria from another relevant jurisdiction or industry standard.

6.1.5. AEMO must publish the definition or the criteria for different types of Power System Stability determined under paragraphs 6.1.4(b) and 6.1.4(c) in a guideline on the WEM Website.

E[O] Online vs offline power system analysis

E[O1] Online analysis

In this Procedure, the online analysis refers to real-time or close to real-time analysis undertaken using online system operational tools in AEMO's control room. The real-time analysis generally includes but is not limited to thermal overload and steady-state voltage analysis. The types of analysis are generally limited by the requirement to have an outcome in real-time continuously and comparatively long simulation speed to assess certain forms of Power System Stability.

Online analysis is often complemented by offline analysis, which can be undertaken ahead of time or retrospectively.

E[O2] Offline analysis

The offline analysis refers to any non real-time analysis undertaken by AEMO for a range of purposes, which include system planning, Outage assessment, general review and power system incident investigation. The offline analysis to be undertaken are generally determined by the Power System Stability to study. For example:

- for steady-state voltage assessment, load flow analysis may be performed;
- for short-term Voltage Stability, Transient Stability and Oscillatory Stability, where only fundamental frequency is concerned, root mean square (RMS) analysis may be performed; and
- for transient performance at system frequencies other than the fundamental frequency, and where information such as instantaneous values of voltage and current are necessary, electromagnetic (EMT) analysis may be performed.

The computer models used to represent the Network, generation systems, Loads and any components of the power system generally vary in the level of detail for each type of analysis. For example, the generation system models used in EMT analysis (EMT models) are typically more complex and describe the performance of the generation system in greater detail than those used in RMS analysis and load flow analysis. Note that increase in complexity of the models often increases the simulation speed, and in some cases, may not necessarily provide a more accurate outcome.

It is also possible to undertake hybrid assessments to study a Power System Stability. For instance, in an EMT analysis, a power system may be largely represented by RMS models, with a small number of critical generating system models represented by EMT models. This is to provide confidence in the outcome of the assessment, without slowing the simulation speed significantly.

In addition, the types of offline analysis may determine the specific offline power system analysis tools that must be utilised. AEMO uses a number of commercially available analysis tools for different types of offline analysis.

6.1.6. AEMO may undertake an offline Power System Stability analysis when:

(a) undertaking an Outage assessment for an Outage Plan;

(b) assessing a Limit Advice in accordance with paragraph 4 of the WEM Procedure: Limit Advice Requirements;

(c) undertaking a general review of the constraint Equations in accordance with paragraph 5 of the WEM Procedure: Limit Advice Requirements;

(d) investigating a power system incident in accordance with clause 3.8;

(e) undertaking any other assessment of SWIS that does not require real-time outcomes, or cannot be performed using online operational tools.

6.1.7. AEMO must use the following principles in undertaking an offline Power System Stability analysis, where applicable to the type of the analysis:

(a) utilise information in Network computer models (provided by a Network Operator in accordance with the WEM Procedure: Network Modelling Data) that are appropriate for the type of offline power system analysis, including:

(i) computer models that represent the Network equipment appropriately;

(ii) Load models, including where required:

(A) if available, Load models that display appropriate voltage-dependent power behaviour; and

(B) if available, Load models that display appropriate dynamic response of the Distributed Energy Resources;

(b) utilise Energy Producing System models that are appropriate for the type of offline Power System Stability analysis, and where the performance of these Facilities is observed to be inconsistent with their actual performance, use data or models in the following order:

(i) where available and AEMO has deemed the data to be valid, SCADA data or High Resolution Time-Synchronised Data;

(ii) generation system models provided by a Rule Participant under Appendix 12.17 of the WEM Rules;

(iii) Energy Producing System models provided by Network Operator under clause 2.28.3A; and

(iv) in the absence of the computer models in paragraph 6.1.7(i) and 6.1.7(iii), computer models that in AEMO's reasonable opinion, represent the generation system appropriately;

(c) utilise relevant supporting information, including any information provided as part of Registered Generator Performance Standards, to support the use of appropriate models in paragraphs 6.1.7(a) and 6.1.7(b);

(d) utilise appropriate power system analysis tool or functions within the tool;

(e) utilise relevant Network operation information, including where required:

(i) Network Reinforcement Schemes, including:

(A) settings related to the activation of the Network Reinforcement Schemes; and

(B) intended actions of the Network Reinforcement Schemes, including applicable inter-tripping of a transmission circuit and automatic shedding of a Load;

(ii) protection settings for Network equipment, including total fault clearance times for Network equipment under a fault; or

(iii) information specified in any Network Operating Guidelines;

(f) use its reasonable endeavour to identify the most onerous power system conditions and Contingency Events, for the class of Power System Stability and the location of SWIS under assessment, to the extent that they respect:

(i) the Equipment Limits provided by Rule Participants in accordance with paragraph 2;

(ii) any operational arrangement and requirements agreed between AEMO and the Rule Participants; or

(iii) any other applicable information provided by the Rule Participants;

(g) where required, in order to support the identification process in paragraph 6.1.7(f):

(i) utilise historical actual power system conditions, including but not limited to:

(A) those recorded by AEMO; or

(B) those identified from activities undertaken under clause 2.27B.6 of the WEM Rules and paragraph 5 of WEM Procedure: Limit Advice Requirements;

(ii) calibrate data where necessary to produce credible power system conditions in paragraph 6.1.7(f); and

(h) Where required, in order to account for uncertainties in the outcome of an assessment:

(i) undertake sensitivity assessment of the factors that may have an impact on the outcome of the assessment; or

(ii) include an appropriate margin.

6.1.8. AEMO must use reasonable endeavours to maintain and update its power system models to ensure consistency between simulated performance and actual SWIS performance, to the extent that performance can be compared.

Appendix A. Relevant clauses of the WEM Rules

Table 8 details:

(a) the head of power clauses in the WEM Rules under which the Procedure has been developed; and

(b) each clause in the WEM Rules requiring an obligation, process or requirement be documented in a WEM Procedure, where the obligation, process or requirement has been documented in this Procedure.

Table 8 Relevant clauses of the WEM Rules

Clause
3.2.7